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# ENGLISH MECHANIC

AND

# WORLD OF SCIENCE.

WITH WHICH ARE INCORPORATED

"THE MECHANIC," "SCIENTIFIC OPINION," AND "THE BRITISH & FOREIGN MECHANIC."

ILLUSTRATED WITH NUMEROUS PRACTICAL ENGRAVINGS.

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THE ENGLISH MECHANIC

AND WORLD OF SCIENCE.

## NATURAL GAS AND GASEOUS FUEL.

THE utilisation of natural gas and the production of gaseous fuel are two matters which, just at the present time, are attracting a great deal of attention—the one in the United States, the other in Germany. Gaseous fuel is comparatively an old subject; but the utilisation of natural gas has been revived by the fact that large quantities of it are about to be laid on to the town of Pittsburgh, which has an unenviable reputation for soot and smoke throughout the whole of the vast continent of North America. The inhabitants may be a little too sanguine as to the future, but there can be no doubt that if the supply shows no signs of abating, natural gas will be used very extensively in Pittsburgh, perhaps to the complete exclusion of coal. Gaseous fuel, which in this connection means principally water gas, is attracting much attention at Essen, and the success which has there followed the attempts to manufacture and store it, has resuscitated the old schemes for supplying Berlin with gaseous fuel from lignite mines about 30 miles distant from the city. The opinions which the late Sir W. Siemens held on the subject of converting coal into gas, and supplying that to householders, instead of the soot-producing mineral, are well known, and have been set forth in our back volumes; but he did not contemplate forcing the gas at high pressures through long lengths of piping. It is well understood that in the case of a town situated near a coal-mine, it would be much more economical to convert the coal into gas at the mine than to cart the mineral into the town and waste seven-tenths of its potential heat, while at the same time polluting the atmosphere, and now that the Americans are about to show us how to convey their natural gas into a town, something may possibly be attempted in this country—at least by the method suggested by Sir W. Siemens. Natural gas has been used in Pittsburgh for some time now in several mills and glassworks: in one mill it has been employed for nine years, latterly doing all the work at times, until some of the wells failed, and coal had to be resorted to while fresh wells were bored. The number of companies chartered in Pennsylvania to supply natural gas was up to February, 1884, no fewer than 150; but since that date a very large number of new charters have been granted, and the utilisation of the gas is proceeding apace. Next to hydrogen, natural gas is the most powerful of gaseous fuels, and one of the most economical, while it is especially adapted for many purposes because it is free from sulphur and other deleterious elements. Invariably of a more or less complex character, and varying in composition with different localities, the natural gas of Western Pennsylvania belongs to the paraffin series of hydrocarbons. In Butler County, Pa., one well yields a gas having the following composition:—Hydrogen 6·10, marsh gas 75·44, ethane 18·12, carbonic acid 0·34; while another well, comparatively near it, yields a gas consisting of hydrogen 13·50, marsh gas 80·11, ethane 5·72, and carbonic acid 0·66. In another county a natural gas is obtained which has the high percentage of 22·50 for hydrogen, with marsh gas 60·27, ethane 6·80, carbonic acid 2·28, nitrogen 7·32, and oxygen 0·83. Wells in New York State, Virginia, Canada, and other parts of North America yield a gas which is almost entirely composed of methane, light carburetted hydrogen, or marsh gas, as it is commonly called, which may be said to be composed of one-quarter hydrogen, three-quarters carbon; while some others yield a gas which is mainly propane, having the approximate composition of hydrogen 18, carbon 82. These figures will serve to show that the natural gas varies in composition with locality; but the differences are not so great as to call for any special devices in utilising the gas; and any furnace which will burn one variety will yield good results with others, the only alterations being in connection with the air supply, and as a rule that is amply provided for. Amongst those who have had most experience with the gas wells, it is the general opinion that the outflow is subject to a gradual diminution, tending to ultimate extinction, but while in some cases wells have been used up in a few years, there are others which have never failed to yield an enormous quantity of gas, as, for instance, in West Virginia, where wells have been burning for more than a quarter of a century. The pumping of oil has some effect on the yield of gas, but it is thought probable that in the majority of cases the diminution is due rather to a choking-up of the vents by deposits of salts or paraffin, than to any failure of the original source, for the lower sand rocks of the oil regions are evidently flowing with petroleum, the more volatile constituents of which are obviously in a state of compression and escape as gas when released by a bore hole. The temperature of the gas as it issues freely from the mouth of a well never exceeds 45 degs. Fahr., while its pressure when escaping freely has not in any case been found equal to 2lb. on the square inch. The low temperature is explained by the assumption that the gas undergoes very considerable expansion as it reaches the mouth of the well—an assumption which is probably correct, for blocks of ice are often seen to be thrown from the stand pipes while the gas is burning. In the mains laid in Pittsburgh the gas has a temperature of 45 degs. Fahr., but its velocity varies with the amount of friction in the pipes. Experiments made by a committee appointed to investigate the subject on behalf of the Engineers' Society of Western Pennsylvania shows that from a well indicating a normal pressure of 3½oz., gas occupied 4¼ minutes in traversing 16,000ft. of pipe, the pressure at the well increasing to 15lb. in consequence of the resistance due to friction. With an initial pressure of 90lb. per square inch the gas occupied 2¼ minutes in traversing the 16,000ft. of piping. In another case gas from a well having a normal pressure of 20oz. travelled with a velocity of 23,400ft. per minute, while a rubber ball was driven through three miles of 5⅝in. pipe in 2½ minutes. The more durable of the wells in existence did not tap the gas-bearing strata until a depth of more than a thousand feet had been reached, and the famous Murraysville well, which supplies the gas used in the Edgar Thompson Steel Works, has a bore-hole 1,337ft. deep. Not much has been done at present in utilising the natural gas in smelting furnaces, but it has been extensively employed in iron and steel mills, glass factories, salt works, and paper and other mills. As would be expected, however, few of those who use the gas obtain the best possible results, as they consume it in a very crude manner; but it is used with great economy in those cases where it is employed in the Siemens regenerative furnace. The committee above named made an experiment to test the economy of the gas as compared with coal for generating steam. They employed a tubular boiler 10ft. long, 3ft. 6in. in diameter, with 4in. tubes, and with selected coal evaporated only nine pounds of water per pound of fuel, although the water was passed through a heater placed in the flue. The temperature of the water before entering the heater was not less than

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60° Fahr. The same boiler, when heated by natural gas, gave an evaporative efficiency of 20·31lb. of water per pound of gas, which was taken to be 23·5 cubic feet. A similar result was obtained when nearly all the tubes were plugged, but the gas required much more air than the coal to accomplish complete combustion. It is noteworthy that the best results were obtained when the products of combustion contained considerable percentages of carbonic oxide, and with the boiler in question it was found that the increased quantity of air required to effect the almost complete conversion of carbonic oxide into the dioxide reduced the economical result. A sample of combustion products taken from the flue of a boiler doing regular work, yielded nitrogen 85·88, carbonic acid 6·16, and oxygen 7·96, although more than usual care was taken in this case in regulating the draught. Improved furnaces and burners are now being introduced; but in consequence of the companies having made contracts to deliver gas at rates a trifle less than the cost of coal, in order to induce manufacturers to make a change, there is still much preventible waste. The natural gas brought into Pittsburgh burns slowly when mixed with air in the proportion of 1 to 6, rapidly with 8 volumes, explosively with 9; but it is only with 10 volumes of air that the true exploding mixture is obtained. With 12 volumes of air to 1 of gas, the mixture burns somewhat explosively, and with 13½ it burns quietly. So far very little has been done in using the gas for illuminating purposes, as it cannot be permanently charged with the vapours of the heavy hydrocarbons and stored in tanks. That difficulty can, however, be overcome by placing the charging apparatus near the burner, and consuming the gas before it has time to separate into strata of different composition. There are other reasons, however, which militate against any general use of the natural gas for illuminating purposes, and the most important of those is the enormous pressure in the mains. At the wells the gas has a pressure of 75 to 100lb. per square inch, and that must be reduced to about 5in. of water in the street pipes which deliver the gas to the mills. For that purpose regulating valves are employed; but they are not satisfactory, and tank governors similar in principle to the familiar gas-holders are being adopted. The best wrought-iron pipes must be used, and all fittings in houses must be of first quality, cast iron being inadmissible, even for mains. The natural gas, especially that which issues from wells having a pressure of 1lb. and upwards when the gas is allowed free escape, carries with it minute quantities of heavy and solid hydrocarbons, and these, under the influence of the high pressures necessary to force the gas along many miles of pipes, are frequently deposited in the street mains. A peculiar substance resembling butter is often taken from the mains conveying the Murraysville gas to Pittsburgh. A sample on analysis was found to be composed mainly of solid paraffin blown into a sort of light froth, and holding in its pores common salt, water, small quantities of lime and magnesia salts, and even coarse sand. As to the price of the gas when supplied to private houses for heating purposes, the average for some time was 50 cents per 1,000 cubic feet, but latterly one company has reduced the charge to 12½ cents, at which price it is cheaper than coal. A few years ago, so little was thought of natural gas, that oil prospectors considered themselves very unlucky if, after the expenditure of time and capital in boring, they struck gas instead of petroleum; but the latest news from the gas region is that several of the companies are about to consolidate and lay gas mains to Philadelphia, New York, and other cities. The cost of laying so many miles of pipeline will, however, be heavy, and it is doubtful if the natural gas of Pennsylvania can compete with ordinary unpurified coal-gas, or with the water-gas which is now being made in large quantities. Of late, too, the demand for the natural gas has enormously increased in Pittsburgh, and the field of its usefulness is gradually extending, for, to mention only two instances, it is now employed to extract grease and oil and cleanse delicate fabrics, which it does readily while under pressure, and it is also used for manufacturing electric-light carbons, for when imperfectly burned at a high temperature, it deposits carbon of remarkable density. So much attention being paid to the utilisation of a natural gas will assuredly lead to renewed attempts to gasify the solid fuels, and it is not improbable that before the century expires gas will be the principal form in which fuel will be used in the more go-ahead cities of the United States.

## SIMPLE EXERCISES IN TECHNICAL ANALYSIS.—V.

By An Analytical Chemist.

### Venetian Red Paint.

51. THIS is a red ochre found in Italy. "Antwerp red" and "terra rosa" are similar ochres. The former is imported from Flanders, the latter from Italy. The following is the composition of a few samples of

Venetian Red Paints.

| | (1) | (2) | (3) |
|---|---|---|---|
| Oil | 17·24 | 17·35 | (Dry) |
| Insoluble silicates | 22·40 | 5·35 | 17·9 |
| Oxide of iron ($Fe_2O_3$) | 36·56 | 56·6 | 39·0 |
| Chalk | 23·80 | 20·7 | 43·1 |
| | 100·00 | 100·00 | 100·0 |

52. *Note.*—A natural ochre should not contain *sulphate of baryta*, so that whenever this salt is found in the insoluble, the sample is probably an imitation. The following is the result of the analysis of an

Imitation Venetian Red.

| | |
|---|---|
| Oil | 17·5 |
| Sulphate of baryta | 24·8 |
| Oxide of iron | 25·9 |
| Chalk | 31·8 |
| | 100·0 |

### Chinese Red Paint.

53. This is also known in commerce by the names of "gold yellow" and "orange paste." The following is the composition of some samples of

Chinese Red Paint.

| | (1) | (2) | (3) |
|---|---|---|---|
| Oil | 11·62 | 10·7 | 13·4 |
| Basic chromate of lead | 89·38 | 89·3 | 86·6 |

54.—*Basic Chromate of Lead. Estimation.*—(*a*) Precipitate the lead as described in Art. 11; multiply the sulphate found by 1·401 for the amount of basic chromate of lead ($Cr_2Pb_3O_9$). (Another basic chromate having the formula $Cr_2Pb_4O_5$ is known.)

(*b*) To insure accuracy, it is always advisable to estimate the chromium in the sample by the method described in Art. 46.

From the amount of chromium thus found, the percentage of basic chromate of lead can be calculated.

55.—In practice, except when adulteration is suspected, it is usual to burn off the oil, and to test the residue qualitatively. If no substances other than lead and chromium are found, and if the colour of the paint is satisfactory, qualitative testing is usually sufficient; but it must be remembered that it is by no means conclusive. Sulphate of lead, and the chromates of calcium, barium, and aluminum should be looked for, as these are occasionally added in order to vary the hue and tone of the sample.

### Turkey Red Paint.

56. This is a very pure oxide of iron. The amount of water does not exceed 0·5 per cent. Traces of silica and lime may also be found, even in pure samples. The amount of oxide of iron should not be less than 99 per cent.

The following is the composition of an imitation sample :—

Turkey Red Paint (Imitation).

| | |
|---|---|
| Oxide of iron ($F_2O_3$) | 65 |
| Sulphate of baryta | 30 |
| Chalk and water | 5 |
| | 100 |

### Indian Red Paint.

57. The colouring matter used in this paint is very different from what might be expected. True Indian red is a vegetable colour prepared from sandalwood; the colouring matter in this paint is a pure oxide of iron.

### Blue Paints—Common Blue.

58. The following is the composition of a few few samples of

Common Blue Paint.

| | (1) | (2) | (3) |
|---|---|---|---|
| Oil | 13·95 | 14·9 | 14·5 |
| Sulphate of baryta | 44·50 | 60·0 | 77·6 |
| Prussian blue | 8·05 | 7·1 | 7·9 |
| Chalk | 33·50 | 18·0 | — |
| | 100·00 | 100·0 | 100·0 |

59. — *Prussian Blue* (*Estimation of*). — Prussian blue being an organic colouring matter (formula $K_4Fe(CN)_6$), is destroyed at the same time that the oil is burnt off, and converted into $Fe_2O_3$. Its determination is, however, seldom attended with difficulty. It loses, on ignition, 52·71 per cent. of its weight. When, therefore, the oil in a Prussian blue paint is determined as described in Art. 10. the total loss must be diminished by the loss due to the ignition of the Prussian blue. The proportion of Prussian blue in the sample is calculated from the amount of oxide of iron ($Fe_2O_3$) found, as described in Art. 34. Multiplying the amount of $Fe_2O_3$ by 2·1142, gives the equivalent of Prussian blue. Now, from the total amount of Prussian blue subtract the amount of $Fe_2O_3$ found, the difference is the loss on ignition due to the Prussian blue, take this loss from the total loss on ignition, the remainder is the loss due to the oil. An example will make this clear. Suppose the "total loss on ignition" to be 20 grains, and that 3gr. of $Fe_2O_3$ are found by weighing as directed; $3 \times 2{\cdot}1142 = 6{\cdot}3426$gr. = Prussian blue; and $6{\cdot}34 - 3 = 3{\cdot}34$ = loss due to ignition of the Prussian blue; therefore, $20 - 3{\cdot}34 = 16{\cdot}66$ = loss due to the oil alone.

60. If the paint should contain ferruginous earths, this method could not be employed, for the oxide of iron in the earth would not be distinguished from the oxide of iron left by the ignition of the Prussian blue. We have, however, never met with a Prussian blue paint containing such earths, and, as the amount of Prussian blue seldom exceeds 8 per cent. in such paints (equivalent to about 3½ per cent. of oxide of iron), their presence would be readily indicated by an increase in the percentage of oxide of iron.

### Celestial Blue Paint.

61. Composition:

| | (1) | (2) | (3) |
|---|---|---|---|
| Prussian blue | 5.30 | 6·57 | 5·33 |
| Sulphate of baryta | 92·24 | 92·36 | 90·40 |
| Chalk | 2·00 | | 3·56 |
| Moisture | ·46 | 1·07 | ·71 |
| | 100·00 | 100·00 | 100·00 |

62. The analytical processes are the same as for common blue paints. Being usually sold in the dry state, the amount of Prussian blue can be approximately determined by multiplying the loss on ignition, less the moisture, by 1·897.

### Metallic Blue Paint.

63. Composition:—

| (No. 1) | |
|---|---|
| Oil | 32·47 |
| White lead | 49·56 |
| Prussian blue | 17·97 |
| | 100·00 |

| (No. 2) | |
|---|---|
| Oil | 20·6 |
| Sulphate of Baryta and Oxide of Iron | 61·9 |
| Chalk | 1·8 |
| Ultramarine | 15·7 |
| | 100·0 |

64. No. 1 would be analysed as follows:—

(*a*) *Oil.*—Total loss on ignition less that due to ignition of Prussian blue as explained above.

(*b*) *White Lead.*—Dissolve the ash in dilute nitric acid, evaporate to a small bulk to expel the acid, add dilute sulphuric and alcohol, and weigh the sulphate of lead thus precipitated as in Art 7.

(*c*) *Prussian Blue.*—Boil off the alcohol from the filtrate, concentrate, add ammonia, and weigh the precipitate ($Fe_2O_3$), as in Art. 34. Multiply by 2·1142 for Prussian Blue. (Note.—The difference between the amounts of Prussian blue and oxide of iron to be subtracted from the "Total loss on ignition").

65. No. 2, in consequence of the presence of ultramarine, presents some difficulties. It was treated in this manner:—

(*a*) *Oil.*—Loss on ignition, 20·65 per cent.

(*b*) *Alumina, Silica, and Sulphate of Baryta.*—The residue was treated with hydrochloric acid, the insoluble was dried, and weighed 60·94 per cent.

This was found to contain a large quantity of sulphate of baryta, and it was then deemed advisable to take a fresh quantity.

(*c*) Took a weighed quantity of paint, ignited; treated ash with dilute hydrochloric acid in the cold; no iron dissolved; filtered; boiled the insoluble in carbonate of soda to dissolve silica and alumina; filtered the insoluble sulphate of baryta and oxide of iron; precipitated the alumina from the first filtrate (HCl solution); and estimated the chalk. No iron or zinc present in the filtrate.

(*d*) *Sulphate of Baryta and Oxide of Iron.*—Weighed the insoluble left on boiling in sodic carbonate. Amounted to 62·9 per cent. Fused this with carbonates of potash and soda to make sure that all the silica was removed; weighed a second time 63·02 per cent. Average of two experiments (*d*) and (*b*) = 61·98 per cent.

(*e*) *Chalk.*—Estimated in the acid solution in (*c*). Found 1·77 per cent.

(*f*.) *Ultramarine.*—Having ascertained the amount of all the substances present except those proper to ultramarine, this was here determined by difference. The direct determination of ultramarine is a matter of some difficulty. See below.

### China Blue Paint.

66.—*Composition:*—

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Oil ...... | 51·66 | 17·85 | 18·00 | 26·28 | 18·2 | 19·9 |
| White lead | 1·85 | — | 6·80 | — | — | — |
| Sulphate of baryta .. | — | 28·75 | 34·60 | 24·03 | 28·9 | 29·3 |
| Chalk .... | 1·60 | 23·30 | 20·85 | 2·68 | 21·8 | 21·2 |
| Ultramrne. | 44·73 | 28·80 | 18·20 | 28·04 | 31·1 | 29·6 |
| Oxide of iron .... | ·16 | 1·30 | 1·55 | — | — | — |
| Oxide of alumina & silica .... | — | — | — | 18·97 | — | — |
| | 100 | 100 | 100 | 100 | 100 | 100 |

67. It may truly be said that a mixed china blue paint is more difficult to analyse than any other paint. It will be observed that the composition varies considerably. We give, for the sake of clearness, the method employed in the analysis of No. 4 in the above group. The others are, if anything, simpler.

(*a*) *Total loss on ignition.*—Took 25 grains and ignited. Loss = 6·75gr. = 27·00 per cent.

(*b*) *Total insoluble.*—Treated with aqua regia and oxidised with nitric acid the whole of the sulphur, which separated. Weight when dried = 8·38gr. = 33·52 per cent.

(*c*) *Alumina and soluble Silica.*—Added potash to the filtrate; dried and weighed = 5·37gr. = 21·48 per cent.

Made acid, added ammonia till alkaline; a second precipitate of alumina, with a trace of oxide of iron, formed. Weight = 0·62gr. = 2·48 per cent.

Total alumina = 21·48 + 2·48 = 23·96 per cent.

(*d*) *Chalk.*—Precipitated as in Art. 8. Weight = 0·67gr. = 2·68 per cent.

(*e*) *Ultramarine.*—After separating the chalk and any soluble barium salts, if present, add chloride of barium to the filtrate. Weight of sulphate of barium thus formed = 5·19gr. = 20·76 per cent. 20·76 × ·6095 = 12·65 = per cent. of sulphate of soda corresponding to the sulphide and thiosulphate of soda in the ultramarine. A standard sample of ultramarine was found to contain 45·11 per cent. of sulphate of soda, or, rather, salts of soda, which, estimated as sulphate of soda, amounted to 45·11 per cent. The amount of ultramarine in the paint was, therefore, determined by the following proportion:—

45·11 : 12·64 : : 100 : 28·04 = ultramarine.

A standard sample of ultramarine, when similarly treated, gave the following results:—

| | Per cent. |
|---|---|
| Insoluble in aqua regia .......... | 37·07 |
| Sulphate of soda ................ | 45·11 |
| Alumina ......................... | 17·82 |

(The percentage of alumina is much lower than that usually found in ultramarine blue.)

Loss on ignition 2·6 per cent.

(*g*) Insoluble in paint due to ultramarine, therefore $\doteq \frac{28\cdot04 \times 37\cdot07}{100} = 10\cdot39$, and 33·52 (*b*) − 10·39 = 23·13 = insoluble sulphate of baryta.

(*h*) Loss on ignition due to ultramarine = 28·04 × ·026 = 0·729, and 27·00 (*a*) − 0·729 = 26·28 = loss due to oil.

(*i*) Alumina in ultramarine $= \frac{17\cdot82 \times 28\cdot04}{100} = 4\cdot99$, and 23·96 (*c*) − 4·99 = 18·97 = percentage of alumina and soluble silica.

The composition of ultramarine varies sensibly, and this adds to the difficulty in analysing a china blue paint.

When treating of blue pigments we shall have something more to say about ultramarine.

(*To be continued.*)

## NOTES ON THE CASSEGRAIN.

By Dr. Royston-Pigott, F.R.S.

THE extreme convenience of this form of telescope compared with the Newtonian, especially in very large instruments, renders it an instrument of great interest.

My 18¼ Cassegrain, made by Mr. Calver, presented peculiar features. The effective focus was 62ft.; the field lens of the eyepiece was 3in. in diameter. The field of view was as flat as a plane in appearance, and the light of the moon, spread over about 5in. in its last appearance at the aperture of the big mirror, was subdued to a most pleasant degree. In some of the craters of the moon we could see a great number of distinct terraces reaching downwards to a depth hitherto unseen by me and others. The appearance of Pico down to its base, though only half-illumined, was surprisingly fine. Jupiter appeared almost too brilliant for strong eyes; Saturn very bright. Mr. Calver made me no less than five convexes with appropriate slides for focussing, which, with three eyepieces, produced great variety in magnifying power.

The foci and positions of these convex mirrors were carefully calculated so as to throw the final image 15in. behind the mirror—a novel arrangement, which enabled me to receive the image on a plane mirror fixed upon a revolving elbow, and which always enabled one to choose the most convenient position for observation. This contrivance prevented all awkward positions.

Doubtless the most facile arrangement of all is that of the Nasmyth Altazimuth, where the observer sits in one position with the observing tube constantly horizontal; but this provides no Right Ascension or Declination circles, and the finding of an object invisible to the naked eye is a matter of great uncertainty.

The focus of large parabolic mirror 10ft. 10in., and this being 18¼in. diameter, gave a proportion of focus nearly seven times the diameter of mirror. There are several points in detail worthy of close consideration. To begin, for a parabolic concave there is no possibility of avoiding aberration, which produces ultimately in the eyepiece a blurred image, except by making the convex reflector of hyperbolic curvature, and there is no known method of testing this curvature except by innumerable alterations and refixings in the Cassegrain tube.

On the other hand, if the big mirror is adapted to be used as a Gregorian, then the convex reflector must be accurately elliptical; and this curvature can be exactly tested without the big mirror being brought into play at all. These elliptical convexes also can be readily executed so as to represent innumerable elliptical curves of revolution, and the powers of the Gregorian adjusted at will. There is some slight advantage in the image appearing erect. I am not aware that any silver-on-glass Gregorians have yet been made, but for land objects or night-glasses at sea they would do admirable service. You usually see the coastguard armed with a 3ft. telescope, with the aperture cut down to, perhaps, 1in. or 1¼in. Mr. Calver is making me a finder for my 18¼, consisting of a 6in. mirror of 24in. focus, and of superb definition. What could a coastguard station not discern with this at night? The light would be about twenty times as great as the Admiralty optical weapon.

(*To be continued.*)

## HOME-MADE ENGINE PATTERNS.

## II.

### The Bed,

SHOWN in plan in Fig. 6, in elevation in Fig 7, in cross section in Fig. 8, naturally claims our first attention as being the basis of our operations. We do not want a massive-looking bed for a small engine, and I have drawn a large flat ogee moulding to impart an air of lightness and elegance to its appearance. It will occur to some that the section looks uncommonly heavy. So it does, but this is one of those things to which I referred in my first paper, when speaking of the difficulty of maintaining uniform proportions between corresponding parts in large and small engines. In an engine of six or eight h.-p., we should make the bed in section like Fig. 9; but in this case it would not be worth our while to do so, since no advantage worth mentioning would be gained in economy of material. Cutting out like that would require the insertion of the rib A, else the bed would curve rounding on its face, so that all we could save would be the bit of metal marked B, therefore the shortest and best plan is to adopt the plain shape we have sketched.

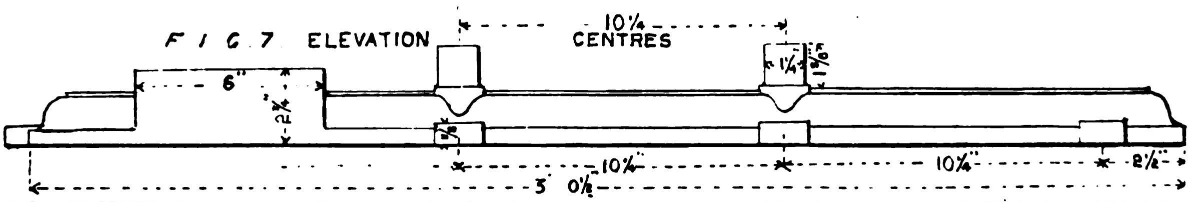
Again, the lugs for the hold-down bolts look somewhat out of proportion, and rather ungainly. But, while ¾in. hold-down bolts would be strong enough for an engine of six or eight times the power, we cannot have less than ⅝in. bolts in this, and, as the breaking off of a lug is an awkward thing, we give plenty of metal there, to avoid, if possible, that disaster.

As we go along, I shall not so much discuss the different ways in which our work may be done, as describe simply one method of doing it, guaranteeing, of course, that the patterns, if made to these instructions, will mould without causing any difficulty.

"Boxing-up," applicable to cored beds of a different section ("E. M.," Vol. XXXVII. p. 520), is not suitable in this case, where the inside of the pattern is wide enough to deliver itself freely. Nor, I apprehend, will it be necessary to give any rounding at all to the face, because, by thickening the metal at B, B (Fig. 8), we have counteracted the tendency of the plate to pull rounding when cooling. But with every precaution there is always some slight element of uncertainty associated with the "buckling," as it is called, of castings.

Now our way is cleared, and we can proceed accordingly. Looking at the bed in section (Fig. 8), we elect to have the flanged portion, C, C, made as a frame and fastened to the sides. Fig. 10 is intended to render the general construction clear. In the first place, then, we prepare two pieces (Figs. 8 and 10, B, B, B), 2ft. 9in. by $1\frac{3}{16}$in. by 1¼in., squared dimensions, and one piece 6½in. by $1\frac{3}{16}$in. by 1¼in. (which last piece, by the way, had better be worked in a length with one of the others, and cut off afterwards). One edge is planed $\frac{1}{16}$in. under square (for taper, Fig. 11), and the hollow of the ogee moulding is worked on the opposite edge. A mitre joint is cut at one end of each of the long pieces, and a similar joint at both ends of the short piece, which joints may then be glued and keyed, their further security being assisted by a few cross nails. Never trust to glued joints in moulders' patterns if nails or screws can be used. They are not like pieces of cabinet furniture, since in patterns mere appearance goes for little. Those who have seen patterns being "bedded in," or rapped, during withdrawal, will understand that this is not a needless caution. Let a couple of cross ribs (Fig. 10, *a*, *a*), ⅜in. thick, into rebated grooves, in positions indicated in Fig. 6, giving them also $\frac{1}{16}$in. of taper towards the back of the bed—*i.e.*, the face that lies on the foundation plate, and the uppermost face in moulding.

The semicircular end could be cut from one solid piece; but the chances are, in that case, that the pattern would become broken off accidentally



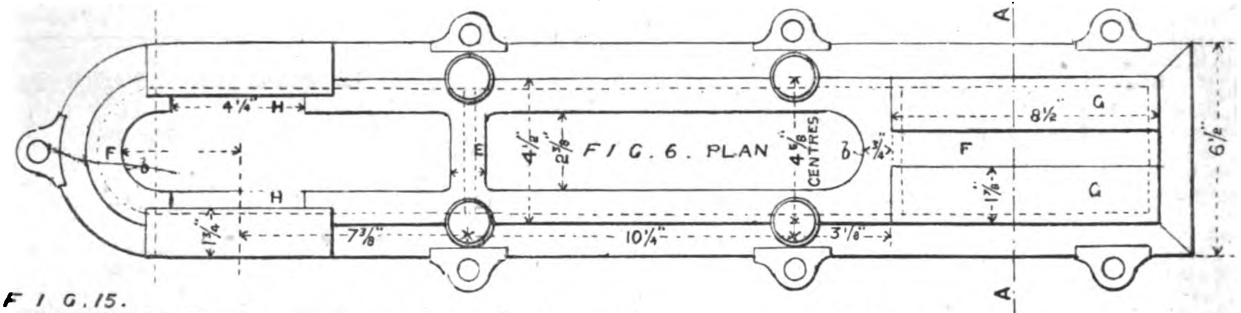
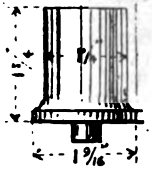


FIG. 15.

FIG. 14.



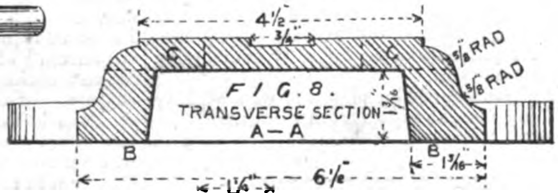


FIG. 9.

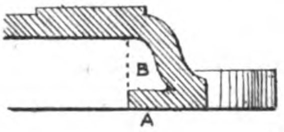
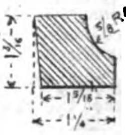


FIG. 11.



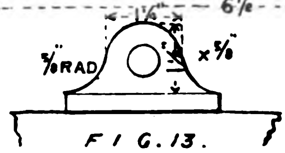


FIG. 13.

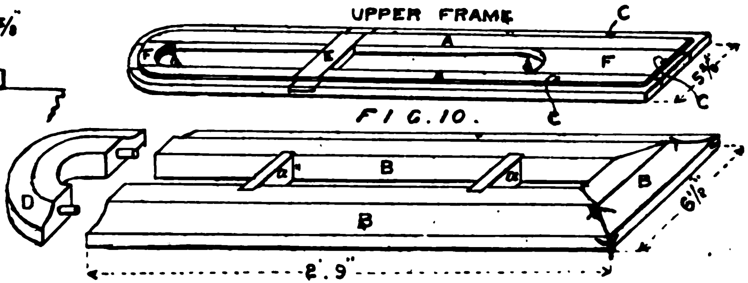


FIG. 10.

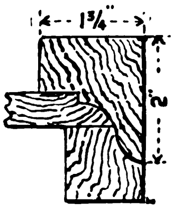


FIG. 17.

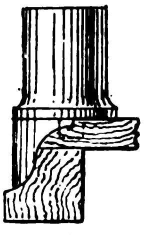


FIG. 17.

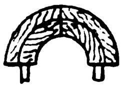


FIG. 12.

somewhere across the short grain. In a larger pattern we should glue this portion up in three or four rows of segments, as we should glue up a wheel ring (" E. M.," Vol. XXXVII. p. 143), but in this instance, two quarter circles glued together with a tight-fitting dowel (Fig. 12), will make a substantial job. The half-circle itself will be fastened against the ends of the straight pieces with tight-fitting dowels well glued (Fig 10, D). These should stand not less than ¾in. or 1in. away from the face. The lower frame is now complete.

For the upper frame we prepare two strips (Fig. 10, A, A), 2ft. 10½in. (2ft. 11in. in the rough) by 1⅜in. by $\frac{7}{16}$in.; fit in a cross bar, E, by half-lap jointing to dimensions (Fig. 6), and glue two ends, F. F, between, also to dimensions (Fig. 6), their grain running longitudinally. Strike the curves, *b. b*, with compass, set to 1$\frac{3}{16}$in. radius, and cut with paring gouge. Rebate back the square edge (Fig. 10, *c*, *c*, *c*, not exactly square, but slightly tapered upwards towards the face), representing the top fillet of the bedplate (Fig. 6 and 7), to 4½in., and downwards ⅛in.; then glue and brad this upper frame upon the lower one. When dry complete the convex portion of the ogee.

There is nothing rigid about this pattern; therefore when we fasten top and bottom frames together we shall assist it somewhat by glueing the frames together upon a " bottom board," that is, a piece of board planed up straight and in winding, or on a true bench, there allowing it to remain till set dry and hard. If it is allowed to set thus, it will not get out of truth afterwards, except by rough usage.

Prepare seven lugs, ⅜in. thick, 1¼in. by 1⅛in. (Fig. 13), striking the curves with compass set to ⅝in. radius. Slightly taper their edges in the direction of the face of the bed, and brad them on at centres given (Fig. 6). Narrow strips, ⅛in. thick, will form the filling-in to complete the thickness over the lower part of the moulding. Put a ¼in. round print upon each lug.

The four bosses for the guide bars will be turned to dimensions (Fig. 14) with a ⅜in. stud on the bottom, the grain running longitudinally. Note that the longitudinal dimension allows an ¼in. for facing. Besides this, give $\frac{1}{32}$in. taper in the length. Now when you come to mark the centres of these bosses, in positions shown in Fig. 6, you will find that the centre comes just by the edge of the fillet, and that some blocking is necessary; in fact, that the boss has to be continued over the ogee (Fig. 16). Why not have turned the bosses the entire depth and fitted them over, instead of using blocking-up pieces? is an idea that will suggest itself. Well, in practice it would take about twice as long, and would not be so neat a job—at least, in the hands of an unskilful workman, for the grain round the cut edges would become jagged, or "spalt" out, to use a workman's term. These blocking pieces will be got out, say 1in. longer than we require, and plenty wide and thick enough and fitted to the ogee. Chalk the moulding, and cut each blocking piece to a fit with a chisel and paring gouge. For the instruction of those of my readers who are not mechanics, let me mention that the paring gouge is a long gouge ground on its inner or hollow edge, instead of on its outer edge. These tools are used for paring the edges of long sweep for which a firmer gouge would be most unsuitable. They are made of various curves, termed respectively flat, middle flat, and quick, and of widths ranging from ¼in. to 1¼in. In length they measure about twice that of a firmer gouge. Fig. 15 gives a representation of one of these tools.

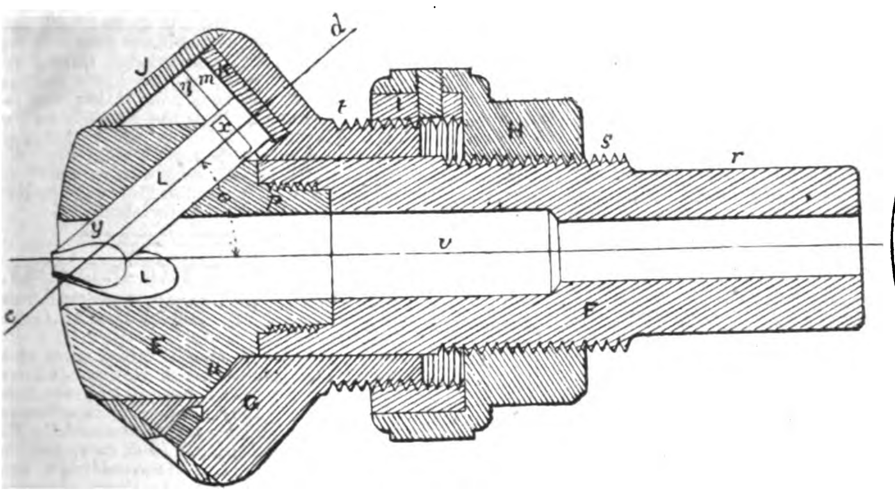
Well, having fitted each block in place, secure it temporarily with a ¾in. screw, and plane off its top face level with the face of the bed. Then bore in each boss centre a hole with a ⅜in. centre bit, for the reception of the pins of the turned bosses. Dropping these into place, mark their curve on the blocking pieces, remove the latter, work to shape, and replace permanently (Fig. 16). We shall not put prints on for the bolts of the guide bars, because these bolts must be tight fitting, which means drilled holes. Hence the bosses are complete.

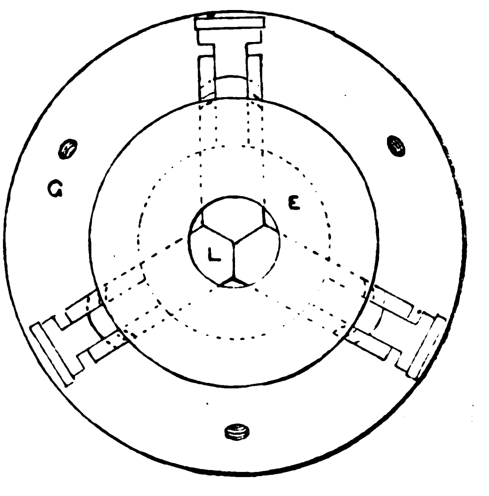
The two blocks for the crank-shaft bearings will be prepared to 6in. by 1¾in. by 2in. (this last allows for facing), and fitted with paring gouge and chisel over the moulding (Fig. 17), and fixed to centre given (Figs. 6 and 7). On the inner edges of these blocks a portion of the bed plate must be cut away to allow the crank to clear, Fig. 6, H, H. Two cylinder facings 8½in. by 1⅞in. by $\frac{1}{16}$in., fastened at G, G, Fig. 6 will complete the pattern.

Glass-paper smoothly, varnish with a coat of shellac varnish, and when dry, lightly rub down the grain which has become roughened, and apply a second coat. The pattern will then be ready for the foundry.

## BLUNT'S SELF-CENTRING CHUCK.

THE following is an illustrated description of a new self-centring chuck which has been recently patented by Mr. B. W. Blunt, of Nechells Park-road, Birmingham. The illustrations show the chuck in longitudinal section and the end with cover J removed:—Two round central parts, E and F, form the head and body of the chuck respectively. They are suitably attached to each other at P by being screwed together. Externally the end of F nearest to E forms a round guide, on which the block G is made to fit and slide. The other end of F forms a shank *r*, by which to attach the chuck to the machine in connection with which it is desired to be used. Between the guide and shank there is upon F an external screw S, which fits into a corresponding internal screw on the nut H. There is also a round hole *v*, which passes centrally through E and F to admit the article to be fixed in the chuck. Externally the cylindrical part of E of largest diameter, forms a guide upon which G is made to fit and slide. There is also a short cone, *u*, formed on the outside of E, through the surface of which three round holes pass obliquely into the centre hole and form guides for the three round clips L. Each of the three guides last mentioned is similarly situated in relation to either of the others, and also in relation to the central axis of the chuck, or so that each of the centre lines *c d* of the guides for the clips makes an equal angle with either of the others, and also an equal acute angle, O, with the central axis. The clips L are made to fit into and slide in the guides above mentioned. At one end, *y*, they are suitably formed to allow all of them at the same time to





approach the centre of the hole *v*, and to grip the article to be held by them. Near the other end of each clip there are two grooves, *x*, formed upon opposite sides of it, into which a suitable slide, *n*, on the block G is made to fit and slide, for the purpose of separating the clips. The block G has three sets of grooves on the front of it. In one of these grooves in each set a flat hardened steel plate K is fixed, to move in contact with the outer end of the clip and to cause it to move in towards the centre of the hole *v*. The other grooves, *m* and *n*, in each of the above sets form the slides which separate the slips. The sides of the plate K, which slide on the outer ends of the clips, are so situated that the centre line *c d* of the guides in E are perpendicular to them. Also each of the three sets of grooves in G already mentioned is similarly situated in relation to either of the others, and in relation to the central axis of the chuck. At its front end the block G fits into a conical cover J, the latter being attached to it by three small screws. There is an external screw *t* upon the back end of the block G, which engages with and fits into the nut I. Internally G has a central round hole passing lengthways through it, into which the head and body of the chuck fit. The cover J has a central round hole of the same diameter as that of the largest part of E. The nut H has a central round hole passing lengthways through it, in which there is an internal screw on the circumference of least diameter. This screw has preferably a left hand thread, which fits on the corresponding screw S on the body F. The other part of the central hole in H forms a recess into which the nut I fits and is rigidly fixed. Externally the end of H into which the nut I is fixed is round, and the other or smaller end is hexagonal. To actuate the chuck, the nuts H and I are turned round the axis by means of a spanner applied to the hexagonal part of H. The screw S causes the nuts to move bodily in a longitudinal direction according to the direction in which the nuts are made to revolve. Also according as the nuts move the screw *t* on the block G passes further out or enters further into the nut I respectively. Thus the block G moves along the axis in the same direction as the nuts H and I, but at an additional speed depending on the pitch of the screw *t*. When G is made to move in the left-hand direction, then the clips move towards the axis, and when the block G is made to move in the opposite direction, then the clips are separated further apart.

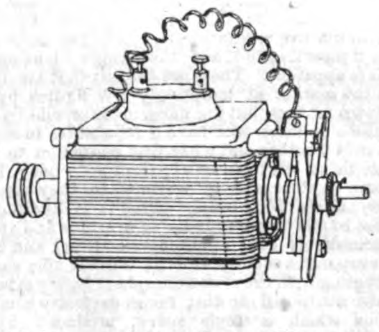
# ELECTRICAL MOTORS, AND THEIR CONSTRUCTION.—IV.

By John E. Chaster.

(*Continued from page* 315, *Vol. XL.*)

I MUST apologise for having kept so many readers waiting for this article; but business having called me away from time to time from town, I have completed the article at the earliest opportunity. I trust that few of the numerous readers interested in electrical matters have been inconvenienced.

The machine is now ready for wrapping with wire, and it should be taken in pieces, and whilst doing so it is advisable to carefully number or otherwise mark the parts that fit together, so that when finally put together no mistake may occur. Having got the motor in pieces, the field magnets are to be bound with canvas or calico, and well covered with either shellac or Brunswick black varnish, where the wire is to be wrapped on. The field magnets are to be wrapped with six or seven layers of No. 18 B.W.G. double cotton-covered wire. The exact amount got on will be determined by there being sufficient room for the armature to revolve when bolted up. About 1¼lb. of wire will be ample for the field magnets, and seven or eight ounces of 22 B.W.G. double cotton-covered for armature. When wrapping the machine it is by far the best plan to have a small detecting galvanometer and battery, such as a Leclanché, so that in case the insulated wire should at any part touch the iron of the field magnets the fault would be detected. This is effected by putting on the first bend of wire and joining the free end to the one terminal of the galvanometer, and from the other terminal of galvanometer take a wire to one binding screw of the battery, and from the remaining binding screw the wire comes that must be made fast and in good metallic connection with the iron of the field magnets. It will thus be seen that if the wire that is being wrapped on the field magnets should in any place make metallic connection with the field magnets, the galvanometer will, owing to the closing of the circuit, immediately be deflected. Should this occur, the wire must be taken off again until the leak be discovered when it should have a piece of calico, or, better still, fine linen, wrapped round the bared place on wire, and then remounted.



Secure all the ends of the wires either to the neighbouring coil or else by passing the finishing end beneath the adjoining layer and then drawing tight. All the three—viz., the two field magnets and armature, are ready to receive a coating on the insulated wire of thick shellac varnish. When dry, the machine may be finally mounted, and the ends of the field magnets so connected that the north pole of the one field magnet beds against the similar pole of the other field magnet.

When this has been ascertained, those two ends should be cut short so that there is left just enough wire to solder them together. This joint can then be insulated by binding round either cotton or tape, and carefully tucking same away so as to be out of sight as much as possible. One end of the field magnets is to be taken to one of the binding screws of the vulcanite (Fig. 22, p. 315, Vol. XL.), and the other end goes to one of the brushes of the commutator. The other commutator brush has a short length of copper wire to the remaining binding screw. The machine is now ready for trying to see how it runs. If carefully made it will revolve with a single bichromate, though to get its full efficiency it will be necessary to employ six or eight bichromate cells, each cell having a zinc surface of 3½in. wide and 6in. long immersed in the liquid. With a small boxwood pulley on the shaft, and about ¾in. to 1in. in diameter and ½in. in width. the machine is capable of driving a small lathe, fretsaw, and all light-running machinery.

Many persons have of late been writing against the Siemens H form of armature. For a dynamo from which a large amount of electrical energy is required, it does heat after a short time of running when made of large dimensions; but for small motors it is certainly the best considering all things, and is by far the easiest for amateurs to fit together; and if made of the very best carburetted annealed iron, it does not heat to an extent sufficient to do any damage to insulation of wire.

A suggestion was made by a Mr. Jones that I should use for my motor a clumsy imitation of the Siemens armature formed of strips of iron made in the shape of a cross. As I like to give everything a fair trial, I fitted one up in this style. When I placed this form of armature within the field magnets, I found the resulting power from the motor to be considerably less than with the Siemens H armature. This serious defect is attributable to the small amount of wire this cross form of armature holds compared with the Siemens H form. This cross form is more difficult to wrap than the ordinary Siemens, and requires more careful attention in connecting the ends of the wires to commutator.

After running it for a few hours, I found a considerable decrease of power, although the E.M.F. and current from batteries was the same as at starting. This suggested that the error must be in the armature itself.

On unwrapping the armature I found that the separate laminations of the cross form of armature had each set up a small counter rotary motion of its own, and had cut through the insulation of the cloth, and also that on the wire; so that the lower coil was short-circuited.

I trust that amateurs will be able to finish and complete the motor in a satisfactory manner, as it makes a motor of very high efficiency when correctly fitted up, and I should advise all amateurs to get the castings ready made, for making patterns of these is very troublesome, and beyond the capability of most amateurs. Mr. R. A. Lee, of 76, High Holborn, whose name must be well known to all readers, and who advertises in this journal, has made some very beautiful patterns of this motor (from my designs), the castings from which are everything that can be desired, well carburetted, thoroughly annealed, and so clean that I found there was scarcely any filing and turning required in fitting them up.

The engraving of the motor in this number is from a photograph taken from the finished machine, and will, in combination with the drawings previously given, make the general construction and fitting quite clear.

The motor being completed, requires a battery to drive same, and I propose therefore giving a few articles on the various forms of batteries suited for the purpose.

## DR. HUGGINS ON THE SOLAR CORONA.

In a lecture recently delivered by Dr. W. Huggins, F.R.S., before the Royal Institution, he gave an account of his experiments in photographing this rather puzzling phenomenon. In the course of the lecture, Dr. Huggins said:—Much of the light from the corona comes from near the ultra-violet end of the spectrum, therefore it might be expected to be seen through coloured media exercising the requisite selective absorption; but then comes in the drawback that the particular rays in which the corona is specially rich are near the limit of the power of the eye, and have but feeble influence upon vision. He therefore looked to photography for aid, especially as it is possible to accentuate photographic effects, so that the photograph is no longer true to nature. At first he tried experiments with interposed media, such as coloured glasses and layers of coloured solutions, including, for instance, potassic permanganate; but there were objections to this plan because of the reflections from the two surfaces, or from the decomposition of the chemicals by light having possibly the power of producing coronal-like images on the photographic plates. He next took advantage of the selective power for particular rays exercised by certain salts of silver. It has long been demonstrated that chloride of silver is particularly sensitive to the rays in which the corona is relatively rich, so that salt he concluded to be the best for his photographic operations. Then came in the difficulty about the imperfect achromatism of the lenses of refracting telescopes when used for photographic purposes; consequently he employed, in the first instance, a Newtonian reflecting telescope, with a large and a small mirror. In 1882 he thus obtained about twenty photographs, in all of which were forms very coronal in appearance, and critical observers, like Professor Stokes, Captain Abney, and others, thought that there was great reason to suppose that the coronal image had produced a specially visible effect on these plates. In his later experiments he used a telescope with a single mirror only, and the sun's light reached the mirror through a long tube, blackened inside, and containing many blackened diaphragms; he thus got rid of reflections from two mirrors. The backs of the photographic plates were covered with asphaltum, to prevent reflection from the back surfaces of the light which found its way through the photographic films; a circular black disc was placed in the telescope to cut off the image of the sun's disc entirely from the plate. With these precautions against obtaining erroneous coronal effects, what seemed to be true coronal impressions still came out on the plates. The conditions of climate being so unfavourable in England, it was thought well to repeat the trials in a better atmosphere, so the Royal Society appointed a committee and gave a grant for the execution of the work. The scene of operations was Switzerland, and the Riffel was chosen because of its height of about 8,000ft., combined with hotel accommodation. Mr. C. Ray Woods, who had had experience in astronomical photography during total eclipses in Egypt and in the Caroline Islands, did the actual work in a temporary hut on the Riffel, a photograph of which was projected on the screen by Dr. Huggins; it included a likeness of Mr. Woods, and represented the tube of the telescope bound round with flannel to prevent the heating of its exterior by the sun. For the last year or two, however, some fine matter had been in suspension high in the atmosphere of the earth, producing on fine days an aureole around the sun; this aureole was red outside, and violet inside; some thought it to be caused by spicules of ice, others supposed it to be due to vulcanic dust, but whatever it was, it was "matter in the wrong place" for the Swiss experiments of the Royal Society, so that the results were largely vitiated. There are five hypotheses to account for the corona: 1. That it is a large gaseous atmosphere around the sun. 2. That it is matter ejected from the sun. 3. That it is something of the nature of Saturn's rings, and consists of meteoric matter. 4. That we see the impouring of the tails of comets. 5. That there are meteoric streams illuminated by the sun, which are not revolving near the sun, or falling into it, but are parts of the elliptical orbits of comets. It would be safe to say that the corona is a complex phenomenon, and that there is probably some truth in all these hypotheses. An American professor has questioned the reality of the corona altogether, and suggested that it is but a diffraction phenomenon, but his theory rests upon negative evidence. He has against him the evidence given by the spectrum of the corona, and that photographs taken at different places show the same corona, which objection appears to be fatal to the non-coronal hypothesis. Without doubt there is a limited gaseous atmosphere around the sun, but this will not explain the corona. If there were but one particle of matter in every cubic mile, it would account for the corona, the particles being so close to the brilliant source of the light of the sun. There is gas with the particles, which may or may not be distilled out from them. The notion is gaining ground that there is a repulsive force connected with comets, not due to mass but to surface, therefore somewhat electrical in character, and it is possible that there may be some such force in the surroundings of the sun. If the existence of such force be granted, it may be that the corona consists of some of the blown-away matter of sun-storms; some part of the gas may have been carried up, or have afterwards been distilled from the solid particles by the heat of the sun; nothing is yet known of the condition of the gas between the particles. In the high vacua used by Mr. Crookes, the residual material particles represent a crowded city as compared with the coronal waste.

## DANGEROUS LUBRICANTS.

The following notes on the use of dangerous lubricants and false economy are contributed to an American oil-trade journal by Mr. E. F. Dieterichs:—

When we consider that lubricating means the interposing of substances between the parts in motion, to absorb the frictional heat and tranfer it into space by radiation, thereby avoiding abrasion and heating of the parts, we must see that only such lubricants will be able to accomplish the desired result which are entirely free from inert matter (grit), possess sufficient viscosity to secure adhesion to the metal and to be of such fire test as to secure radiation proportionate with the heat-absorbing quality of the lubricant. The injuries resulting from the use of poor lubricants will not always be perceptible at once, but they are produced gradually and persistently. The bearings of the machinery are tell-tales of the quality of lubricants used; they appear covered with gummy and dirty looking incrustations, the result of decomposed and accumulated impurities, and the saturated timber and floors in the vicinity of the bearings indicate the waste and danger resulting from the use of poor lubricants. Most of the cheap black lubricators are made from the residuum of petroleum stills, which to the best has been steamed and settled, thereby securing a less tarry colour and separating some of its gritty components, but much of the latter, most in the form of charred products, remain.

These residuums are thinned out to consistency for lubricating purposes, and as they are of very low gravity permit the use thereto of the cheapest kinds of natural oils, with their lighter and inflammable products, and frequently even the coarser kinds of benzine alone are used. These mixtures are brought to gravity of 28-29° B., in imitation of the once-celebrated 28° West Virginia oils, and are largely sold under that name to parties who look for a cheap oil and cannot determine its quality. Frequently these oils are mixed in so coarse a manner that when at rest the heavy residuum will separate in the packages, underneath the lighter fluid oil, and the danger of using such oils is apparent. These are the oils that are offered on the market at temptingly low figures by unknown makers, but are never made or sold by well-known refiners who have a reputation to sustain. In cold weather and when first poured on to bearings these oils have an apparent good body, but in warm weather and in warm places they soon thin out, and in flour mills, where it is distributed in close rooms over hundreds of bearings and spreads diminutively over adjoining woodwork and floors, it evaporates rapidly and its inflammable vapours mingling with the close atmosphere highly saturated with floating flour dust forms explosive combinations which a single spark, produced by the accidental getting in the mill of the smallest piece of iron, will explode. In saw mills, also, where pillar blocks, the surrounding woodwork, the floors and sawdust are saturated with such oils, and when on hot days and when the sun shines then the rising vapours can be seen, a flying spark from the rapidly revolving saws is all that is needed to set the whole place instantly on fire. What other explanation do we need when looking for the cause of mysterious explosions in flour mills, so assiduously attributed to the explosiveness of flour dust alone? Flour has been ground for generations in all climates and in all seasons, in airy places and in close and dingy ones, by hand and horse power, by wind and water power, and for a long time by steam power, and if the mills were not as gigantic as at present there was proportionately the same kind of work to perform, and when pushed to run day and night and with utmost strain on their machinery the chances for mysterious explosions were equal to the present time, but were never heard of. The danger from heated steps and bearings was well known, and many of the old hands cannot now be persuaded that anything other than lard or sperm oil is safe and fit to be used. Why, then, do managers of large mills and other establishments persist in running their machinery with poor and dangerous oils? They seem to forget that lubrication is as important a factor in the control and economy of motion and power as the need of hands to attend to it, as they need light to see at their work and fuel to produce the power and motion with which to do it; but inattention to these facts and false economy induce them to pursue a faulty policy. They claim it to be of no use to purchase better oil, as the hands pour it on recklessly any way, but acknowledge thereby poor management and want of control over their men. It is no wonder the men pour it on; they have to do it in order to keep the bearings cool, and while the oil runs out below as fast as they pour it on above, that makes them use it recklessly. With oil capable of doing its work with regularity they would not do so, as lubrication also means exertion; it requires attention and causes labour.

## HOW TO TREAT THE OILSTONE.

The following remarks are extracted from a paper by J. F. Hobart in the *American Machinist*:—

Keep your oilstone clean. Many users of oilstones keep them full of oil all the time, all covered with dirt and gudgeon-grease, and when they want to use them, must scrape a place with a chip before they can make a tool "take hold." Wipe the stone clean after using. Do it every time, too, not once in a while. Get in the habit of it, and it will come natural. Don't let a stone get gummed up. If you have been guilty of keeping such a one, just take a new deal and "try out" your stone. Put it in a kettle with water and potash, and set it over a fire, or stick a steam pipe into it. Boil for an hour or two, then soak and wash well in clean water. You will then be able to see what your oilstone looks like, and it will "take hold" like a new broom. Some men place their oilstones in the sun and let the oil dry out. But the potash is the best; it "kills" the grease on the spot. An oilstone needs "truing up" very often. Don't let a stone get too "hollowing." Use long strokes in rubbing a tool upon it. If it gets a little worn in the centre, take it to the grindstone or a big emery wheel. Hold it against the side of the wheel, not on the face. It will take but a very few minutes to grind the oilstone true and smooth. I never yet saw a loafer hang around a shop half-an-hour without getting out his jack-knife and "going for it," upon the middle of an oilstone. If I have a knife to sharpen, I do it near the end of the stone. The ends don't wear down; it is the middle that gets most of the work. Some journeymen put a wire across the middle of their oilstone. They have to work each side of it, but the loafers have to too.

If you break a stone, don't throw it away. If thick, or nearly new, boil the grease out of it, and glue it together with common glue. It will hold if you get all the grease boiled out before you put on the glue. If the stone has become worn pretty thin, you had better grind it down into slips. It will make some nice ones of the very best quality. Don't put the stone into a block of wood. It makes a nasty thing to keep clean; go to the hardware store and buy a nice oilstone holder. You can put it on in two minutes, and take it off in "no time," and wipe the stone clean as often as you wish. A hard, glossy oilstone is not worth buying. A stone which looks like a piece of marble is good for nothing. A stone with a sandstone complexion is too soft, and will work bad. The "muddy" stone is another to be avoided. Somewhere I have seen a receipt as follows: "Draw your thumb nail along the stone; the faster it cuts away the nail the better the stone." It looks reasonable, but I have never tried it.

Petrified wood makes the best oilstone. I have a Scotch stone which cuts very fast, yet will set an edge to "cut a hair." Some years ago a firm started to manufacture "silex" stones for oil and water, both hand and power. The "silex" stone was ground fine, mixed with some secret "uniting compound," and moulded under hydraulic pressure. The stones thus produced were pretty good, but were apt to "glaze," and then neither oil nor water seemed to have any effect in removing it. Whether or not they are made now, I do not know. There is a knack in using oilstones well. Don't rock your hand and make six or eight bevels on the work, or else make a curve in place of a flat "bevel." Keep your wits upon the top of the tool, and see that it travels as fast as the bottom edge does. The tendency, when pushing from you, is to lower the top of the tool, but a little attention to this point will enable a man to do a job right, and get a better edge in the very shortest time.

**Test of Cod-Liver Oil.**—Pour about ten minims of the oil to be examined into a watch glass. Dip a pointed glass rod into concentrated sulphuric acid, and with the moistened point mark as if writing or drawing on the bottom of the glass, through the oil. Wherever the point goes it will be followed, if the oil is pure, by magnificent streaks of a pure violet colour. The reaction is equally beautiful, if the oil is first cut with or dissolved in carbon sulphide, as prescribed in the German Pharmacopœia If the point of the rod is passed lightly over the surface of the oil, just touching it, the violet streamers may be watched descending little by little until they reach the bottom.

# SCIENTIFIC SOCIETIES.

## LIVERPOOL SCIENCE STUDENTS' ASSOCIATION.

THE fifth evening meeting of the current session of this association took place on Friday, Feb. 19th, in the Common Hall, Hackinsbey, the president, Mr. Norman Tate, in the chair.

The paper of the evening, on "Mineral Crystals," was read by Mr. Charles E. Miles, who, in the course of his address said: Hidden from sight of men in the bosom of the earth lie great treasures of form and colour known as mineral crystals. From their symmetrical outlines and rich appearance, they have not inaptly been termed the flowers of the mineral kingdom. It is strange that with all their attractive features, and notwithstanding the general march of science of late years, comparatively little more is known about the laws which govern the formation of crystals than what was known some sixty years ago. Crystals may be looked upon as the most perfect form which inanimate matter assumes, and when perfectly developed they form complete geometrical figures. However much crystals may be complicated in form, they all can be referred to one of six distinct plans or systems of crystallisation. Not only have crystals symmetrical outlines, but law and order control them completely. Even in a seemingly confused mass of crystals we can notice that a definite plan fixes their arrangement one with another. We have some evidence of the molecular structure of crystals by their action upon light. It is found that each system of crystals possesses its own peculiar action upon light in its passage through them, interfering with its passage differently. Some crystals, on being excited, exhibit peculiar electrical properties. So far the electrical condition has been little understood, but it may yet be found that these electrical conditions set up under the process of crystallisation have much to do with the manner in which minerals are found crystallised or associated together in the earth's crust. Of late years much advance has been made in the science of petrology, or the study of rocks, simply owing to the knowledge obtained of the optical characters of mineral crystals under the microscope, the practical outcome being a knowledge of the mineral structure of many rocks, which by ordinary chemical analysis could not be obtained.

## CHEMICAL SOCIETY.

THE following among other papers were read at recent meetings of the above Society:—

"On the Atomic Weight of Titanium." By Prof. T. E. Thorpe, F.R.S. The atomic weight of this element was made the subject of investigation so far back as 1823 by Heinrich Rose. In 1829 Rose published a second series of determinations, which were followed in 1847 by the determinations of Pierre, and in 1849 by those of Demoly. These determinations have given values for Ti varying from 47·92—56·39. In framing his arrangement of the elements in accordance with the Periodic Law, Mendelejeff adopted the number 48 as the atomic weight of titanium. A number less, than 50 was in fact demanded by the law. A redetermination of the atomic weight of this element, therefore, was obviously required, not only to fix its value as a chemical constant, but as affording an excellent test of the validity of Mendelejeff's hypothesis. The exact determination of the atomic weight of titanium is rendered difficult from the circumstance that comparatively few compounds of this element exist which are wholly suitable for the purpose. The author of the present communication has made use of the tetrachloride and tetrabromide as the bases of his experiments. He has determined the amounts of chlorine and bromine in these compounds, and also the amounts of titanic oxide which they yield by decomposition with water. The mean of the whole 31 experiments becomes 48·013, the probable error of the series being ± 0·021, and the probable error of the result ± 0·0085.

"On the Physiological Action of Brucine and of Bromostrychnine." By Dr. T. Lauder Brunton, F.R.S. The difference between the effect of brucine and strychnine appears rather to be one of degree than of kind, and to be chiefly dependent on the more ready elimination of brucine. Like strychnine, brucine produces death by convulsions and not by paralysis; but like curare, it is innocuous *when taken* into the stomach, though fatal when *injected* under the skin. Bromostrychnine has an action very much like that of strychnine.

A lecture "On Chemical Changes in their relation to Micro-Organisms," was delivered by Professor Frankland, D.C.L., LL.D., F.R.S. A plant being defined as an organism performing synthetical functions, or one in which these functions are greatly predominant; an animal as an organism performing analytical functions, or one in which these functions greatly predominate: the micro-organisms were classed by the lecturer among animals. Their life essentially depends upon the taking asunder of more or less complex compounds, resolving them into simpler compounds at the expense of potential energy. As micro-organisms are commonly termed "ferments," and their analytical operations "fermentations," it is necessary to sharply distinguish between organised ferments and certain bodies which bring about analogous chemical changes, but which are not only not organised, but exist in solution. These latter, or "soluble ferments," as they are commonly termed, are said to act by contact; they produce certain chemical changes in the fermentescible substances without themselves furnishing from their own substance any of the products of change; the effects they produce are essentially analytical, consisting in the assimilation of water and the splitting up of the fermentescible substance into two or more new molecules, and may be brought about by purely chemical means. They differ only, or chiefly, from the organised ferments in that they are unorganised and do not increase in amount during their action upon fermentescible substances, of which a very large, although limited, quantity may undergo transformation by the action of a very minute quantity of the ferment. A list of changes brought about by unorganised ferments was given. In that portion of the animal kingdom with which we are best acquainted, oxidation is the essential condition of life; it is the kind of action by which the animal changes actual into potential energy. The changes effected by micro-organisms are essentially of the same character as those brought about by the higher orders of animals—that is to say, they are all changes by which potential becomes actual energy. With one or two exceptions, the chemical changes effected by micro-organisms—unlike those produced by soluble ferments—cannot be brought about by other means. The observations of Hutton and others have shown that micro-organisms retain their vitality in presence of a variety of substances which rapidly prove fatal to higher animals; the unexpected fatal effects of spongy iron would seem to promise, however, that there are substances fatal to bacterial life which have no toxic effect on more highly organised animals. It has not yet been shown that any degree of cold, however intense, is fatal; animation may be suspended, but it is restored when the temperature rises. With regard to heat, the lowest fatal temperature recorded is 40° C., but many species can withstand much higher temperatures. Chloroform and compressed air are said to arrest their action, but to have no influence in preventing the changes brought about by unorganised ferments. The position of micro-organisms in nature is only just beginning to be appreciated; their study both from chemical and biological points of view is, however, of the highest importance to the welfare of mankind, and leads the inquirer right into those functions of life which are still shrouded in obscurity. In the course of the lecture the best known micro-organisms and the chemical reactions due to them were passed in brief review.

**All Made from Smoke.**—The old saying that nothing is wasted or lost in nature is true in regard to the smoke from the furnace of Elk Rapids, Mich. In this furnace are manufactured 50 tons of charcoal per day. There are 25 charcoal pits, constructed of brick. Each pit is filled with 100 cords of hard wood and then fired. The vast amount of smoke from these pits, which was formerly lost in the air, is now utilised. Works have been invented to convert the smoke into chemicals and acids. These works are a curiosity. First, they have a circular tube made of wood, with pine staves, 16ft. in length, bound together with heavy iron hoops. This tube is placed directly over the pit in a horizontal position, with an opening from each pit into the tube. At the end nearest the building there is a large drum containing a rotary pan propelled by machinery, the power of which is gas. That acts as a suction or draught for the smoke, which is conveyed into fire-stills with copper pipes 2½in. in diameter. The boxes in which the pipes are situated are 20ft. square, 8ft. deep, made from heavy pine, and filled with cold water; they are all connected by copper pipes. They are connected with the main still, 100ft. in length, 10ft. wide, and 8ft. deep, filled with copper pipes 2½in. in diameter, in horizontal position, surrounded by cold water; from this it is conveyed to the purifier, from which runs what is called pyroligneous acid, which is as clear as amber, with an unpleasant odour. From the acid is produced, first, acetate of lime; second, alcohol; third, tar; fourth, gas, which is consumed under the boiler. Each cord of wood contains 28,000 cubic feet of smoke; 2,800,000 feet of smoke handled every 24 hours produces 12,000lb. of acetate of lime, 200 gallons of alcohol, and 25 pounds of tar. These products have a commercial value in the manufacture of various articles. The smoke from 40,000 cords of wood consumed per annum is thus made a source of much profit, as the works are automatic and require no workmen to run them.

# SCIENTIFIC NEWS.

ACCORDING to Prof. Backlund's elements. Encke's comet should make its nearest approach to the sun on the 7th inst., and its nearest to the earth three days later. M. Bigourdan describes it, as observed at Paris last month, as a brilliant nebulosity about 2′ in diameter, with a bright centre shading off gradually. There was a small nucleus a little *n.f.* the centre, but no tail.

On the 7th inst. the position of Wolf's comet will be R.A. 3h. 18m. 42s., N. Dec. 0° 18·2′ at 6h. G.M.T.

The *Proceedings* of the Royal Irish Academy for July, 1884, contains a catalogue of known variable stars, with notes and observations, by J. E. Gore, F.R.A.S. It occupies 62 pages, and will be useful to those who are interested in variable stars.

The death is announced of Prof. T. C. Archer, the director of the Edinburgh Museum of Science and Art, at the age of sixty-nine.

Mr. John Francis Campbell, of Islay, died recently at Cannes at the age of sixty-four. He published a few months ago a work on thermography, and was the inventor of the Kew sunshine-recorder, but he is more widely known by his collection of the folk-lore of the Western Highlands.

The death is also announced of Hofrath Schmid, professor of mineralogy at Jena.

At the annual meeting of the Paris Academy of Sciences, amongst the prizes awarded we note that the Monthyon was apportioned to M. Riggenbach, the Swiss engineer, for his railways in mountainous districts; the Lalande for astronomy to M. Radau, for a memoir on refraction; the Poncelet, for progress in mathematics, to M. Houel; the Salz, for astronomy, to M. Gurzel for a memoir on ancient eclipses, in order to determine the value of the secular acceleration of the motion of the moon; the Tremont prize was awarded to M. de Taste, for his works on meteorology; and M. Marsault was awarded 1,500 francs for his studies on miners' safety-lamps.

The National Fish Culture Association is endeavouring to put the propagation of fresh-water fish on a more extended basis, and for that purpose is erecting a large establishment at Dalaford Park, Bucks, near the River Colne, for breeding various species of salmon, trout, and other fish, including the German carp, which is superior to the English species, both in rapidity of growth and as an article of diet. The site is well chosen, and anglers throughout the country may have cause to thank the association for its efforts. The association also purposes carrying out a scheme for obtaining records of the temperatures of the sea at several parts round the coast in order to gain knowledge which will be valuable in its endeavours to promote the propagation of sea fish.

Mr. S. F. Baird, the United States fish commissioner, is helping in the work of pisciculture in this country, and has already forwarded to South Kensington a large consignment of ova of the more highly-prized American fishes.

The use of the electric launch as a police boat on the River Thames and elsewhere is likely to prove a success, for, compared to a steam launch, its movements are noiseless, and the same power that is employed to propel it can be utilised for supplying current to an arc lamp for "searching" purposes. The launch with which the experiments have been made is 25ft. long, with a beam of 5ft. 6in., and carries 50 accumulators, each weighing 40lb. It can maintain a speed of eight miles an hour for four hours; but can be made to travel faster on emergency. The search lamp is of 3,000 candle-power, and, as the term implies, the beam can be sent in nearly every direction.

Mr. J. Roach, who is constructing several vessels for the United States Government, has received orders to use iron for all shafts, as steel is not considered trustworthy. It is said that of the iron shafts Mr. Roach has put into steamers none have broken, but the number of steamers is not stated.

A company has been started in New York, with a capital of £40,000, to build "navigable trains of air-ships," in accordance with the designs of an inventor who has already seventy-eight patents in connection with aëronautics, and is about to present some 250 more improvements to the Patent Office. The principal novelty in the idea is the making up of a "train" of air-vessels, each consisting of a balloon circular in perpendicular section, held together by means of cables passing through the cars. Each portion of the "train" is provided with screw propellers and rudders, by means of which it is conceived that it will be possible to ascend and descend without interfering with the gas in the balloon or the ballast in the cars.

According to an American paper, the two Fontaine locomotives, which cost about 45,000 dollars, including the expenses of their trials, were sold lately to the Lake Erie and Western Railroad for 2,700 dollars. One of the engines is said to have run 15 miles in 10 minutes on one occasion.

MM. Jeannolle et Cie. recently forwarded an account of their experiments with electricity as an anti-incrustater to a manufacturers' meeting at Calais. By passing a current through a boiler, they not only caused the impurities in the water to settle in a pulverulent condition, but loosened the old incrustation.

Cremation is making progress in Paris, and Prof. Brouardel, who was charged by the Council of Hygiene to report on the matter, proposes to establish a crematorium in Père la Chaise as an experiment.

Mr. E. T. Hardman, who was sent out to Western Australia to explore the Kimberley district, reports a discovery of the gigantic extinct Kangaroe, *Diprotodon Australis*, which is an interesting addition to Australian palæontology.

With a view of keeping some record of the action of the Whitworth scholarships and of ascertaining how the endowment fulfils the intention of the founder, the Science and Art Department of South Kensington has issued a circular asking those who have held scholarships to state in what profession or occupation they have been employed since the expiration of their scholarship.

## USEFUL AND SCIENTIFIC NOTES.

**Screws, Bolts, and Nuts.**—Mr. Morris Cohen, of Kirkgate, Leeds, sends us an illustrated price list of screws, bolts, and nuts for clock, model, and mechanical work. The illustrations show the actual size of the screws, &c., but their dimensions are also given in the priced list, which should be very useful to amateurs and others. We understand this is the first list of the kind ever published.

**Asaron.**—The essential oil of *Asarum Europæum* contains 1 per cent. of an odourless kind of camphor —asaron $C_8H_{10}O_2$—which is possessed of remarkable phosphorescent properties, and admits of distillation in small quantities without undergoing decomposition; it is slightly soluble in boiling, but readily so in alcohol, ether, chloroform, and petroleum ether.

Sympathetic ink for writing on postal cards, the *Paper World* says, is made of diluted sulphuric acid, one part by measure of acid to seven of water. When this ink is used the card will at first show roughened traces of the writing, but after being allowed to dry for a short time these disappear, and it is as invisible as if done with water. Of course, only a gold pen or a quill must be used. If it is desired to avoid the suspicion of using sympathetic ink, it may be written upon, across the first writing, with tincture of iodine, which will entirely fade out when the heat is applied to develop the invisible ink.

According to the annual statistical report of the secretary of the British Iron Trade Association, the home production of iron ores in 1884 was considerably less than in 1883, as is evident by the diminished production of pig iron; but to what extent the output was reduced there are no official figures yet available to show. In the Cleveland district, however, the total output of iron ore has been ascertained by the Cleveland Mineowners' Association to have been 6,005,000 tons, against 6,700,000 tons in 1883, and 6,326,000 tons in 1882. The output of 1884 therefore showed a decrease of 695,000 tons on 1883, and of 321,000 tons on 1882.

In Norway and Sweden accumulations of moss, often more than a foot thick, and half decomposed, serve to make paper and millboard, as hard as wood, blocks of which, formed by the hydraulic press, may even be turned in the lathe and polished. This substance is said to possess the good qualities of wood without the defects, such as warping and splitting, so that it is suitable for making doors and windows. Plant has, it is said, been laid down in Sweden for working up these deposits of a hitherto waste substance into a useful material.

# LETTERS TO THE EDITOR.

*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* Editor *of the* English Mechanic, *332, Strand, W.C.*

*All Cheques and Post-office Orders to be made payable to* J. Passmore Edwards.

*⁂ In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

> "I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original."
> —*Montaigne's Essays.*

## THE SOLAR ECLIPSE ON MARCH 16, 1885.

[23888.]—It is very desirable that amateur astronomers should not always lose sight of the fact that the words "invisible at Greenwich," which appears in our national ephemeris in reference to certain solar eclipses, do not always imply that such phenomena are entirely excluded from the gaze of all the inhabitants of Great Britain and Ireland. We have a case in point in the eclipse of Monday, March 16. A glance at the diagram, which is inserted at page 396 of the *Nautical Almanac* shows that the course of the central line on this occasion traverses the continent of North America; and although it is not total, but only annular, it seems to be exciting a good deal of interest among the astronomers there, and no doubt the times of commencement and ending, and the angles, which the points of first and last contact, when joined with the centre of the sun's disc, involve with reference to the Vertex and North Point, will be very eagerly scanned. But although in these islands we are not permitted to enjoy much of this spectacle, there is one station at least where scientific men are to be found at which the phenomenon will be unique and striking, and it is to be hoped that amongst the staff of persons employed in connection with the Atlantic telegraph and the Meteorological Department, some one will be found to describe what is to be seen, if the weather proves favourable, on the evening referred to. At Valencia the commencement of this eclipse is visible shortly before sunset—viz., at 5h. 40m. local mean time, and the middle of the eclipse happens at 6h. 34m., soon after the sun has descended below the horizon at 6h. 4m. The appearance of the sun as it dips beneath the sea will be sufficiently remarkable—a large semicircular incision being made in the disc on the right-hand side, commencing along a line parallel to the horizon, and cutting its globe almost perpendicularly at the time of sunset.

For the sake of such of your readers as may choose to verify these statements by a computation made on the partially-graphic method, I will add the elements of the calculation and a miniature diagram showing the result. It must be remembered that the actual projection requires a half-sheet of demy, and an ellipse of which the semi-major axis is 10in. See Vol. XXVI. p. 408.

Elements.—I. Lat. 51° 42′ 52″ N. Geoc. Long. 0h. 41m. 40sec. W.

| | | | |
|---|---|---|---|
| G. M. T. of Conjnct. Mar. 16— | 6h. | 14m. | 24sec. |
| Equ. of Time | | 8 | 37 sub. |
| | 6 | 5 | 47 |
| Long. W., subtract | 0 | 41 | 40 |
| Sun's hour angle | 5 | 24 | 7 |

II.

$\rho$ cos. $l$ = 9·79128

P = 1·75572 P = 56·98′

1·54700 $\delta$ = 1° 27′ 12″ S.

2·

0·45300

Value of 10 divs. of Lat. Par. Scale = 2·838in.

III.

$\rho$ sin. $l$ = 9·89392 +

P = 1.75572

Cos. $\delta$ = 9·99986

1·64950

P $\rho$ sin. $l$ cos. $\delta$ = 44·62′ +

Difference = 48·01

Moon above parallel = 3·39′.

Value of 10 divs. of Lat. Par. Scale = 2·838 in.

IV.

X cos. D = 29·23′

X = 9·36 ascending.

Moon above parallel = 3·39 +

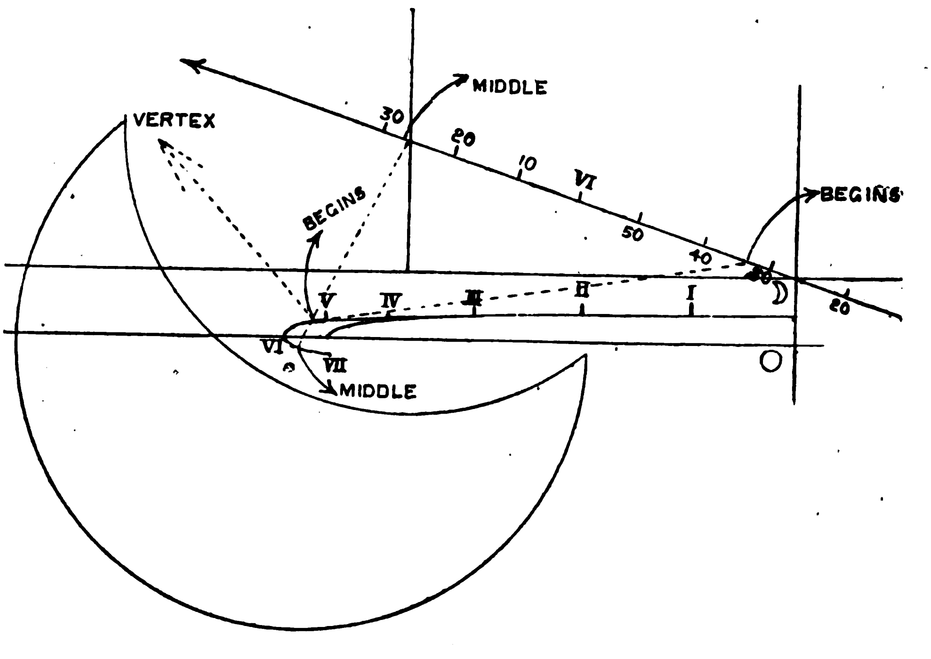
Moon's ½ diam. = 15·6

Sun's = 16·1

The foregoing elements are quite sufficient to furnish the construction of the requisite diagram, of which the following is a miniature.

James Pearson, M.A., F.R.A.S.

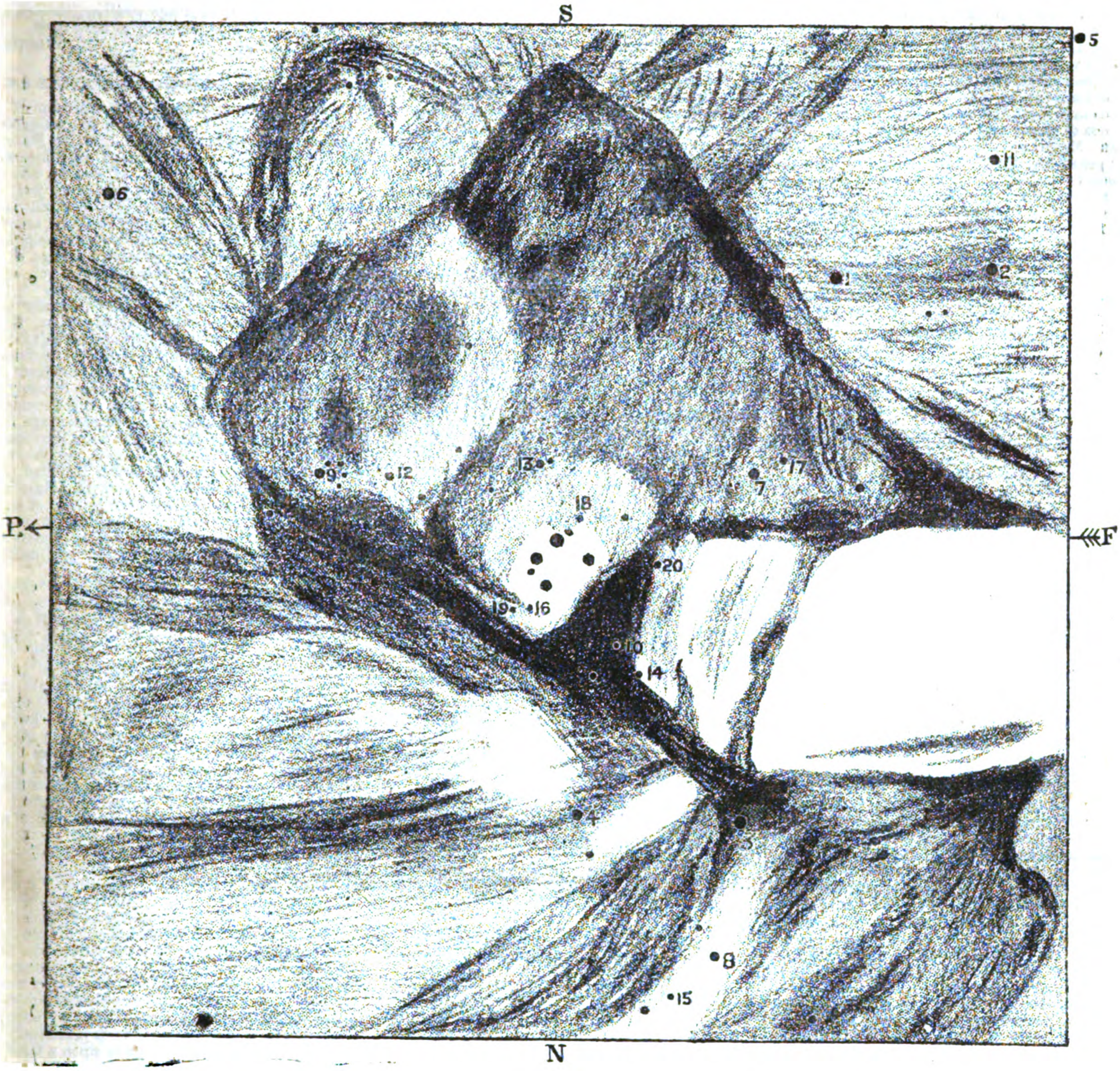
Fleetwood Vicarage, Feb. 23, 1885.



## THE OCCULTATION OF ALDEBARAN.

[23889.]—I have received two communications in reference to the above phenomenon, both of which, I am happy to say, indicate the success with which the partially-graphic process of computation, which I have recently devised, and which is described in Vol. XXXVI. p. 405, and Vol. XXVII. p. 10, of the English Mechanic, may be applied to practical purposes. The only merit I claim for it is its brevity and accuracy. It accomplishes in three-quarters of an hour a calculation which, by the methods of Woolhouse or of Shadwell, would require a host of figures and a very large expenditure of time. And this it does on a half-sheet of note-paper and a half-sheet of demy.

The first communication is from Prof. Smyth, of Edinburgh, who states in a letter to the *Scotsman* newspaper of Feb. 23, "The interval between the two signals turned out to be, by the assistant's notation on the chronometer, not more than two seconds and 6-tenths; but the difference of either from the Rev. James Pearson's calculation was an affair of minutes—until the already ascertained



error of the chronometer was applied, and then the absolute time of the first signal was found to be 5h. 4m. 58·2sec., and of the second 5h. 5m. 0·8sec.; while the time computed by Mr. Pearson was 5h. 4m. 58sec. In so far, then, a signal success." A cumulus cloud prevented all further observation.

The second communication is from an observer in Belfast, who writes: "Occultation of Aldebaran well observed. True local time 5h. 29m. 40sec. Long. 0h. 23m. 40sec. W.; Lat., 54 deg. 36m. N. Telescope employed, 4¼ refractor; power, 74. Definition very good. Local time correct to five seconds." A computation made on these data by the partially-graphic process gives the time of ending 5h. 29m. 40sec., which, considering all the circumstances, may be pronounced to be an equally exact prediction with the former.

**James Pearson, M.A., F.R.A.S.**

Fleetwood, Feb. 23, 1885.

## STARS NEAR THETA ORIONIS.

[23890.]—The annexed sketch of part of the central portion of the Great Nebula in Orion, showing the general features of the nebula itself, and the positions of the stars inclosed in it, may be of use to those of your readers who may be desirous of looking for other faint stars besides the fifth and sixth in the Trapezium with small apertures. The sketch shows all the stars in Bond's catalogue within 180″ *p.* and *f.*, and the same distances north and south of the brightest star in the Trapezium ($\theta'$ Orionis of Flamsteed, C of Σ 748, 628 of Bond's catalogue), and most of the stars seen at Malta, Parsonstown, and Washington. All Bond's stars are laid down from the co-ordinates given in his work, and the nebula has been sketched in from the drawings of Lamont, Bond, d'Arrest, &c. The delineation given here does not pretend to any great degree of accuracy, but will be sufficient for purposes of identification. In order to prevent confusion, I have not attached reference numbers to any of the six stars of the Trapezium, or to any below the 13·5 mag. in Argelander's scale—a magnitude which may be taken to be about the *minimum visibile* in a refractor of 7in. or 7½in. aperture.

The reference numbers, arranged in order of magnitude, Bond's Nos., the magnitudes in Argelander's scale, and the co-ordinates $\triangle\alpha$ and $\triangle\delta$ in seconds of arc, reckoned from $\theta'$ Orionis as the origin, are as follows:—

| | | | Co-ordinates. | |
|---|---|---|---|---|
| | Bond's No. | Mag. | $\triangle\alpha$ ″ | $\triangle\alpha$ ″ |
| 1. | 685 | 7·7 | + 96·9; | − 95·8 |
| 2. | 708 | 8·5 | + 150·6; | − 99·5 |
| 3. | 669 | 9·8 | + 62·9; | − 99·2 |
| 4. | 635 | 10·5 | + 7·9; | − 97·7 |
| 5. | 724 | 10·5 | + 182·3; | − 177·0 |
| 6. | 558 | 10·7 | − 159·7; | − 119·0 |
| 7. | 671 | 11·5 | + 69·0; | − 25·2 |
| 8. | 663 | 11·7 | + 55·1; | + 146·3 |
| 9. | 575 | 11·9 | − 85·4; | − 22·7 |
| 10. | 647 | 12·1 | + 22·0; | + 37·4 |
| 11. | 709 | 12·3 | + 152·1; | − 137·4 |
| 12. | 589 | 12·7 | − 57·8; | − 21·0 |
| 13. | 622 | 12·7 | − 8·1; | − 28·4 |
| 14. | 651 | 13·1 | + 28·8; | + 47·0 |
| 15. | 657 | 13·1 | + 39·4; | + 164·4 |
| 16. | 618 | 13·1 | − 11·0; | + 24·0 |
| 17. | 676 | 13·1 | + 77·9; | − 28·4 |
| 18. | 636 | 13·3 | + 7·8; | − 9·3 |
| 19. | 612 | 13·5 | − 17·0; | + 24·0 |
| 20. | 654 | var. | + 32·6; | + 9·2 |

The magnitudes of Nos. 1 and 2 are taken from Prof. Safford's table on p. 123, as they appear preferable to those given on p. 85. No. 18 has been called the seventh star of the Trapezium, its position from C. of Σ. (*cf.* English Mechanic, Vol. XXXIV. p. 448) being about 136° 12·1″. O. Σ. failed to see it at Pulkova with the 15in. refractor, as also Nos. 19, 16, and 13. No. 20 is the celebrated variable, No. 78 of Sir J. Herschel's catalogue in the Cape observations. It varies from about 11·5 mag. to invisibility, and the change is very rapid. Several others have been also thought variable.

Those observers who see, or imagine, faint stars inside the Trapezium should determine the limit of visibility with their telescopes on such occasions by means of the stars shown on this chart. Prof. Holden found that 11·0 mag. Arg. was about the limit of visibility with the central 3·5in. of the 26in. refractor, and a power of 175, in January, 1878; with a power of 400, he fancied he saw the fifth and sixth at intervals, knowing exactly where to look for them.

In letter 23842, page 539, for 633 ‖ read 633**. In the table on page 8 of Prof. Holden's monograph of Σ. 748, for 617 read 617 ‖, and delete the two asterisks attached to No. 640.

Feb. 21. **H. Sadler.**

## DRAWINGS OF THETA ORIONIS.

[23891.]—No doubt Mr. Binns (letter 23867, p. 557) will pardon me if I direct his attention to the fact that I never asserted that *he* had said anything about the moon in reference to his observation of October 4th, 1882. According to the almanac, the moon was at that time about 30° N.N.E of $\theta$ Orionis, and ought, as she was at her last quarter, to have been shining "brilliantly," and I fail to see how my statement to that effect was in any way erroneous. Possibly the behaviour of the moon, as seen from your correspondent's residence on the morning in question, may have been as eccentric as that of the satellites of Jupiter on a previous occasion, duly reported by him on page 99 of Volume XXXIX; but that is Mr. Binns' business, not mine.

As Mr. Binns seems to be still under the pleasing delusion that his drawing could represent the appearance of the Trapezium, relatively to the cardinal points, as he has shown them, in a direct or any other eyepiece, or in any conceivable hour angle, it would be cruel to attempt to disabuse him.

After reading letter 23843, however, I would venture to suggest, with all due defererence to him as an "Assoc. M.I.C.E.," that the next time he favours us with a drawing of some celestial object it should be executed in ink, and not in pencil, and that if he happens to describe a circle, or a few stars too many in his first attempts, he should take a fresh piece of paper and commence *de novo*. The ENGLISH MECHANIC is a scientific paper, and not a "penny dreadful"; and though it may be too much to expect that Mr. Binns's drawings should resemble the objects he intends to portray, yet, at all events, they should be executed with some trifling degree of care. I fear that Mr. Binns has neglected to duly lay to heart the excellent advice tendered him by a "Fellow of the Royal Astronomical Society," on page 121, of Volume XXXIX. **H. Sadler.**

### THETA ORIONIS.

[23892.]—I BEG to thank "A Fellow of the Royal Astronomical Society," Mr. Gore, and others, for their answers to my question about Theta Orionis, &c. I have procured the number referred to by "J. C. L."—*i.e.*, No. 877, Jan. 13, 1882; but there is a curious difference between the angles given there by Mr. Sadler and those by Mr. Binns in the MECHANIC for the week before last.

Would "A Fellow of the Royal Astronomical Society" or Mr. S. tell me if there is any mistake in these two drawings? I see Mr. Binns says he made his on the meridian. Perhaps that makes some difference; but I thought the angles were shown correctly on the meridian but wrongly off, and I do not understand what Mr. B. says about "the cardinal points so nearly agreeing with each other." If the several drawings are rightly orientated, as seen on the meridian, should they not agree? But perhaps this is my stupidity. I see a small star near Mira Ceti—I suppose that alluded to by "Epsilon" (p. 462). It is very blue in my 7½in. reflector. Rev. T. Webb gives no measnres, but says "suspected of being connected with it." Would "A Fellow of the Royal Astronomical Society" give measures and say whether this is a fact, and would he or Mr. Sadler give latest measures of ζ Tauri, 80 Tauri, O. Σ., 98 Orionis, all in Webb, but I cannot see them separated, except O. Σ. (14) Orionis, angle 200°, distance ¾″ ? ? white, beautiful blue, or make out "pair *n.* a little *f.*" the latter star, spoken of by Webb, p. 361. Has this little pair closed up? I see bright star *s. p.* δ (Delta) Tauri, not in Webb, and not marked "D" in Proctor, and a very pretty little triple about 3½ minutes of time following, and 20′ south of 135 Tauri. It is a close pair of, say, 7 and 8 magnitudes, est. angle 70°, dist. 2¼″, with a very faint star about 12″, and *s. f.*; colours deep yellow, deep blue. There is a bright star nearly as large as the big one of the pair a long way *n. p.* Between this and 135, nearer this and in the field with it, with my power 148, a little *s.* of the line joining this and 135 Tauri, is a bright white pair about 30″ apart, or perhaps a little more. Will "F. R. A. S." look at these and say whether they are new? I am surprised such bright and beautiful objects are not in Webb; but I can hardly suppose them to be new discoveries. **J. W. Ruthven.**

### JUPITER.

[23893.]—ON Feb. 27, at about 10 p.m., turning my telescope on Jupiter, I was surprised at seeing Satellite IV. on the disc as a dark spot. I continued to watch it until about 11.30 when I had to retire; it was then near the central meridian, north of the equatorial belt, and almost as black as I have seen its shadow. I was not able to compare the two on this occasion, as I retired before shadow and ingress; but some of "ours" may have seen both, and therefore be able to say whether the Satellite was as dark as its shadow. Webb, in "Celestial Objects," speaks of those dark transits as uncommon occurrences, therefore I thought I would call attention to this one. My telescope is a 7in. mirror; power 250.

Bank Top, Darlington. **W. H. Harris.**

### DARK TRANSIT OF JUPITER'S 4th SATELLITE.

[23894.]—THE transit of the 4th satellite of Jupiter on February 27th was doubtless observed by others as well as by myself. The satellite presented the same black disc on the face of the planet that it did on March 12th last year. The shadow appeared on the planet two hours later, and, contrasted with the satellite, was but a shade darker and about twice as large.

The surfaces of the satellite must be constituted of different reflective matter, since the first and second are bright when they first enter the disc of the planet and then disappear. The third is grey, and the fourth black.

**William Coleman, F.R.A.S.**

Dover, March 2.

[23895.]—THIS unusual and beautiful phenomenon was seen by me on the evening of the 27th and morning of 28th February. It was peculiarly interesting, being dark the whole time of transit. The satellite and its shadow, when each were equidistant from the preceding and following limb of the planet, could not be distinguished from each other in colour; they were both of an inky blackness. When nearing the edge of the planet's disc there was a slight fading of the satellite's colour to dark grey. After egress it was very faint. I judged its light would be about equal to a 10th mag. star.

I used 10in. of 10¼ mirror, a splendid low-power Huyghenian eyepiece, and Barlow lens.

Wick, Christchurch. **E. Miller.**

### THE DOUBLE TELESCOPE.

[23896.]—THE letter of "W. T. N." (23850, page 539) opens up the very interesting suggestion of dividing any large object glass down the middle and using the resulting halves binocularly. I find that by hiding the two inner halves of any opera-glass o.g.—which gives the equivalent effect of "W. T. N.'s" suggestion—one sees the whole image through the two outer halves only, precisely as with two whole o.g.'s, but with much less light.

In the 3⅜in. o.g.'s of my double telescope their focal centres are brought to 2½in. apart (besides room for play of varying widths of eyes) by cutting off ⅜ths of an inch from their inner side, notwithstanding which their focal picture can be found only at the one particular central spot; so much so, that even on turning the instrument from a longer to a shorter range, or vice versâ, the width apart of the o.g.'s always requires readjusting to bring the picture into exact line of sight and prevent overlapping or the contrary effect.

I assume, therefore, that the focal image will still only be found in the exact centre of any object glass, however much it may be cut or mutilated, even to halving it; so that if an 8in. o.g. were divided down the centre, the focal image would be found only on its cut edge exactly half-way up.

To utilise those halves binocularly, the two 4in. wide and 8in. high sections must be mounted in an 11in. single tube 2½in. apart—eye width—with ½in. more for variation in eye widths = 11in. in all.

It is also natural to suppose that having only half the o.g. (although they give the entire picture which whole o.g.'s would give), the resulting picture would be illumined with only half the light of whole o.g.'s.

The questions then arise: Would half the light of one 8in. o.g. so treated equal or excel all the light of two 3⅜ o.g. reduced to 3in. each in width? And, having regard to the greater magnifying power of the former, how should the result of the divided 8in. be expected to compare with that of the two 3⅜in. (reduced to 3in. in width)? Our "F.R.A.S." could no doubt solve these questions if he will be kind enough to oblige. **Montmartre.**

### OBSERVATORY.

[23897.]—REFERRING to "M. A.'s" letter in your last (23868), whether the roof required fastening or not depends very much on its construction. If it is light, it is better to have some contrivance for this purpose; but if it is substantial, which on every ground I think the best, it is not required. I sent you a description of the construction of mine, which appeared, and was figured in No. 815, Nov. 5, 1880, page 210. (There is a printer's error in the size of the plate, which should be 6in. by 3in., 12ft. square.) The ring of the roof is here built up of three thicknesses of 1in. segments of planed flooring board 6in. wide, which is perfectly rigid, and has not warped in the least since it was put up. The rafters for shutters and behind are 3½ by 2in., the others 3½ by 1¼in., covered with canvas. This makes a substantial roof, and has weight enough not to be moved by the wind. It revolves on eight rollers, 4in. diam., 2½in. wide, in iron frames fixed to the plate, and there are also eight vertical rollers 4in. diam. 1½in. wide, running on pins in strong iron brackets 6in. wide, fixed also to plate, with two strong bolt screws which have slots in them to adjust the rollers as near the ring as required. They were set when first put up ¼in. from the ring, and have never been moved since. The ring simply rests on the rollers, and is kept in its place by the vertical ones, and can never jam in any way; it generally only touches two or three of the vertical rollers. Care was taken in fastening the segments of the ring together, that there should be no nails where it runs on the rollers. These were placed towards the edges.

The roof is easily moved by the hand, or by two single 3in. blocks, a hook being placed at each angle of the plate to move the block where required. This is much better than any system of flange wheels, or "live ring," or balls or grooves, and is the plan adopted by Mr. Grubb in the large dome for the great Vienna refractor. I have my doors (two folding doors 2ft. each) to open outwards, and windows also, which are glazed with 21oz. glass, so that they can never blow in, and I always keep the roof with the shutters towards the wind, and tied down to the plate in rough weather, though in this position there is no tendency to blow open.

Fordingbridge. **T. Westlake.**

### A PLEA FOR GOOD MANNERS.

[23898.]—IN lecturing upon astronomy I often have had occasion to refer to much valuable and interesting information in the ENGLISH MECHANIC. I feel that your paper brings such information before a very large number of readers who might not otherwise be interested in the subject, and I think that it is most desirable that all English Mechanics should be as highly educated as possible, and I believe that it is your wish to help them to be so. Now surely one great advantage of education ought to be its humanising effect, as suggested by the well-known phrase "Literæ Humaniores." It may no doubt be easier to be a gentleman *both* by birth and education, than by education *alone*, without that special advantage of birth which, if I remember rightly, a certain distinguished Lord Chancellor once described as the accident of an accident in the case of many of his *confrères* in the House of Lords. But all education, all study of science, such as you encourage in your readers, ought to tend to make them gentlemen by education. This being so, may I, as one of your readers who has often felt much indebted to your paper, earnestly appeal to you in future not to allow in scientific articles, even by way of jocosity, such expressions to appear as that in your last number in reference to "Christie Minstrels," as well as other somewhat similar personalities to which I might refer?

Quite apart from the question whether the members of the Royal Astronomical Society are not capable of judging whether they will choose to vote by proxy or otherwise, or whom they will have on their council, I must say that I think the writer of certain letters in your paper signed "A Fellow of the Royal Astronomical Society" does from time to time use expressions which make it, to say the least, unpleasant to read the said articles. They also make me feel it difficult to refer my audiences to your paper for information when I should wish to do so, because I feel that such a style of writing does not tend to produce that humanising effect upon readers which I have already said all study of science should produce. I also feel it rather hard that such articles should not either be signed with the full name of the writer, or simply by some initials. Why should I, or any other F.R.A.S., be liable to be supposed to be the possible author of the phrases or statements so signed? It is, I hope, and trust it will long be, an honour to hold the title F.R.A.S.; and it will be so if those who hold it are careful as to whom they may recommend for election; but it seems to me that it may some day be necessary to make some regulation that the title shall not be used as a signature to anonymous statements, if such use of it is injudiciously made. I have, I think, read that once upon a time, when a special honour had been conferred upon one of the Manners family, who thereby was so elated that he forgot his good behaviour, it was remarked that the old family motto, "Manners maketh man," might be changed to "Honores mutant mores." I would trust that the holding of the title "F.R.A.S." may never have this latter effect. Let all that is said about science be gently said, with good taste and kindly feeling. A noble science surely deserves that it should never be spoken of in ignoble language.

**Edmund Ledger.**

Gresham College, Feb. 28th.

### THE MUSICAL SCALE.

[23899.]—THE point at issue between "A. S. L." and Mr. N. E. Child is plainly the meaning attached to the word "scale." The latter gentleman evidently uses the word to mean the "mathematical relationship of the tones to one another" (about which "A S. L." speaks on page 453), while "A. S. L." takes these proportions, and, starting from different keynotes, supposes that with each keynote he creates a new scale. There has always been some confusion upon this point—no doubt arising from our having been taught about the scale of G, the scale of C, &c., instead of the scale *on* G or *on* C, &c. Johnson says scale means "ladder, means of ascent, regular gradation, *series* of harmonic or musical proportions"; and it is clear the measure is here denoted, rather than the series of notes after they are measured off: otherwise he would have said series of harmonic or musical *notes*. No doubt other dictionaries would bear out this view; but I cannot refer just now. The marks on a carpenter's rule represent the scale by which he works, and if he transfers these to another piece of wood, he does not construct a new scale, only copies the old one. If we accept "A. S. L.'s" view of the meaning of the word "scale," then are there an infinite number of scales, there being an infinite number of starting points, only limited by our capabilities of division and our ability to hear high or low sounds. The inverted commas in "A. S. L.'s" letter, page 453, go for what they are worth, because we all know how carelessly worded some of our standard textbooks are.

The natural musical scales appear to arise out of the demand of musical ears for simplicity of ratio between the notes chosen from which to construct our music. The simplest ratio 1 to 2 gives the octaves, 2 to 3 the fifth, 3 to 4 the fourth, 4 to 5 the major third, 5 to 6 the minor third; while 3 to 5 gives the major sixth, and 5 to 8 the minor sixth. These are all consonant with the keynote taken to start from, which, of course, is represented by unity, or 1 to 1. They are also consonant, or in simplicity of ratio, with each other, provided the interval between them is not less than makes a concord, and that the third and sixth be both major or minor. Thus, the interval of the minor third, or 5 to 6, exists in purity between the keynote and minor third, the major third and fifth, the fourth and minor sixth, and the major sixth and octave. The interval of the major third, or 4 to 5, exists in purity between the keynote and major third, the minor third and fifth, the fourth and major sixth, and the minor sixth and octave. The interval of the fourth, or 3 to 4, exists in purity between the keynote and fourth, the minor third and minor sixth, the major third and major sixth, and between the fifth and the octave. The interval of the fifth, or 2 to 3, exists between the keynote and fifth, and between the fourth and octave, all which can be easily proved by fractions, thus:—The ratio of the major third may be set down as $\frac{4}{5}$, and the minor third, or $\frac{5}{6}$ths of this, is $\frac{4}{5} \times \frac{5}{6}$, which equals $\frac{2}{3}$ or the measure of the fifth, showing there is an exact minor third between the major third and the fifth, and so on through the series.

Now, there are two large gaps at each end of the scale not yet filled. But we shall find no notes there that will be consonant with the keynote, as all our other notes have been; for there can be no concord less than a minor third until you reach the unison, or greater than a major sixth until you reach the octave. The modern musical ear, however, demands something in these spaces before admitting any scale complete. Take the major second of the natural scale first. We shall find, if we adopt that note which is an exact fourth below the fifth of the key, that the ratio with the keynote will be 8 to 9; but if we take that note which is an exact third below the fourth, or an exact fifth below the major sixth, the ratio with the keynote will be 9 to 10. And if we go to the corresponding place at the other end of the scale, and seek for the flat seventh, we shall find the note which makes a perfect fourth with the fourth of the scale to be in the ratio of 9 to 16 with the keynote; while the note which makes a minor third with the fifth, or a fifth with the minor third, will be in the ratio of 5 to 9 with the keynote. This shows that for perfect harmony we require the major second and minor seventh to be double, and there is no doubt that true musicians produce these on voices and strings and any other just-intonation instruments. Herein probably lies the explanation of the difference between the major seconds existing between the fourth and fifth, and between the fifth and major sixth of the scale. These major seconds are not alike, the former having the ratio of 8 to 9, while the latter has the ratio of 9 to 10.

Now, if we seek the major seventh, which the modern musical ear demands as a leading note to the octave of the keynote, we shall find that a major third above the fifth, or a fifth above the major third, will be in the ratio of 8 to 15 with the keynote, and if we go to the corresponding place at the other end of the scale, we shall get the minor second in the ratio of 15 to 16 with the keynote, making a major third with the fourth and a perfect fifth with the flat sixth. These intervals are all pure, and if it be desired to construct scales on C, setting them out in the following table will help us:—

| | Ratio. | | |
|---|---|---|---|
| C, keynote | 1 | or | 1· |
| D flat, minor second | 15/16 | " | ·9375 |
| D grave, major second | 9/10 | " | ·9 |
| D acute, major second | 8/9 | " | ·888 |
| E flat, minor third | 5/6 | " | ·833 |
| E, major third | 4/5 | " | ·8 |
| F, fourth | 3/4 | " | ·75 |
| G, fifth | 2/3 | " | ·666 |
| A flat, minor sixth | 5/8 | " | ·625 |
| A, major sixth | 3/5 | " | ·6 |
| B flat grave, minor seventh | 9/16 | " | ·5625 |
| B flat acute, minor seventh | 5/9 | " | ·555 |
| B, major seventh | 8/15 | " | ·533 |
| C, octave | 1/2 | " | ·5 |

Now, the sounding of these notes one after the other would not constitute a musical scale, as understood by the musical ear, but would appear to be a musical scale with several foreign notes interpolated. The natural major scale on C ascending would be C D acute E F G A B C, and descending G B A G F E D grave C, as the ear prefers the large tone to the small tone when choice is offered. For proportions reference can be made to the table. Of minor scales several are believed in, that on C (in modern use) being C D acute E flat F G A B C ascending, and descending C B flat grave A flat G F E flat D grave C; there is also the scale C D acute E flat F G A flat B C and C D flat E flat F G A flat B flat acute C; the old Scotch scale of C D acute E G A C, and the scales of some barbarous tribes with less notes than this; but there are no intervals found in any of them that do not appear in our own modern major scale, and consequently there is but one natural scale, and that is it. The minor mode is simply a setting up of the sixth as a governing note instead of the keynote, and paying homage by ascending as you would to a keynote. It may be argued that some people (untutored savages, for instance) do not sing their notes in these proportions to each other, and consequently there are other proportions and other scales. Do we not know, from sad experience, that our friends depart from these simple proportions and vex us?—and we say they sing out of tune, not that they use other scales; and if we sought out the natural musicians among these savages, I believe we should find these sweet singers using the notes of our own major scale, omitting those they have not learnt to use.

Now, the beauty of these natural intervals is admitted on all hands; musicians invariably receiving praise when they perform them, and tempered intervals are an abomination to the true musician? Can we not get these pure intervals in some way from our keyed instruments, which are now so universally used, and so cease from spoiling good ears by bad models. **S. E. Hunt.**

## MR. BOTTONE AND HIS PRIVATE CORRESPONDENTS.

[23900.]—I HAVE received over fifty letters last week asking for advice on electrical matters. Out of these fifty three contained stamps for reply; the rest were distinguished by requiring information of the most intricate kind, without any idea of the loss of time this entailed. Among these latter, a gentleman hailing from Lambeth sent me as a kind of riddle a piece of silk, which he says is largely used by a German electric company, and wished to know what the company uses it for. Evidently it is used for insulating purposes. But how much better it would have been to have asked these questions in the columns of the ENGLISH MECHANIC, when all would have profited by the replies.

Except in very urgent cases, I must decline answering querists privately—especially when they do not care to pay for postage. **S. Bottone.**

## SCREW-PLATES—LECLANCHE CELLS—WOODEN CHUCKS—VICES—QUININE AND OIL — REFINING SILVER — POLISHING WOOD—ZINC ROLLING—SCREW-CUTTING—THE MARCH OF INTELLECT—OUR UNCONQUERABLE CORRESPONDENT.

[33901.]—As I have been unable for several weeks to send my usual quantum of replies, I should like to notice a few queries which have appeared during the past month, some of which have been more or less answered. In the first place, I would say, Don't attempt to make a screw-plate (55821) for anything larger than ¼in.; they are most unsatisfactory to use, and you will waste a lot of time and temper. I sometimes use one made from an old file for screwing brass gas threads, but they are no use for iron. If you cannot afford to buy dies, you might meet with an old secondhand die stock. You could then file up and cut some dies, which would give you years of work.

It is not always sulphate of zinc which forms crystals in Leclanché batteries (55844). In fact, I don't altogether see how sulphate of zinc is to get there at all (*vide* page 526). The solution has a habit of creeping up and over the sides of the glass vessels. It will then evaporate, and leave a film of ammonium chloride both inside and out, and it will even form stalactites, which will hang like miniature icicles from the bracket on which the batteries stand. Crystals of sal-ammoniac will not dissolve in water *at once*, and a novice might infer that they were insoluble. Remedy, slightly warm the empty glasses, or cells, and cover them for about an inch from the top, both inside and out, with a varnish composed of sealing-wax dissolved in methylated spirit; gather up the crystals, put them back and add more water. Always see that the cells are half-full of water, and if the addition of water won't make them ring the bell, add some sal-ammoniac, and see that the zincs are not worn out. My batteries have been working eighteen months; they have had in the interval nothing but water, and I have had no occasion to examine the zincs.

The best way to screw wooden chucks (55848) for the lathe is to use a tap; but it is rather difficult to make a tap enter the wood to a sufficient distance to enable it to hold; that is, it gives way and strips the thread. To obviate this disadvantage use a piece of iron or brass plate which is already tapped; this is screwed to the base of the chuck, and serves to hold the tap while it cuts a correct thread in the wood. I put brass plates on all my wooden chucks, in which case I don't cut the thread in plate until it is screwed to the chuck. I think I should look at a piece of wood and a lathe a long time before I should attempt to cut such a screw with back gear and slide-rest. The chuck is, of course, turned up afterwards.

In screwing pipes and rods (55906) with dies, it is a great advantage to have a special set of jaws for the vice. Malleable cast iron will do very well. These jaws should be just filed to fit the vice, and be drilled through at the joint to fit the pipes and rods mostly in use. They will give a better grip than the bare jaws of the vice, and will prevent pieces of pipe from being done to death.

Quinine (55719) can be dissolved in almost any oil without the use of chloroform, and without using almond oil as a special solvent. Procure the ordinary sulphate, mix with the proper quantity of water, and add sufficient dilute sulphuric acid to dissolve. Now add ammonia till all the quinine is thrown down or precipitated; wash this precipitate with water, and allow it to get moderately dry. The application of a little heat will now cause it to dissolve in oil. Cod-liver oil is most generally used, and it is not necessary to heat the whole quantity of oil, as a small portion can be used, and when cool, mixed with the remainder.

The best method of making nitrate of silver from alloyed metal is that given by "Bobadil"; but after dissolving the alloy in nitric acid, the solution should be neutralised; that is, sufficient soda or other alkali should be added to correct the unavoidable excess of acid; the solution should be stirred with a glass rod (or piece of wood) while the alkaline solution is being added, and the instant the least permanent precipitate or cloudiness appears, desist from any further addition. The solution can now be filtered (or cleared by subsidence), and *clean* strips of copper inserted. The object of neutralising the solution is, *inter alia*, to save the copper, as the free acid will at once commence to attack the copper, and this, for several reasons, is undesirable.

The correspondent (55984) who says he is a French polisher, and wants to know how to polish work in the lathe, had better follow the usual routine while his work rotates in the lathe.

For all practical purposes cast zinc is, for batteries, quite as good as the milled variety (55987), and it can be made absolutely as good by a judicious application of the hammer. If there is one thing in all the world which can't be done by looking at it, that one thing is zinc rolling: don't attempt it, it will end (if not in vanity), at least, in a good deal of vexation of spirit (and pocket). I pay 1½d. per lb. for scrap zinc, and at that price I can afford (as an old employer of mine used to say) to have something to "come and go at"; but, then, I don't make my batteries to sell, and if I did I should sell such as I would use; rolled zinc ⅜in. thick, which is about as thick as can be bought, is only a plaything in batteries. It may, or may not, be of service to "L. W." (55993) if I suggest that his work could possibly be bolted to the saddle, using a long cutter-bar. I look upon the letter of "O. J. L." (23874) as a sign of the rapid march which intellect is making. He is to be congratulated on the possession of an unlimited quantum of moral courage—congratulations which I cannot offer to the writer of another letter (23873) which terminates on the same page. Vituperation certainly shows that a writer (who uses it) lacks courage or ability to meet his opponent in a fair way. It is just possible that "Invicta" may *not* be an old correspondent under a new name; but for some time past I have thought that there are some people who would like to know where he lives. It does not matter if he does call me insolent and ignorant, as I shall only give him permission to call me—well—something else.

**Os.**

## THE STATE OF MAN.

[23902.]—"O. J. L." (letter 23874) constantly refers to "the Creation" and "Adam and Eve" as Mosaic. This is to be regretted, as the history of these two events was as unknown to Moses as it was to Solomon or any other of the Israelites until after the Captivity. The Jews brought these back with them—Adam and Eve as a legend, or probably old ballad; and the Creation as a modern writing of singular power and beauty, in grammar and imagery—a thousand years in advance of anything written by Moses. If the Apostle Paul had not referred to Adam, the story would probably have ceased for ever. **Priam.**

## GAS-ENGINES.

[23903.]—STRANGE as it may seem to your correspondent who, on p. 558, appears to have lost himself, I am still of the opinion that all that it is possible to say about the gas-engine has been said in these pages. He apparently forgets that the 40th volume is just concluded, which means twenty years, and if he will search through the volumes he will find not only articles, but many valuable papers on the subject, besides innumerable letters and replies. It is, of course, possible to say many things about the gas-engine which are not true; but even on that head I maintain that my statement is perfectly correct, for if the back volumes of the "E. M." contain much that is sensible and to the point, they also contain items here and there which are simply nonsense, *e.g.*, in Vol. XXXIII., and, if your correspondent will forgive me for saying so, even in Vol. XL. I would suggest to "Invicta" that he should give us a little less "gas" and a little more "engine," and though I do not doubt that he is a master of "impertinence" and "courtesy," I would point out to him that his reply to my simple question about the cost of gasoline gas was literally and absolutely impertinent, for, instead of answering the question, he avoided it altogether, and, as usual, told your readers what he could do "an he would." We are all willing to learn; but at present "Invicta" has taught us nothing. Will he commence by giving us straightaway a design for a gas-engine as he thinks it ought to be? **A. Sieger.**

### GAS-ENGINES.

[23904.]—I am very much disappointed with "Invicta's" reply to my challenge. After the way he commenced to write on this subject, I fully expected he would have given some information about the extraordinary gas-engines he has had so little experience with, especially as he offered to give us the practical information that myself and other writers were so ignorant of, and still persists in his statement *re* gasoline for the Otto engine, and writes that the person who made the oil-gas apparatus informed him that on a test being made by Messrs. Crossley with the gas, their engine needed no alteration. The authority for my statement was the representative of Messrs. Müller (the makers in question), who informed me that Messrs. Crossley had written to their firm declining to have anything more to do with their gas generators, on account of the trouble they had in getting the valves and firing arrangements of the correct size and shape. I am sorry that "Invicta" has forgotten the address where he saw the gas-engine using a mixture of 20 vols. air to one of gas; but he refers me to Mr. Clerk's paper on his gas-engine for that highly successful engine giving off a duty of 17·83 per cent. I have since read that paper, and to my surprise find that this is the source that "Invicta" has obtained the knowledge from regarding the consumption of gas and the mixture used in the Otto, Lenoir, Hugon, and Brayton, and Sir W. Siemens's regenerative engine. His statements are portions of the paper he refers to, being twisted about to suit the different queries he replied to. As this paper makes no mention of the Ord or Bisschopp engines, it can only be assumed, that is why "Invicta" did not know the ratios of gas and air used in them. Mr. Clerk, in his paper read before the Institution of Civil Engineers (session 1881-82, Vol. XLIX. part 3) stated that his engine consumed 22 cubic feet of Glasgow gas per indicated horse-power per hour; and 17·83 was only an approximate estimate of the efficiency of his engine from the indicated horse-power, assuming that Glasgow gas had a heat capacity of 505,000 heat units per cubic foot. The consumption of Glasgow gas per brake horse-power was 29 cubic feet per hour, and Dr. Adams, in the correspondence that ensued, afterwards pointed out that by a recent analysis of this gas by Dr. Mills, the heat capacity was 735·588 heat units per cubic foot. This works out nearer 11 per cent. than 17·83.

I have yet to learn that Dr. Siemens, Professors Rucker and Kennedy, Drs. Hopkinson and Adams, Messrs. Imray, Bousfield, Davey, and the other well-known gentlemen were converted to Mr. Clerk's theory, and that the believers in slow combustion were so refuted as "Invicta" seems to imagine, especially after the same size of Clerk engine went to the Crystal Palace Exhibition, 1882, where, in competition with the Otto, it consumed 63 cubic feet of gas per brake horse-power. As "Invicta" is writing to the inventor, perhaps he will ask about this also, and oblige the readers with his reply.

I may mention that I am in no way connected with either gas-engine makers or sellers; but, perhaps unfortunately for "Invicta," I am in possession of the knowledge, and have a slight connection with the low-pressure steam motor mentioned by him that is made of cast iron—perhaps the one that he has been experimenting upon to determine the proper sizes and forms for the different powers. I have great pleasure in informing him that one of these motors is on exhibition in London, and that it works at less than ¼lb. per square inch, and very often it is working below atmospheric pressure with a vacuum inside the boiler, and the consumption of coke is less than 9lb. per brake h.p.

This cast-iron motor or safety engine is made at Leeds, and known as the Domestic Motor—Davey's patent, No. 3833, 1884. It was exhibited at the Dairy Show driving a cream separator, and has been described in *Engineering* and the *Electrician*. As "Invicta" seems burning with a desire to give a description of his new cast-iron steam motor, and to air his knowledge of heat and its uses, I shall be pleased to see this description, so that I can judge if he has been copying other inventors' ideas from the patent specifications.

If his experiments are not yet complete enough to give the description asked for, and he will publish his address, I will communicate with him, as I can show him one of these motors that does not require a safety valve, it being open to the air like an ordinary teakettle. As "Invicta" is able to set Siemens's people in the right way of making a success of their regenerative engine, in the next issue we may expect to hear that he is the inventor of the condensing engine, and that James Watt knew nothing whatever about steam, or studied heat and how to utilise it, as he says he has done. Finally, I would recommend "Invicta" to ascertain that the statements made in advertising testimonials and papers published by interested persons are correct, before again attempting to pass them off on the readers of the "E.M." as his own experience—especially the statement about the gas-making machine that will make gas of good illuminating quality at ninepence per thousand feet. **R. A.**

[23905.]—In my opinion, although "Invicta" has taken up over a column (letter 23873) trying to prove that "black is white," he has not in any way disproved the statements of "R. A.," and only quotes the inventor's statement with regard to the consumption of gas in the Clerk engine. I have seen the register of gas used for a Clerk 2 h.p., and it has shown a consumption of quite 50ft. per hour, and the engine was not doing anything like its full work. I was looking about after a gas-engine some time ago, and the "Otto" people were the only ones from whom I could get any exact statement as to gas used.

I went to every place in London where engines were for sale, and from almost everyone of them I got the same stereotyped reply on the gas question, which was, "It costs *about the same* as Otto's." Well, at last I bought one, and it had not been at work long before I found it used 60ft. of gas per hour.

Now, the Tangye 1 h.p. engine at its utmost requires between 60ft. and 70ft. per hour. What is the cause of this? And how can the engine be made to use less? Will you kindly explain?

I should like further particulars about the engine that uses from 15ft. to 18ft. per hour. You say it is to be seen in Leeds. I should like to see it myself; but as you give no name, and Leeds is a large town, I cannot spare time to make a house-to-house inquiry. I cannot help thinking that if the engine was so successful as you state, we should have heard more about it, and there would have been no occasion to go to Leeds to see it. On the whole, I think that your letter very carefully evades the original question, and unless you give the information asked for by "R. A.," I, for one, shall regret the space wasted by printing your letter and the time lost in reading it, and, no doubt, with all our readers judgment will go by default. **Volt.**

### SHORTNESS OF STEAM IN LOCOMOTIVES.

[23906.]—I gather from the criticisms of several of your correspondents on the failure of some of the new Midland engines, that they attribute it to shortness of steam. Below you will find a description of the method I adopted in a somewhat similar case which had the advantage of being both effective and inexpensive.

Having fitted up several locomotives in Mexico some time ago, two of which were of English construction, in making trial of the two English engines I found, in going up an incline of 2 per cent., the steam fell away rapidly. The above engines were constructed to burn wood. To remedy the above defect, I shortened the exhaust pipe down to the third bottom row of tubes, and sharpened the exhaust by making the hole in the mouth of the exhaust pipe a little less, and then added a petticoat or crinoline. I found I had abundance of steam. **Exhaust.**

### NEW BRAKES.

[23907.]—Mr. G. Mitchell (p. 168, 55931) says the new Midland brake is the same as the one on the Lancashire and Yorkshire: he has made some mistake. The L. and Y. brake is Smith's automatic vacuum, and has a sleeve round the piston-rod and a separate reservoir. The Midland has a packed piston-rod, and no additional reservoir. The principle may possibly be somewhat the same, but the apparatus is very different, and goes by another name.

It is quite true the two-minute Midland Clayton leak-off brake is to die; indeed, the leak-off dangerous hole is being done away with at a great rate—that is, fifty carriages a week are having it altered. This new "ball-valve" brake only began on Monday, 16th February, but it soon gives a lot of bother: it sometimes won't come off; it sticks; and if you want to change an engine or shunt a carriage, the vacuum brake goes "on," and there you are fixed till you go down the train and pull cords under each coach, just as bad as it was when we had the old Sanders brake, seven years ago.

There are a lot of changes going on just now. The North-Eastern are going to do away with Smith's vacuum and work only Westinghouse on the Scotch trains.

The Great Northern are going to take off all Smith's vacuum, and intend to adopt the automatic vacuum, in place of the non-automatic. This is one of the results of the Penistone accident.

Then there is the South-Eastern going to go in for the "ball valve," and do away with Smith's vacuum; and yet, what they are doing away with is just what the North-Western is putting on. The London and North-Western will soon see the end of the chain brake now; by July next, they say at Wolverton, there won't be a chain brake left on the line.

The Tilbury and Southend fitted a lot of new stock not long ago with the chain brake: it has all got to come off and be thrown away, and they are putting on Westinghouse as fast as they can.

The Midland is taking the steam brake off the passenger engines and putting on the vacuum; so you see, Sir, there is a fine lot of changing going on just now.

What an amount of money has been spent in the kingdom upon fitting and changing brakes—and yet the subject seems as far off a final settlement as ever. **Driver.**

P.S.—Will any correspondent oblige by giving details of the new Midland brakes

### NEW MIDLAND ENGINES.

[23908.]—In reply to Mr. J. Kean, I may state that the run referred to with the new Midland 19in. cyl. engine was made in September last, when those engines began to run in the Nottingham fast expresses. The speeds of 75 miles an hour and upwards were attained in every case on falling gradients varying from 1 in 200 to 1 in 100, viz., below Ampthill and Sharnbrook and approaching Saxby and Nottingham. I have not any full notes accessible here, but will endeavour to send details next week. I may say, however, that the maximum speed reached was about 76 miles an hour, the train consisting of nine coaches, and the weather being fine with dry rail.

Liverpool, March 2. **C. Rous-Marten.**

### MANGANESE STEEL.

[23909.]—In reference to a paragraph which appears on page 571, Vol. XL., I have been using manganese steel since Christmas with the very best results.

The difficulty with Bessemer steel is that it will not stand case-hardening to any extent; but, instead of receiving a hardened skin, seems to be penetrated clean through and rendered as brittle as gingerbread.

On receiving some bars from Messrs. Pfeil and Co. I cut a 3in. length from a ¾in. rod and turned it all over; in the middle of its length I cut a nick 1/16in. deep with a V-pointed screw tool. This piece was afterwards subjected to a case-hardening process for three hours and allowed to cool in the fire; subsequently, it was heated and quenched in cold water, which left the outside as hard as hardened cast steel.

It was afterwards suspended on a swage block, and required three smart blows with a 14lb. hammer to bend it to a curve, the versed sine of which was ¼in., and then showed no sign of fracture at the nick, which had been provided for this purpose. Seeing that the amateurs are still—will they ever finish?—discussing the material and form of their lathe mandrels, I beg to state that, in my opinion, there is no material in the market so suitable as this for the purpose. **W. J.**

### SLIDE-VALVE DIAGRAMS.

(*Continued from p.* 541, *Vol. XL.*)

[23910.]—I now come to the Zeuner diagram, which is one of the simplest.

I will take as an example the same value as that which gave the diagram shown in Fig. 15 (p. 541). As in the former figures, draw A G—to any scale—to represent direction and length of stroke of piston. Bisect at $p$, and draw the perpendicular $J p D$.

Set off the angle $D p y$ ($= \theta =$ the "angular advance" of eccentric). Thus: Make $l p$ equal to the lap, and $l d$ equal to the lead, at the top end (that furthest from the crank) of cylinder. Draw the perpendicular $d y$. With the throw of the eccentric as radius and $p$ as centre, draw an arc cutting $d y$ in $y$.

Join $y p$. $D p y$ will then equal $\theta$.

On $p y$, as diameter, describe the circle $d y m p$,

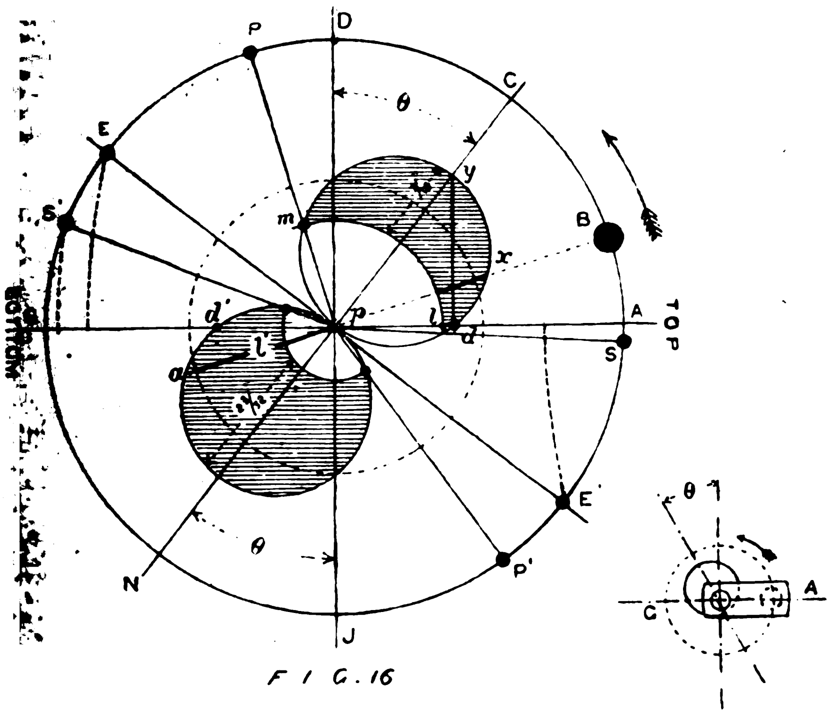


FIG. 16

and call it the top valve circle. The length *p x* cut off any radius *p* B by this circle is the distance the top steam edge of valve has moved from mid-position when crank-pin is at B.

As no steam can be admitted until the valve has moved a distance from its mid-position equal to its lap (See Figs. 1, 2, and 6, page 143, Vol. XXXIX.), we must deduct the lap from *p x*, and this is most readily done by describing the arc *l m* about *p*, with a radius equal to the lap. The part of any radius *p* B included in the shaded space between the arcs, as at *x*, is then equal to the amount of opening of the *top* steam port when crank-pin is at B.

We thus see that steam is admitted when crank is at S; that valve is opened ¼in. at B, $\frac{7}{16}$in. at C, and cuts off at P.

Produce *y p* and on it describe the circle *p d' a* with a diameter equal to *p y*. The length *p a* cut off the radius B*p* produced by this circle, is the distance the bottom exhaust edge of valve has moved when the crank-pin is at B.

As the ports are supposed to be only ¾in. wide, it is obvious that, though the exhaust edge may move through a greater distance, it cannot open the *port* more than ¾in. Hence, if the dotted circle is drawn with a radius of ¾in. we see that the exhaust is as free as possible when crank pin reaches a point between A and B; that it remains full open until the crank is at a point between D and P; and that it closes at E, having opened at E'.

Where, as in this case, there is no exhaust lap, E E' is a straight line at right angles to *y p*.

In considering the steam admission to the lower end of cylinder, the lower circle is used; the "lap circle," in this case only $\frac{9}{32}$in. radius, being described about the centre *p* cuts *p g* in *l'*, giving the lead *l' d'* = $\frac{1}{32}$in. for the bottom end of the cylinder.

Here, as before, the space between the lower valve circle and the lap-circle gives the opening of steam port at the bottom end, and the produced radius is cut off by the top valve circle to a length equal to the exhaust opening at the *top* end of cylinder.

Thus, when crank is at S', steam is admitted to bottom end of cylinder, the exhaust at top being open $\frac{9}{32}$ (found by producing S' *p*) until cut by the top valve circle; at H the steam to bottom is $\frac{11}{32}$ open, and the top exhaust is ¾in.

At P' the steam is cut off at bottom and exhaust at top is $\frac{9}{32}$ open; at E' exhaust opens at bottom and closes at top; at S steam opens to top, the bottom exhaust being open $\frac{9}{16}$; at B the top steam is open ¼in., the bottom exhaust being ¾in.; at P steam to the top end is cut off, the exhaust at bottom being $\frac{9}{16}$ open; at E the top exhaust opens and the lower one closes.

The positions of piston may be found either by striking arcs, as in previous examples, using the connecting rod as radius and placing the one leg on G A produced, or as in Fig. XVII. If the first method is used, the centres of the arcs must be on the same side of D J as the top valve circle *d x y m*. Note, also, that in drawing this diagram the angle θ is drawn on the side of D J next the cylinder, not away from it as it really is (see small sketch of crank and eccentric).

**Glatton.**

## INTERCHANGEABLE MANDRELS.

[23911.]—Could not an accurate fitting of chucks upon the mandrel-nose be insured by the following means?—viz., make the mandrel and chucks with a cylinder fit at both ends, and with the screwed portion between them. Of course, the cylindrical part at the end of mandrel-nose would have to be smaller in diameter than that next to the mandrel face, viz., a shade smaller than the diameter of the nose measured at the bottom of the thread. With chucks which require to be reversed, or in cases where the contracted diameter of the front hole in chuck would be considered objectionable, the required fit upon the front end of nose could be obtained by inserting a bush (in the form of a ring turned perfectly true inside or out) in the central hole of chuck, such bush being of the same external diameter as the cylinder part at the back of the screw on mandrel, and of course fitting the front cylinder part in its internal diameter. I should think with these two cylinder fits made as long as possible and truly parallel, combined with a face fitting of large diameter and a good fit in the screwed part, that very great accuracy would be obtained, and also durability, for, with careful usage, it would be a long time before the cylindrical parts (especially if made of ample length and with no taper whatever in them) would wear sufficiently to throw the chuck out of truth. The ring bush would, however, probably be an element of uncertainty.

I have only read a *few* of the recent letters upon this subject, so possibly the above simple expedient has been advocated by others in these pages, or there may be some fatal objection to its use which I have overlooked.

**Wm. Granger.**

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[23012.]—"Z. Y. X." gives us some further data about "bort." The "black diamond," when a homogeneous, well-shaped crystal, is of course a *gem*, just as Mr. Hope's blue diamond is. Such very rare stones are not now in question. There are three distinct sources of bort.. The first is the "carbonado" or "carbonate." The second is the misshapen or badly-coloured diamond crystals, which are only useful for breaking up into diamond dust. The third is the dust which comes off in the primary outlining of the rough gem diamonds. This primary outlining is, to some extent, effected by fixing two rough diamonds in handles by means of cement, and then skilfully rubbing them against each other so as to make them abrade each other and roughly outline the facets which are to be formed by subsequent grinding upon the revolving iron skyf charged with diamond dust. Bort so obtained is of a peculiar grey colour; but under the microscope it is seen to be composed, as I have already said, of minute, transparent sparks like broken glass or diamond crystals of microscopic dimensions, and it is entirely destitute of colour. The dust thus abraded is carefully caught in a little box, and is afterwards graded by sifting or elutriation. The misshapen or badly-coloured crystals, which are unfit for use as gems, and will not come in for other purposes, are broken up in a hard steel mortar to the requisite fineness, the useful sparks are picked out by means of a lens, the remainder is purified from particles of steel by means of a magnet, or by nitric acid; it is then graded by sifting or elutriation. The carbonado or carbonate is broken up in the same way. I am not aware that, for such purposes as trueing-up hard steel, there is any choice as to the source whence our diamond dust is derived.

I happen to have collected a good many diamond tools myself, and to have given some attention to this matter. I find that all my glass-cutting diamonds are of the boat shape, with the double-curved natural edge. These stones only cut well when used at a particular angle, and when moving on a line with the run of their keel. Used upon copper or steel plates they only grub out their lines; they do not excavate them as the etching needle excavates its line in the copper or steel plate. Writing diamonds are not natural crystals, but *sparks*, and they produce a scratch on the surface; but do not cut glass so that it will divide. An edge, or a solid angle derived from the outer surface of a crystal, is said to cut best and to last longest. These sparks cut best at a particular angle and in a particular direction, which will soon be felt and learnt for each tool if its owner has his fingers properly soldered on. Diamond drills are made of steel slightly widened out at the end, sawn down for the insertion of the diamond spark so as to project at each end crosswise, and then gently hammered together so as to hold the spark safely. Such a tool will drill glass, or china, or quartz quite easily if lubricated with paraffin or turpentine. Cutting tools intended to act as gravers are of very fine coke-like or flint-like texture, brownish-black in colour, and set in hard brass. The larger ones are set in soft steel.

As to the emery powder, I do not think I need add anything to what I said at page 542. If our contributors would only examine these things under the microscope they would see at once why the grinding action of a given abradant differs from the polishing action of a true polishing powder.

Both "Z. Y. X." and Mr. Wenham have an objection to the action of grinding laps, and recommend that we should "pare away" our hardened steel by means of a cutting diamond tool. Mr. Wenham even writes: "Some of our best lathe-makers now prefer to true up their hardened steel mandrels by a diamond-turning tool." I should be glad if Mr. Wenham would name one tool-maker who thus shapes hard steel. If anyone can exhibit a single object of such size as a lathe-mandrel in hard steel shaped in this way, I shall be glad to see it and report upon it. I believe that it is an entire mistake, due to paper-theorising, to say that any one of our tool-makers does this. Whitworths *grind up* their beautiful steelwork. Smith and Coventry, of Manchester, shape their beautiful hard steel cutters by fine emery grinding-wheels on the principles which I have described. None of our ornamental lathe-makers make their hardened steel traversing mandrels otherwise than by grinding. The real fact is that pieces of diamond of the proper shape for paring away hard steel are extremely difficult to set in such a way that they are safely held so as to do any quantity of work, and their work would never be so smooth as that of the accurately-made metal glazing wheels.

Mr. Wenham makes another suggestion, which upon paper is pretty, but in practice is misleading, and can never have been tried by him. The use of a revolving wheel to press the diamond sparks into the edge of the slicer is not necessary, because the razor back or smooth agate, as used by the lapidary, answers perfectly. The inertia of the razor blade is quite enough to imbed the diamond particles in the metal, and it can be *felt* in its action when held in the hand. The revolving wheel could not be felt in this way, and when cut into would be useless for the future. Then, for other wheels than the slicer, their face-contours would need for every variation an exact counterpart wheel. This would be impracticable.

Nickel has been used as a base for diamondiferous cutters. Discs to act as slicers, crown-wheel-like face-cutters, and other forms of tools have been made in nickel and charged with diamond dust. These were patented in 1877 by S. Dessau, and I find some of them in my cabinet. They are directed to be used with water, and have been highly spoken of; but I have never used them. Nickel as the diamondiferous base would have the advantage of not rusting. Its homogeneousness and firmness of texture also make it eminently suitable for receiving and holding the microscopic diamond sparks.

**James Edmunds.**

Grafton-street, Bond-street.

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[23913.]—I fear that our friends will not be satisfied with their work if they attempt to follow out the directions given to them (I am sure with the best intentions) by Mr. Wenham (23882), and although systems in use forty years ago may still be favourably looked upon by men of the old school, their results were unsatisfactory, and modern workshop practice is vastly different.

Having been engaged all my life in making the hardened steel ornamental lathe mandrel, I may perhaps supplement the directions given by Dr. Edmunds. His directions, which are perfectly clear and sound, are regularly in use for very fine steel work for the ornamental lathe in my factory in Norwich.

The Doctor, however, only deals with the trueing up of the hardened chuck bearing surfaces of a finished mandrel; but when the finest screw taps can be cut throughout with revolving cutters and finished with laps to a perfection never previously obtained with chasing tools, is there anything unpractical in finishing a mandrel nose by similar means, or can we do better than follow out what he has said?

If anyone tests the nose and face of a fine ornamental lathe mandrel, they will generally find both these and the portion upon which the pulley is fixed soft; occasionally, the face and nose in the hardening process get somewhat hard, but not to the extent of the sliding parts, which should be so hard that the corner of a new file will not mark them. The prussiate process which Mr. Wenham describes in his kindly-meant directions would only give a skin-deep hardening, which would be ground off before the usual amount of distortion could be cured, and yet this system is probably carried out by some lathe makers, for I have had to put new traversing mandrels and collars into comparatively new lathes which had proved inaccurate and unsatisfactory, and upon testing, these have been found perfectly soft in places, and having a kind of piebald appearance.

The chief reason why mandrels are spoiled in the hardening is because they are allowed to swag in the fire before they are chilled. Now, a lathe mandrel with its large collar put as Mr. Wenham describes in a U-form sheet-iron holder would be supported upon its collar at one end and its tail at the other, and when hot enough to harden, would probably be swagged down in the middle, and when chilled would be found to be bent. This bending, therefore, is not caused by the chilling, but by allowing it to be unsupported in the middle while soft and flexible; then again, the process described by Mr. Wenham would harden the mandrel in the portion upon which the pulley is fixed as well as at its slide bearings, and this would render it extremely difficult to key out and finish to fit the pulley. With the greatest care occasionally a mandrel will get hard a little too far towards its central portion, and this entails a considerable amount of grinding to perfect. The practical point in this hardening is that the mandrel should be bedded upon soft ashes for its whole length, and also be continuously turned while hot; the swagging while hot is fatal.

Mr. Wenham says: "Some of our best makers now prefer to true up their hardened steel mandrels by a diamond turning tool." This was the practice in our shops when I was a lad, and I have seen it done, but better work can be obtained by modern systems. Our traversing mandrels, made of the finest and best quality of cast steel, when bored out and hardened, are set up on dead centres with a temporary wood pulley upon them, and are slowly and continuously revolved while they are ground into shape by a dry emery wheel revolving at a very high velocity. This wheel must, as Dr. Edmunds observes, run very freely in its bearings, but without the least shake. Its surface also must be exceedingly true, or it will not produce good results. The secret in the circular saw is to have it turned up very true, so that all its teeth cut; each tooth then does its own work, and the saw cuts evenly, quickly, and easily; so it must be with an emery wheel—its cutting face must be positively true. Such wheels should be turned up with a diamond tool used similarly to a graver, and this is a purpose for which a diamond tool answers perfectly; but its use for trueing up large hardened steel surfaces is a mistake.

As to the final trueing up of the bearing, we do this upon the same principles as the Doctor described, using a copper wheel with crocus, and the last touch is finally given by working the mandrel into its bearing with a dash of crocus, washing it out quickly with oil immediately the practised hands of the workmen find it runs easily.

The trueing up of the hardened chuck bearing surfaces must be done after the mandrel is mounted in its own permanent bearing, and it cannot be done better than by the methods described by Dr. Edmunds. With such fine work of course the skilled mechanic feels his way, but he will never succeed unless he understands the principles of the method.

Mr. Wenham objects to the revolving cutter described by Dr. Edmunds on the ground that "every portion of the spiral in a screw increases in angle from the top to the bottom of the thread, and it is only a corresponding portion of a spiral, such as that in a chaser, that can touch the thread in every part." Surely this again is a mistake. The increasing sharpness of the spiral is just the same in cutting a screw with a single-point tool as with a revolving cutter, if only both have the same value given to them. Then, again, the copper chaser would have to be withdrawn and replaced continuously, like a hand chaser, and would totally fail to replace the revolving V-edged lap.

Perhaps Mr. Wenham did not see the model screws exhibited at the conversazione of the Amateur Mechanical Society by Dr. Edmunds. I venture to say that more accurate screws than those can hardly be produced, for their surfaces when viewed through a lens were most perfect.

While writing upon lathe matters, I desire once more to protest against the adoption as a standard lathe mandrel nose of the Whitworth thread with its rounded form, in place of the beautiful thread devised by Dr. Edmunds. These threads, known as the Whitworth standard, while answering every purpose for bolts and nuts, are only rounded off at top and bottom by rule of thumb, and as Sir Joseph Whitworth himself admitted, to suit the eye of a careful workman, each pitch requiring a different circle to round it down. It is, therefore, impracticable to make such a thread with exactitude, or to obtain the best results with it out of a cylindrical shell of a given size; and unless my clients order otherwise, I shall adopt the Edmunds thread from 50° truncated 7½ per cent. for all my fine screws.

Messrs. Whitworth and Co., under date of the 27th ult., have favoured me with the following data as to their lathe-nose threads, and as the information is not to be found in their list of screw threads, it will be of value to many readers of the English Mechanic. It must be recollected that the 6in. Whitworth lathe, light pattern, is their 5in. lathe, but with its headstocks and slide-rest an inch taller:—"In reply to your letter of the 25th, the pitch of thread, diameter of screw, and threads for the Whitworth lathe mandrels, are as follows—

| Height of Centres. | Diameter of Screw. | No. of Threads per inch. | Angle of Thread. |
|---|---|---|---|
| 5 inch | 1·25 | 6 | |
| 6 ,, | 1·375 | 5 | |
| 7 ,, | 2· | 4 | Average about 50° |
| 8·5 ,, | 2·25 | 4 | |
| 10 ,, | 2·5 | 4 | |
| 12 ,, | 3·25 | 3 | |

We do not make lathes except in very special cases below 5in. centres, and then the spindles are screwed with the Whitworth pitch of thread angle 55°."

I should be glad if Mr. Boord would favour us by saying when we may expect the decision of the Council of the Amateur Mechanical Society upon the standard mandrel head with its screw thread.

Griffin Works, Norwich. **Edward Hines.**

## STATE OF MAN.

[23914.]—It is rather difficult to make any comment upon the subject matter of letter 23874, p. 559, without straying into forbidden regions of discussion; but perhaps I may point out to "O. J. L." that the theory of a state of barbarism after expulsion from paradise is inconsistent with the Hebrew writings, for in Gen. iv. 17, we read that Cain "builded a city," a statement which cannot be reconciled with the hypothesis of a long relapse into savagery. Moreover, in v. 22, same chapter, brass and iron are mentioned, at a period only about 900 years after the creation of Adam.

**Wm. John Grey, F.C.S.**

Gateshead-on-Tyne.

## THE NEW TIME NOMENCLATURE.

[23915.]—The following appeared in the *Times* newspaper, 2nd March, viz.:—

"A New Clock.—A very interesting clock has just been fixed opposite the National Provincial Bank in Bishopsgate-street. It is on the 24-hours principle, and is remarkable as possessing probably the simplest method which has yet been introduced for indicating time upon the new enumeration. The new clock has only one hand, the long minute hand, and the figures around are placed as heretofore; instead, however, of indicating the hours, they indicate the minutes only, which are marked from five to 60. The hours are shown on a sunk dial revolving under the upper dial, a space being left in the upper dial in which the next hour figure comes forward instantaneously upon the minute hand completing its circuit of 60 minutes. In short, the solitary hand marks the minutes, and the sunk space shows the hour."

I happened to notice the clock to which allusion is made a few days back, remarking that it would be difficult to arrange any better principle for showing distinctly the time, according to the 24-hour nomenclature, *for large clocks*, but for watches I consider the hours from 13 to 24, placed on an inner circle, preferable.

An improvement in detail upon the clock-face mentioned above, would be to have the *hour figures* still larger than they are—there is plenty of room for this, I fancy.

There is a very large clock on the Piazza, at Venice, with the hours from 0 to 24 arranged around the circumference of the dial, with one hand to indicate the hour, the minutes being shown through a square opening just above the 12 in the lower part of dial, but the figures move forward instantaneously only every five minutes; so that the new clock, though similar in the ideal of its construction to the Venice one, is far superior in its operation.

**Gamma Sigma.**

## VIOLINS.

[23916.]—If I venture to revive a subject which many will doubtless think an unprofitable one, it is not with the intention of asking anyone to devise a new form of fiddle. When we read accounts of the fine qualities of tone attained by the old masters, are we to believe that every violin made by the Amatis, Stradivarius, and Guarnerius is an excellent instrument? Time may improve a good instrument, but it hardly seems likely that it will convert a bad fiddle into a good one. Notwithstanding that 150 years have elapsed since Stradivarius died, no one seems to have been able to improve upon his model. I am unaware whether any exact measurements of one of his instruments have been made. If any reader possesses such, I trust he will communicate it to these columns. It becomes interesting to investigate such matters, because there can be no doubt that the curvatures of back and belly are of very great importance. I seem to remember having read somewhere that the approximate curve of the belly lengthwise was a sphere of about 40in. radius, and crosswise about 5in. radius. But it appears to me that a sphere is altogether an unsuitable curve for such a purpose. I should judge that both should be catenary curves, that is, the same as a slack rope will assume when stretched between two supports. Now although this may seem a small matter, yet it must be of importance, because if the form of soundboard be such that it is irregularly affected by pressure, the vibrations will be interfered with and the sound diminished. I shall be glad to hear what other correspondents have to say on this matter, and if there be one amongst "our" circle of readers who has dissected a genuine fine old instrument, I hope he will give some account of its peculiarities.

**Orderic Vital.**

## MECHANICAL MATTERS.

[23917.]—I have to thank our good friend "J. H." for his kind compliance with my request respecting a set of engine patterns. When I have glanced down the sale columns, I have often thought how useful a series of constructive articles, such as those now commenced, would be.

In reference to the matter of lathe-mandrels, I would remark that it seems almost impossible for an amateur to construct a parallel mandrel, free and easy running, and yet without shake, if he uses a pair of hard steel collars. It is at once evident that unless the cylinder and collar fit perfectly in every part it will soon become shaky and unsatisfactory; and when once this happens, there are no means of adjustment to remedy the defect. Is it practicable to cast two pair of split bearings in steel in the same way as in brass?. If these were fitted and hardened, any after adjustment, if necessary, could be easily managed.

And with reference to the ordinary coned bearings, can it be shown that hard steel has any great advantages over good hard brass?

**Orderic Vital.**

Anhydrous Analysis.—In consequence of the author of letter 23887, p. 562, not having received proof in time, several errors escaped correction. On page 563, 12th line from bottom of first col., read "Inorganic" chemistry. In 14th line from top of 2nd col. read "volatility." In "Class 2, Division II." read "coloured black or white," and in the two following paragraphs, for fragments of boric acid, read "amorphous fragments in boric acid." In p. 564, 5th paragraph, read "top of the vertical sublimate," and "yellow while hot," and in 21st line, 2nd col., read "dioxydised" for deoxydised.

**Petroleum for Fire Engine Furnaces.**—It is proposed to substitute crude oil for coal for the working of the engines of the Fire Department in Brooklyn. Commissioner Poillon, Chief Nevins, and other officials witnessed an experiment of firing up an engine with the oil recently. The points of superiority claimed for the new plan is that steam can be raised up more quickly than with coal; that it is much cheaper than coal, a barrel of oil costing 1·60dol. and a ton of such coal as is now used, costing 4dol.; that as much heat can be obtained with one barrel of oil as with a ton of coal; that an engine can take to a fire enough oil to last five or six hours, while it can take but an hour's supply of coal; that with oil an engine will send out no sparks, and the running over of hose by supply waggons will be averted.

# REPLIES TO QUERIES.

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[54825.]—**Salt.**—In the "E.M.," 24th October, 1884, p. 183, Dr. Allinson states regarding salt:—"Animals in a state of nature will not touch it, though some writers affirm that buffaloes go long distances to a salt lick. . . . Even if some animals will take it, we must not argue that they are right, for animals can and do make mistakes, like human animals." Now, I can assure Dr. Allinson that he is wrong in saying that animals in a state of nature will not touch salt; and also wrong in his supposition that animals that do take it get no good by eating it. I have been engaged in breeding and fattening cattle for the last twenty-five years (in hilly country quite 150 miles from the sea in a straight line), and can state positively that salt is absolutely essential to the health of both cattle and sheep, whether born and bred here, or brought here from other pastures. I use about four tons of rock salt per 1,000 head of cattle, and about 12cwt. per 1,000 sheep, per annum. Abstinence from salt has the effect of causing the stock to fall off in condition, and to become dry in the coat and hide-bound, all of which symptoms disappear when the animals can satisfy their craving for salt. The kangaroos, which certainly are "animals in a state of nature," greedily lick the salt put out on the run for the cattle and sheep.—HENRY SHARP, Green Hills, Adelong, N.S. Wales, 10th January, 1885.

[55049.]—**Powerful Opera Glasses.**—My last communication (p. 500) brought me correspondence with some 30 of our readers inquiring for these glasses. Upon orders going forward to maker No. 2 in Paris, he replied that he must raise the price of the 7-power instruments. Differing altogether with "Philoctetes," who says, p. 522, that high powers must necessarily mean high prices (the only difference between high and low power being small instead of large field, and high instead of low magnification, with the same light), I wrote to maker No. 1, who answered that he would put in hand at once a certain quantity of 7-power, as well as of 4 and 10-power glasses, to ascertain the lowest cost at which these three sizes can be respectively supplied. On receipt of the information I will advertise it on our front page. He assures me, meantime, that there will be, at any rate, no need to increase the price as his neighbour has done.—MONT-[illegible].

[55226.] — **Screw-cutting.** — Referring to "Valetta's" reply to "Glover" *re* screw-cutting in "E. M.," 28th November, 1884, page 290, I took his index to cut four threads to an inch, but could not have the wheels to gear. My leading screw is two threads to an inch, and number of teeth per wheel are from $\frac{1}{2}\frac{5}{0}$ increasing five each wheel. Any information will be very thankfully received.—YOUNG TURNER.

[55372.]—**Rotating Apparatus for Vacuum Tubes.**—If "D. C." will please refer to above number, p. 522 of "Ours," and will kindly furnish the desired information, he will greatly oblige, amongst others—J. W. S. L.

[55384.]—**American Organ.**—To MR. FLOYD.—I first removed a portion of the tube board to suit the length of the 8ft. reeds, and glued a mortise-board on the bottom. I then made mortises on top of the 4ft. tube board, between the end of the reeds and the plunger holes, and glued the board on. I found it necessary to put on the little mortise-board, as the tubeboard projected over the 4ft. row, and I could not fix it over the 8ft. row; as the space between end of tube and plunger-hole would be too short for the mortise, I left the reeds straight. The tone, though not so loud as the other rows, is clear and without harshness, and the reeds speak as promptly as the others. Do you know if there are any Munro reeds made of shorter scale than the ordinary ones? and would you kindly say what would be the best kind of reeds to use for an organette?—H. M. I. R.

[55487.]—**Hot-Air and Vapour Baths.**—I should like to ask if an atmospheric gas-burner could be used in the above baths without any ill-effects to the patient.—G. P. H.

[55520.] — **Condensation on Galvanised Roof.**—Kindly refer to advertisement columns.—T. P.

[55571.]—**Turbines.**—Thanks to "Essar" for his attention to above query. On referring to my former letter, I find I have not explained sufficiently. As I have but a small supply of water, I must, to increase my fall and power, excavate tail race to a depth of 30ft. My pond is about 15ft. over level of farmyard, and I shall then have a total fall of 45ft. I purpose setting turbine about 10ft. under level of farmyard floor, and having the remaining fall of 20ft. utilised by means of a draft tube of cast iron, 9in. in diameter, perfectly airtight above, and having its lower extremity sealed by the water of the tail-race to prevent the air from entering and liberating the water. Now here is my difficulty. All the authorities I have consulted agree in saying that a draft tube will work under above-mentioned conditions, provided that the draft tube is *placed perpendicularly*; but none of them will say positively that it will be equally effective when laid on an incline. Now, the water in a draft tube is governed by exactly the same law as the water in the suction-pipe of a common lift pump, and we every day see these last prolonged almost indefinitely, and lifting water from wells at great distances from the pump barrels. I myself can see nothing to prevent the draft-tube acting when set on an incline; but I fear that the air might get in at the glands of turbine and cause the water to leak off at bottom. To obviate this I thought of putting a valve at bottom of draft-tube, and then, should it leak away when standing still, I could by closing valve and opening sluice of turbine, fill all the tube again, as the air would escape to pond, the whole length of pipe being inclined. However, before completing the work, I should wish to know if any of the readers of our valuable journal have seen anything on the same plan at work.—E. F.

[55605.]—**Ritchie's Electro-Motor.**—In reply to "Gatton Park," I have referred to Prof. Thompson's book, and find that he does call Ritchie's magneto-electric generator a "motor"; but if the querist will refer to p. 530, Vol. XVIII., he will find that Mr. Ritchie himself describes it as a machine for producing current for working clocks. "The mere mechanical part of causing the armature to rotate in front of the magnet-poles might be performed by a weight or other motive power, and might be continuous, or started at regular intervals, by a governing clock." The number of the patent is 169, 1864, "Applying Magneto-Electricity for Propelling Clocks." "Four coils are arranged on soft iron polar extensions of a permanent magnet, and a keeper is rotated over them; or a disc wheel carrying small bars of iron is rotated before the poles of a permanent magnet." I presume the apparatus could be used as a motor, but that was not its purpose. I can find no other motor of Ritchie's.—NUN. DOR.

[55606.]—**Ritchie's Electro-Motor**—Consists in an electro-magnet poised on a pivot between the two poles of a permanent horseshoe magnet; the wires which are coiled round the pivoted electro-magnet dip into a circular trough, divided into two halves by a central partition placed in a line with the poles of the permanent magnet. This trough is filled on either side of the partition with mercury, and as each half of the trough is connected with opposite poles of the battery, it acts as a commutator.—S. BOTTONE.

[55689.]—**Marine Piston Speeds.**—I cannot tell your correspondent what piston speed was employed on the *Livadia*; but he may get at what he appears to want to know by remembering that it is very rarely indeed that the number of revolutions is less than 55 per minute, while in small vessels it often reaches even 200. There is no reason why with large engines a speed of 1,000ft. per minute could not be maintained.—ESSAR.

[55690.]—**Electro-brassing.**—Brassing by the galvanoplastic process is not an easy thing for any one without considerable practice; but the querist will find much information in Gore's "Electro-Metallurgy," Longmans. For coating castings of iron he may try the following:—Dissolve 2 parts of sodium bisulphite, 5 of cyanide of potassium, and 10 of carbonate of sodium in 80 parts of distilled water; add 1 part fused chloride of zinc and 1½ part of acetate of copper dissolved in 20 parts of water.—NUN. DOR.

[55692.]—**Sand Blasts.**—I think the sand blast patent has expired by efflux of time; but the querist will find details in back volumes, pp. 314, 437, Vol. XXVII.—NUN. DOR.

[55707.]—**Bessemer Steel Tires.**—This is to be done only by finding the sectional area, and multiplying that by the known weight of the metal in a given area. I think there are rules in Hoare's "Iron and Steel," pocket-book, published by Lockwood and Co., but cannot refer, because, like the Spanish Armada, the book is not in sight.—ESSAR.

[55723.]—**Gramme Dynamo.**—To S. BOTTONE OR "W. H. E."—Send me full details as to size and shape of your field magnets and armature, and what you require the machine for when done, and I will do my best to assist.—S. BOTTONE.

[55725.]—**Liquid for Hydraulic Machinery.**—The usual thing is to add about 20 per cent. of glycerine. I don't know where to find a table giving the freezing points of mixtures of water and glycerine.—E. T.

[55728.]—**Creasote Oil.**—The cheapest would be brick faced with cement; but I think iron would be better.—ANILINE.

[55736.]—**Legal Rights.**—This query can be answered only by referring to the Act incorporating or granting powers to the water company, whichever it may be. Companies of the kind have certain powers which enable them to compel customers to put in proper fittings, but exactly what they are depends on the wording of the respective Acts.—LIMB O' TH' LAW.

[55738.]—**Tinmen's Solder.**—By running the proper mixture at a suitable heat, tin solder comes out bright.—E. T.

[55752.]—**Legal.**—If you can prove that the property is yours, summon the person who refuses to give it up.—LIMB O' TH' LAW.

[55753.]—**Flywheels.**—I have looked up this flywheel, and don't wonder that it passed with "little notice." It consists in arranging some tubes so that mercury would shift its position as the wheel revolved. If "Norfolk" thinks that a flywheel weighing cwts. can do the work of one weighing tons, he must have altogether failed to grasp first principles.—ESSAR.

[55760.]—**Blow-off Pipe.**—I am not aware that boiling water is more resisted by the atmosphere in its outflow than cold water, and can only suggest that the difference mentioned by "Yama" arises from a fall of pressure in the hot cylinder. The formula I gave assumed that the pressure was constant.—WM. JOHN GREY, F.C.S., Gateshead-on-Tyne.

[55785.]—**Locomotives.**—Many thanks for the replies of "Invicta" and E. Gobert, B.Sc. The information has been of great service to me. There is, however, one point I observe in the numerous experiments recorded in "Railway Machinery," no mention is made of the depth of fuel corresponding to the recorded draught. On this account the experiments seem to me to be somewhat defective. I notice in a chapter on the combustion of fuel in a recent edition of Rankine's "Steam Engine," mention made of a method of firing boilers which has been in use in France, and is called the "Système Beaufume." Any information about this will much oblige.—ASTERISK.

[55794.]—**Gas Tanks.**—As a lime-light operator in country theatres, using gas bags, I am considerably interested in this query, and in connection therewith I should like some information respecting a statement in Chadwick's "Lantern Manual." It refers to a gas tank of special construction. The pressure was applied by water from a ball-tap cistern, and conveyed to the inside of the holder by a pipe. The end of this pipe dipped into a vessel of water placed in the upper part of the inside of the holder, and from it was an overflow pipe conveying the water to the bottom of the holder. The author states that the pressure was due to the difference in height between the surface of water in the cistern and that of the vessel within the tank, and that, however much or little gas was in the tank, the pressure was constant. Is that so? Is not the pressure due to the difference between surfaces of water in holder and cistern?—CUIDADOSO.

[55798.]—**Stove.**—Kindly refer to advertisement columns.—T. P.

[55801.]—**Smith's Bellows.**—To "INVICTA."—A circular bellows would be made in a way very similar to that already given by me, with the exception that the wood part would be circular instead of oblong. In practice I cannot say I like the circular form so well as the oblong. As you desire it, I append a rough sketch showing on

FIG. 1.

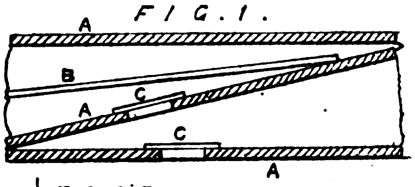


FIG. 3

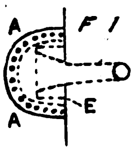


FIG. 2.

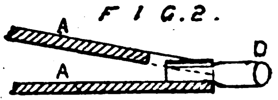


Fig. 1 bellows in section; A A A are the flue boards; B, one of the four stretchers; C and C the air valves; Fig. 2 shows how the blastpipe is secured to the reservoir. It will be seen that the pipe is flattened, so that it has less height. This is then made up with a piece of wood cut to fit it so that it stands up square. The top board A is cut away as shown, to allow this to be done, whilst E, Fig. 3, shows the apron piece. This being well nailed round the edge and over the lap, makes a simple and tight joint. It must be, of course, nailed on when the reservoir is empty, or it would be likely to prevent it fully closing. Weights placed on the upper board, and well secured there, regulate the force of the blast. I trust the sketch, rough as it is, will make all clear to you. If not, I am still at your service if I can help you.—Invicta.

[55802.]—**Silos**—I have never seen a silo without sides of some kind, either walls of brick, stone, or concrete, or else boards. When boards are used, or even when the walls are not smoothly plastered, the air will enter, either through the joints or down by the rough sides of the walls, and cause some of the ensilage to mildew. I have seen a very simple means of applying pressure. In the main it is the same as that described by "Tredagh" in the "E.M." of Feb. 13th; but in lieu of two screw-jacks a cruciform forging is used, having the two opposite ends screwed, the one right-handed, the other left-handed. These screws are furnished with nuts and hooks, to which the chains are attached, and the main bar is then twisted round by means of the cross arms, and the nuts and chains are drawn together; consequently, the ensilage is compressed. I believe the article is patented. Messrs. Carson Bros., 21, Batchelors-walk, Dublin, are the manufacturers.—E. F.

[55815.]—**Boat.**—Fig. 1, p. 373, Vol. XL., is a rough drawing showing the manner in which the boat should be designed. The left side of the figure commences amidships and shows the curve aft, ending at the transom; the right side also begins amidships and shows the curve forward both from gunwale to garboard strake. Should "Nero" require further assistance, write again stating particulars of the boat he intends to build, and whether a rowing boat or small yacht.—James McCash Govan.

[55826.]—**To "Invicta."**—Thanks for your kind answer and offer of circular, to obtain which I have advertised my address.—Jay Jay See.

[55827.]—**Gravity and Dead Escapements.**—The "Country Parson," who asserts as dogmatically and courteously as if he were in that place where he is safe from contradiction, that "Sir E. Beckett is distinctly wrong in stating as he does that clockmakers charge less for making the gravity escapement than the dead-beat," is himself distinctly wrong in both ways. For, first, I have never said so; and, secondly, what I have said is distinctly and simply true—viz., that Mr. Brock has never charged me or anyone that I know of for a four-legged gravity escapement regulator, with pendulums up to 40lb. weight, more than half of what I know used to be, and I suppose still is, the price of the best dead-escapement regulators with only 12lb. pendulums (p. 127 of 7th edition). He is no less wrong in saying that I do not sufficiently recognise the distinction between the suitability of the gravity escapement for turret clocks and regulators. Not that "suitability" is the right word; for the four-legged gravity escapement is equally "suitable" for regulators and for small turret clocks, and the double three-legs for large ones, though the superiority of the gravity escapements is, one may say, infinitely greater for turret clocks. For regulators which have nothing to do but mere going—no striking or electrical work—I do not think there is any material difference between the four-legged gravity, my five-legged single-beat impulse (p. 106), Sir G. Airy's single-beat one (p. 105), and a good jewelled dead escapement, with a fine train.—Edm. Beckett.

[55843.]—**Photo-Micrography.**—To "Invicta" and Mr. Bottone:—I have put into effect your suggestions, and have used the ferrous developer. The yellow stain is gone from my plates, but the film is extremely thin. After intensification in the ordinary way, the contrast between black and white is too marked, and the negative is useless for printing a positive from. Has the light I use anything to do with the failure?—John Carrington.

[55870.]—**Optics with the Lantern.**—I am much obliged to L. Wright and W. Shrubsole for replies to my query. The latter does not quite understand why I cannot get lime near enough to condensers for parallel beam. It is because the curved part of jet strikes against condenser itself when pushed up. I have failed to get a blow-through jet which can be placed close enough. One would think there should be no difficulty in doing so. Are jets never made as in Fig. 1, instead of like mine, Fig. 2? I find I did not make query (2) plain to Mr. Wright. I proceed as follows:—I find where rays cross, after passing through loose lens, by means of smoke, and place my prism at this point. Result—a most feeble spectrum. I then try, by placing prism close to loose lens, to get very fair spectrum. This is what I do not understand; especially as in latter case much light falls outside prism (and is screened off by black card fitting close round prism), and is therefore lost. Can Mr. Wright help me, and also tell me focus of cylindrical lens he uses, and how it is fixed? I suppose it is placed in lantern front, just between condensers and slit. I do not understand answer (3); surely a longer jet would render it less possible to push lime up close to condensers—not easier.—S.

FIG.1.

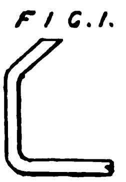
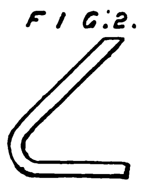


FIG.2.

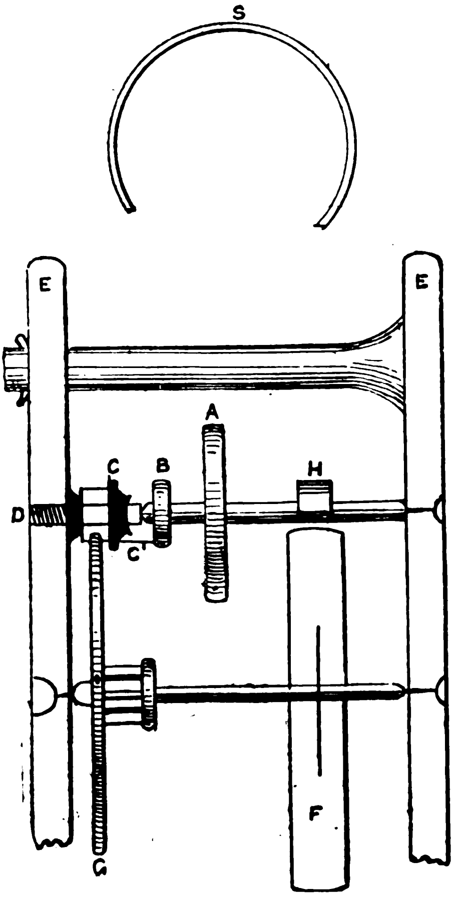


[55876.]—**Improving Light of Coal-Gas.**—At the Health Exhibition last year there was exhibited by the Omega Gas Light Company a lamp in which the illuminating power was increased by the gas passing through a carburetter. The burner used was for a consumption of 2½ft. per hour, giving, with ordinary gas, an illuminant of four candles; but this was increased by the carboleine arrangement to 17 candles, at an expense of less than a farthing for three hours' consecutive burning.—T. K. W.

[55884.]—**Fixing Clock Wheel.**—Either turn the pinion down at one end to fit hole in wheel and rivet, or drive piece of brass on arbor and treat same way. If you do not understand this, write again, and say where you want wheel fixed on pinion or plain arbor.—Noterom.

[55885.]—**Silvering Graduated Dial.**—If the graduations are not engraved you must have them painted after silvering; if engraved, silvering should not alter them.—Noterom.

[55887.]—**Altering Clock.**—The sketch below is taken from Sir E. Beckett's book which, I think, is what "Clockey" wants. A is the 'scape wheel, mounted firm on a staff; B, the mainspring (watch) which drives it; C is a brass plate riveted on to the pinion with a carrier (C') fixed firmly into it for the purpose of clamping the end of mainspring. This pinion is hollow, and runs on a foot (D) screwed into the plate E, the foot is a little longer than necessary; for the purpose of receiving a bushing for the 'scape pivot. F is a fan or fly fixed stiffly on to the second wheel G. This fan has one side longer than the other, so that the short side will pass the boss H mounted on the 'scape arbor; P, the long side, will fall against it. I just send the above, as "Clockey" desires it, though I would not advise him to go to the trouble of altering his turret clock. I think if he looks to his hands and gets them as close as possible to the dial, also sees that the minute hands are well and properly balanced, or if he will go to the trouble of putting a deep moulding all round his dials with the exception of the bottom, as per sketch S, it would improve matters by keeping the wind from playing on the hands.—Annie.



[55926.]—**Indicated Horse-Power of Launch.**—

Area of piston—

$$= \frac{22}{7} \times \frac{64}{4} = 50\ 3 \text{ sq. in.}$$

Travel of piston per min.—

$$= 300 \times \frac{16}{12} = 400\text{ft. per min.}$$

Load on piston—

$$= 100 \times 50{\cdot}3 = 5{,}030\text{lb. per sq. in.}$$

Indicated horse-power—

$$= \frac{5{,}030 \times 400}{33{,}000} = \frac{2.012}{33}$$

$$\therefore \text{I.H.P.} = 60{\cdot}9$$

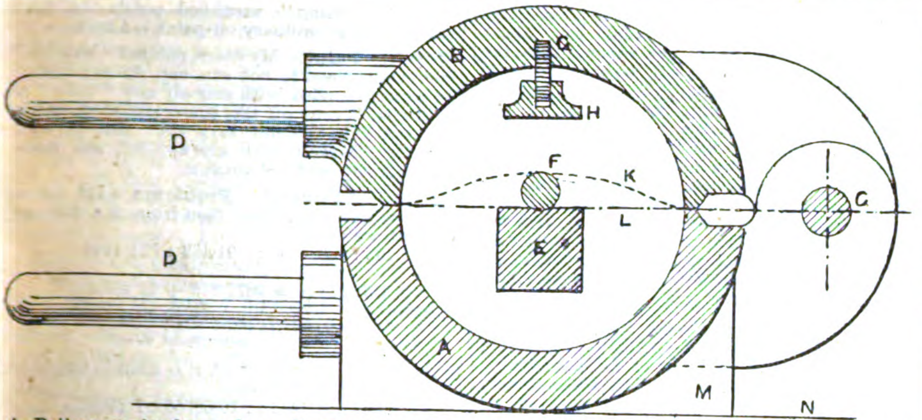
Not having the *Engineer* of Oct., 1879, or "Burgh on the Indicator," I cannot work your sum by their rules; but the above is the ordinary rule given in the textbooks. What do you mean by "300ft. piston speed"? If the No. of revolutions is 150 per min., the piston speed is 400ft. per min.—Weiv Revir.

[55930.]—**Watch Winding.**—In these so-called perpetual-winding watches there is an arrangement which acts somewhat like a pendulum, except that the ball of pendulum rises and falls at a right angle to the bow or pendant, the weight of the ball is nicely counterbalanced by two springs, so that the least motion of the wearer sends the pendulum up and down, and slowly winds up the watch in that way; that is the object of having the bow made in a peculiar shape and rigid, so that the watch will always remain in one position when worn, 12 hours or (24, I believe, now) upwards. As soon as you purchase a watch of this description it has to be wound with a key, then you are supposed to walk three miles per day, and your watch will be wound for the night; if you remain a day in bed your watch will run down. They are no better timekeepers than ordinary watches. If you wish, I will forward a sketch.—Annie.

[55932.]—**Plating Dynamo.**—Thanks for replies. Mr. P. Ward's proposal will not exactly suit. I trust Mr. Bottone will give me further information. The F.M.'s are of a very heavy pattern, and contain a considerable amount of residual magnetism, and upon rotating the armature it gives off 15 ams. and 1·5 volt, and deposits splendid copper and hardly makes any difference to the engine (a 1 h.p. Tangye gas); but when I switch the current through the F.M. coils and arrange the resistance to pass 15 ams., the E.M.F. rises to about 12 volts, and visibly slackens the engine, and, of course, I burn more gas and do not deposit any more copper. 15 ams. is not near enough for my purpose; hence the query. In the mean time will try slower speed; am at present running 1,500 revs. per min. for 13 hours per day.—Volt.

[55935.]—**Electro-Chemical.**—In his reply to this query, Mr. P. Ward mentions a current having "several million volts pressure, with about 0·2 ampères quantity." I would like to be informed how he obtained this current, which, taking "several" to mean only 34, represents over 1,000 h.p.—Wm. John Grey, Gateshead-on-Tyne.

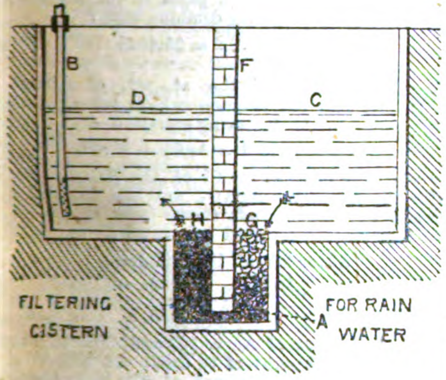
[55905.]—**Cores.**—Cast-iron pipes for gas and water mains have been made in Glasgow for a considerable number of years back with dry sand cores. They are cast on a declivity of 10 to 15 degs. in green-sand moulds with dry sand cores, and made from ¾in. diam. by 4ft. 6in. long, up to 7in. diam. by 9ft. long, and by one founder I know they are made as large as 12in. diam. by 9ft. long. I send you sketch of cross section of corebox, which is drawn about 3in. to 1ft. These core-boxes are of cast iron, in two parts, with hinge joints and handles; each of the two parts is planed on face and the half circles; they are afterwards clamped together and bored truly cylindrical from end to end, the part for socket being, of course, bored to a larger diameter. The cores are made as follows: Place the box on a table, fold back the top part and fill both with sand, lay in the core-box, which has previously been well coated with thick clay-water, into the bottom part on top of it; place round smooth pricker rod for vent hole, adjust screwed chaplet, add socket in top part, scrape sand in top part flush, and in bottom part rounded with a hollow scraper; brush joint clean, pull over top part with a "clash," ram up ends firmly, withdraw pricker, strike top part at several places with wooden mallet, open top part leaving core complete in bottom part; adjust chaplet to thickness of pipe, lift core gently by both ends and lay it over blackwash trough and take a tin can with small hole in bottom and fill it with blackwash and allow it to stream on core all the way along, and the core is ready for the drying stove. The core bars used are of square malleable iron, for a 3in. pipe ⅞in. square, and for a 6in. pipe 1¼in. square, and other sizes in



A. Bottom part of core-box. B. Top part of core-box. C. Hinge joints two or three in length. D. Handles for opening—two top, two bottom. E. Core bar of malleable iron. F. Pricker rod for vent hole. Q Screw nail chaplet, one in middle of length. H. Socket for chaplet. K. Line that sand is scraped to in bottom part. L. Line that sand is scraped to in top part. M. Webs for supporting core-box 3 or 4 off. N. Table about 2ft. 6in. high.

proportion, the bars for 9ft. pipes being about 11ft. long. With ordinary care the core is not appreciably oval, and is certainly the best and cheapest core for this kind of work. I am afraid the Editor will object to my going more fully into detail.—ASTERISK.

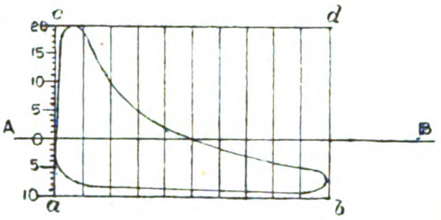
[55938.]—**Rain Tank.**—The most simple plan I know of is that shown in sketch. In this the filtering chamber is dug out below the cistern proper, and a brick wall (F) built from the centre of it to the top of cistern; the bottom of wall being arched to allow the water to pass. The filtering medium is arranged as follows:—The lower part of the chamber is well packed with *coarse* charcoal to the height of A; above this, on the side marked G, is placed fine well-washed gravel, which becomes coarse as it reaches the top of the chamber. The other side (H) is then filled with small charcoal, well rammed down. This completes the filter, which acts on the principle of the "ascension" filters, that being, I believe, about the best system. To return to sketch. The unfiltered water is stored in the side of cistern marked C, and filters through till at the same height in D. In the latter I have shown the position of supply-pipe (B) of pump. Can give further particulars if this description is not clear enough.—CHEMICUS.



[55939.]—**Legal.—Attaching a Patent for Debt.**—"B.Sc., Plymouth," is wrong. The sheriff can seize and sell a patent the same as a bale of cotton. In the case of the sale of a bale of goods the sale is perfected by delivery. In the case of the sale of a patent the sale is perfected by an assignment from the sheriff, to be, of course, registered at the Patent Office.—Z. Y. X.

[555941.]—**Refining Silver.**—"Nitrate" can separate his copper from his silver in the following manner:—Dissolve your silver in nitric acid with a little water; when all is dissolved add common salt till no more white precipitate falls down. The ppt. is chloride of silver, and the remaining liquid will contain nitrate of copper and nitrate of sodium. Then wash ppt. in filter, put into a crucible with some carbonate of soda and melt; the heat must be high enough to melt silver. The metal that results is pure silver. Redissolve this silver in weak pure nitric acid to form nitrate of silver.—J. K. S.

[55943.]—**Indicator Diagram.**—You must first ascertain the strength of the spring of your indicator; then suppose the figure (which is not drawn to scale) to represent your diagram in which A B is the atmospheric line, divide *a b*, the length of the stroke, into a convenient number of parts, say 10. Again, suppose, at cut-off, your spring indicates 20lb., divide the vertical line *a c*, so that the part above A B may contain 20 parts. Now, to get the mean pressure throughout:—At each intersection of a vertical line with the curve above and below the atmospheric line, draw a horizontal line to intersect *a c*. This will give the pressure at each division, giving in all 10 pairs of readings, those above and those below A B; adding these together and dividing by 10, we get the mean pressure.—WEIV REVIR.



[55943.]—**Indicator Diagram.**—I have not time to trouble our editor with a sketch; but the following will be found a most ready and most correct method of finding the I.H.P. Divide length of diagram into ten equal parts by vertical lines. Take a narrow slip of paper, say 7in. length, move it along the diagram, carefully marking off the length thereon of the whole nine vertical ordinates. Now, for instance, suppose they occupy a total length of the slip equal to 6¼in.; then this length must be multiplied by the scale per square inch, as found stamped on the indicator spring; divide the product by 10, and result equals the mean pressure per diagram. Disregard the atmospheric line in this instance.

$$\frac{\text{Area of piston in sq. in.} \times \text{mean pres.} \times \text{ft. per min.}}{33{,}000}$$

gives the I.H.P.—YAMA.

[55947.]—**Pressure of Water in Pipe.**—Though this is addressed to Mr. Davies, I may be permitted to say: A simple rule for the pressure of water in pipes is the following—For every 7ft. of head there is approx. 3lb. per sq. in. pressure; for accuracy add 1 per cent. to the result. 25ft. head gives pressure of 10⁵⁄₇lb. per sq. in., or, at lowest point, there is press. of $10\frac{5}{7} \times 1\frac{43}{56}$ = approx. 19lb. Suppose you have head of 12ft.:—

| | | | | | |
|---|---|---|---|---|---|
| For a | ½in. pipe | press. is | | 1lb. | approx. |
| ,, ,, | 1 in. | ,, | ,, ,, | 4lb. | ,, |
| ,, ,, | 1½in. | ,, | ,, ,, | 9lb. | ,, |
| ,, ,, | 2 in. | ,, | ,, ,, | 16lb. | ,, |
| ,, ,, | 2½in. | ,, | ,, ,, | 25lb. | ,, |
| ,, ,, | 3 in. | ,, | ,, ,, | 36lb. | ,, |
| ,, ,, | 3½in. | ,, | ,, ,, | 49lb. | ,, |
| ,, ,, | 4 in. | ,, | ,, ,, | 64lb. | ,, |

If you require the longitudinal bursting press. per inch of length, multiply the diam. in inches by the press. per sq. in. Knowing the diam. of the pipe, you find its sectional area, which call *s*; knowing the diam. of the pipe, you find its periphery, which call *c*; measure the length of the pipe, which call *e*; call the head of water, *h*. The discharge in cub. ft. per sec. is equal to $Q = S \times 100 \sqrt{\frac{h}{c} \times \frac{s}{c}}$ — $\frac{s}{c}$ is called the hydraulic mean depth. Suppose the pipe flowing full and its diam. 1in., let $h$ = 25ft. and $l$ = 100ft., $s = \frac{11}{14}$ sq. inches, $c = \frac{22}{7}$in., $\therefore \frac{s}{c} = \frac{1}{4}$ and $\frac{h}{c} = \frac{1}{4}$, $\therefore Q = \overline{\frac{11}{14} \times 100 \times} \frac{1}{4} \times \frac{1}{144} = \frac{1}{8}$ cub. ft. per sec. approx. = about 5 gallons per min.—WIEV REVIR.

[55951.]—**Visibility of Stars.**—The cause of the stars not being visible so low down towards the horizon as the sun and moon, is because their light is not capable of penetrating the stratum of air that is resting upon the earth (for this stratum of air having to support the air that is above it, it is more dense, and it has a pressure of 15lb. to the square inch). When the stars have risen 14° above the horizon, they become visible because we are looking through an atmosphere that is not so dense, and the higher they get the plainer we see them, and when we look at them immediately over our head, we are looking through an atmosphere of various pressures; that near us is 15lb., while that higher up gradually decreases to nothing. Therefore if there were no air upon the earth we should see the stars as low down towards the horizon as the sun and moon; but if the air had a pressure of 15lb. to the square inch throughout, we should never see the stars, while the sun and moon would always appear as large as they do when they are rising and setting because a dense atmosphere magnifies their diameter, and it is a fact well known that what will magnify one thing will cause another to become totally invisible. Therefore, as the stars cannot penetrate horizontally the stratum of air that is resting upon our earth, they must be invisible.—STAR-GAZER.

[55958.]—**Electro-Magnet.**—No. 24 B.W.G., s.c. will do very well, and the thickness of wrapping you mention is right. For quick-action magnets, short cores and more wire is better, as there is less residual magnetism; two Bunsens would be ample. Be very careful to have your cores very well annealed.—J. K. S.

[55969.]—**Problem.**—In hydraulic tables we find the following formula for the discharge of water from an orifice with a constant head of water—

$$Q = 8{\cdot}025 \,.\, c \,.\, a \sqrt{h}.$$

Where Q is the number of cubic feet in a second that pass through the orifice, *a* is the area in square feet of the orifice; *h* is the head of water or depth from surface of water to orifice in feet, and *c* is a constant depending on the nature of the orifice. For a circular hole in a flat plate it will be ·618. Our problem being to find in what time a cylinder of certain dimensions will empty itself, the head of water *h* will be constantly varying. Suppose the area of the horizontal section of the cylinder is A, and suppose the depth of water, or *h*, to be divided into thin layers, each $\triangle h$ in depth, $\triangle$ being a small fraction of *h*; then $\triangle h \times A$ will be the contents of each layer. Then as Q is the number of cubic feet that flow in one second, $\frac{\triangle h\, A}{Q}$ is the number of seconds that each layer will require to empty itself, or instead of Q, put its value given above in the formula in terms of *h*, and, for shortness, we will lump up the contents and call them M, so that $\frac{A \triangle h}{M \sqrt{h}}$ is the time that each layer will take to empty itself. By giving various values to *h*, according to its corresponding layer, and adding the results from last expression, we could get an approximation to the time that the whole barrel takes to empty itself; but this can be done exactly by the integral calculus. If we suppose the layers to become infinitesimal, then $\triangle h$ becomes $d\,h$, and the whole time occupied in emptying the barrel will be $\frac{A}{M}\int_0^h \frac{d\,h.}{\sqrt{h}}$ Now the integral of $\frac{d\,h}{\sqrt{h}}$ is $2\sqrt{h}$, t expression therefore becomes $\frac{2A\sqrt{h}}{M}$ If, therefore, we substitute in this the values of A and M, and make $h$ = depth of water when the barrel is full, we shall get the number of seconds it takes to empty itself. A curious fact will be found from the above. If we substitute the value of M in terms of Q obtained from the original formula, or $\frac{Q}{\sqrt{h}}$ in the last expression, it becomes $\frac{2A\,h}{Q}$. Now A *h* represents the contents of the cylinder when full, and as Q represents the number of cubic feet that flow through the orifice with a constant head *h*, then $\frac{A\,h}{Q}$ would represent the time that the barrel full of water would pass through if the height of water were kept up to its original level; but as our result is $\frac{2A\,h}{Q}$ it takes just twice the time for the same quantity of water to flow away when the barrel is allowed to empty itself without being replenished. If the barrel were cone-shaped, apex at the outlet, the time would be represented by $\frac{6\,A h.}{5\,Q}$—M.I.C.E., Bath.

[55969.]—**Problem.**—The contents of the vessel $= \cdot 7854\, h\, d^2$ cub. feet. Assuming the bottom of the vessel to be of inappreciable thickness, $h =$ height from surface of water to c. gr. of opening. Now, the veloc. in feet per sec. $= \sqrt{2\,g\,h} = 8{\cdot}024\sqrt{h}$. Sectional area of hole $= \cdot 7854\ x^2$. Now, call contents of vessel Q, veloc. of issue $v$, sectional area of hole S; we have—

$$Q = \cdot 7854\ .\ h\ .\ d^2 \text{ cub. feet}$$
$$S = \cdot 7854\ x^2 \text{ sq. in.}$$
$$v = 8{\cdot}024\sqrt{h}$$

Let $t$ = No. of seconds in time of discharge
$m$ = a constant less than 1 to be multiplied by result, its value depending on the form of opening. In this case, assume it
$= \cdot 62$

$$\text{Now, } Q = m\ .\ \frac{S}{144}\ .\ v\ .\ t$$
$$\therefore t = \frac{144 \times Q}{m \times v \times S}$$
$$= \frac{144 \times \cdot 7854 \times h \times d^2}{62 \times 8{\cdot}024\, h^{\frac{1}{2}} \times \cdot 7854\, x^2}$$
$$= 29\ h^{\frac{1}{2}} \times \frac{d^2}{x^2}$$
$$\therefore t = 29\ .\ h^{\frac{1}{2}}\ .\ \frac{d^2}{x^2} \text{ seconds—approx.}$$

—WEIV REVIR.

[55969.]—**Problem.**—

Let A = 95 sq. in., area of cylinder.
$a$ = 7·068 sq. in.. area of hole in bottom.
$h$ = 60in., height of cylinder.
$t$ = time of emptying, in seconds.
$g$ = (32·2 × 12) = gravity.

Taking the *vena contracta* at ⅝, the effective area of the hole becomes 4½ sq. in. Then—

$$t = \frac{A}{a} \times \sqrt{\frac{2\,h}{g}} = \frac{95}{4{\cdot}5} \times \sqrt{\frac{2 \times 60}{32{\cdot}2 \times 12}}$$

gives $t$ as 12 seconds. Can "Mechanic" test his cylinder and give us the result?—YAMA.

[55969.]—**Problem.**—When water flows from a circular hole in the bottom of a tank, the velocity of stream is ·594 of the theoretical velocity due to gravity. The discharge from an opening in the bottom of a tank is derived from the ordinary formula, $V^2 = 2\,f\,s$, when the head of water is constant. Thus, $V = a\,C\sqrt{2\,g\,d}$ gives the discharge in cubic feet per sec., when $a$ = the area of opening in feet, and $d$ the depth or head of water, C being the coefficient ·594. Now, the time of discharge of a tank from which supply is cut off is double that when the supply maintains a constant head. Hence, if A = the cross-section of tank, we can find time of discharge through the opening by dividing the volume of the tank by the volume discharged through the opening per sec.; that is to say—

$$t = \frac{2\,A\,d}{a\,C\sqrt{2\,g\,d}}$$

Substituting the dimensions given in the question for corresponding terms in this formula, we derive—

$$t = \frac{d^2 \times 2\,h}{x^2 \times \cdot 594 \times \sqrt{64{\cdot}4 \times h}}$$

—GEO. A. WALTON.

[55969.]—**Flow of Water.**—Let A be area of the vessel, $a$ the effective area of the hole, $h$ the height of the water, A the time for outflow in seconds, and $g$ = as usual, then

$$A = \sqrt{\frac{2\,A^2\,h}{a^2\,g}}\ ,$$

By effective area is meant the area of the hole, allowing for the *vena contracta*. This area may be as high as ·946 of the actual opening, or as low as ·5 thereof. If the hole is a mere opening without any ajutage the coefficient is ·625. It may be mentioned that if the hole is exceedingly small, so that the ajutage is a capillary tube, then Torricelli's theorem no longer holds.—WM. JOHN GREY, F.C.S., Gateshead-on-Tyne.

[55971.]—**Twist Drills.**—The chuck will hold them firmly enough if you screw the jaws up tightly. I suspect you are afraid of breaking something. Try again. Don't waste time in endeavouring to shape the drill.—C. D. R.

[55974.]—**Gasoline for Gas-Engine.**—If you refer to some recent replies, you will, I think, find the best proportions given. The simplest way would be to pass the air and gasoline vapour through orifices of a known size, so that a constant relation of one to the other would result. There is to this plan an objection that any increase from the normal speed on which the calculation was based for the apertures would vary the proportions. A great variation of proportion would bring about its own cure. If too much gas vapour, then the engine would not work at all, neither would it work if the vapour were too dilute. If the cylinder is as strong as the Bischopp, for instance, or, say ½in. metal for a 5in. to 6in. cylinder, you never need fear a burst by the use of a very strong charge. No charge you could fire in such a cylinder would rupture it. On what plan are you proposing to make a gas-engine? I have often, when discussing the question, wondered why for small powers the oscillation cylinder form has not been used. As the advertisement pages will show, the oscillation cylinder is used for steam and water pressure. Then why not for gas?—INVICTA.

[55976.]—**Metallurgy.**—On heating argentic sulphide with free access of air it is converted into metallic silver with evolution of sulphur dioxide. A small quantity of argentic sulphate is also usually formed.—WM. JOHN GREY, F.C.S., Gateshead-on-Tyne.

[55977.]—**Diameter of Driving-wheel of Locomotive.**—The driving-wheel diameter of the Liverpool, built in 1849 by Bury, Curtis, and Kennedy, of Liverpool, for the L. and N.W. Railway, was 8ft. The Great Western had some engines built by Hawthorn in 1838, of which the driving-wheels were 10ft. in diameter, and in these the machinery was put on one carriage and the boiler on another. They proved entire failures; one of them, Ajax, had only 474ft. of heating surface.—B.

[55977.]—**Diameter of Locomotive Driving Wheel.**—The Liverpool had 8ft. driving wheels. They were the trailing pair. The largest size ever used on the G.W.R. was 10ft., an engine called the Hurricane, built by Hawthorn in 1837. The big wheels and machinery were on a separate carriage from the boiler. The machine was an utter failure.—W. B. P.

[55978.]—**Tallow in Loco. Boilers.**—The greatest evil arising from its use is the liability of the furnaces to collapse; hence the general rip-up of the boiler. Tallow does afford a slight resistance to incrustation; but in doing this it also acts upon the iron, reducing its strength by local pitting. Do not use tallow; several evils arise from it, and numerous accidents are recorded and ascribed to its action.—YAMA.

[55988.]—**Cast Net.**—"T. E. L.," write to me, at Pitcairn's Library, King's College-road, N.W., and I will tell you all about it.—J. K. P.

[55988.]—**Cast Net.**—If economy is any consideration I should advise you to write to some firm, such as Hounsell and Co., Bridport, or look up catalogue of Fisheries Exhibition. But if intent on making yourself, use 6lb. thread; this is as strong as 9lb. twine and much lighter. The lighter the net the quicker it sinks. My cast net has a mesh of ¾in. at top and ½in. at bottom, there being several gradations between the two. A minnow net would require to be smaller in the mesh. The size of net must depend on your skill in casting; mine is 12ft. in diameter.—GEO. A. WALTON.

[55990.]—**Lubricators.**—Has "Belgian" never seen such a common thing as the small lubricator? They are small tin cans, generally about 3in. high, and about 2½in. in diameter at the bottom, and tapered up to ⅜in.; a small brass socket with a thread in it is soldered in at the top for the purpose of screwing a spout in—spout about ¾in. long with a bare 1-16in. hole down it to emit the oil. They cost but a few pence.—VALETTA.

[55991.]—**Screw-Cutting.**—There seems to be but one remedy, and that is to get a larger set of wheels. It is possible that the slots in the quadrant could be lengthened. If that would allow the quadrant to rise higher, then that is the course I would advise you on; or, if you could conveniently gear in two intermediate wheels between the mandrel wheel and the stud wheel, that would do. If it is only for one thread that you experience difficulty in gearing the wheels, remedy it as above, if possible; but if it is for several threads, I advise you to get a new set of wheels with a coarser pitch.—VALETTA.

[55993.]—**Screw-Cutting.**—"L. W." must make a square-thread tap on his lathe of the diameter and pitch required, and then the rest will be easily done.—GEO. A. WALTON.

[55993.]—**Screw-Cutting.**—Have you tried to fix your job anywhere on the saddle, and your tool in a chuck, so that the tool revolves instead of the work. If not, try it at once; but if that is impracticable, the only alternative I know of is to cut your thread with a tap.—VALETTA.

[55997.]—**Paint.**—If the shop-front is exposed to much sun, any dark-coloured paint is likely to blister. I should not, therefore, condemn the painter. In sunny positions I have found that paint stands much better when done in late autumn than in spring or summer, as it then has time to harden before the summer sun attacks it. I think also that "flatting" varnished resists the sun's heat better than ordinary oil-paint.—ACIER.

[55997.]—**Paint.**—My doors, painted "invisible" green, are exposed to hot sun and do not blister. The paint is applied with scarcely any "body" in it; in fact, it runs off the brush almost as readily as water. The painter says that this prevents blistering. Several coats are applied, and sandpaper is freely used.—ARCANUM.

[56000.]—**Chemical Problems.**—Let $x$ = atomic weight of chlorine; then from the first experiment we have—

$$108 : 108 + x :: 91{\cdot}462 : 121{\cdot}4993$$

and—

$$13121{\cdot}9244 = 9877{\cdot}896 + 91{\cdot}462x$$

whence—

$$x = \frac{3244{\cdot}0284}{91{\cdot}462} = 35{\cdot}46.$$

In the second experiment let $x$ = atomic weight of potassium; then we have—

$$108 : x + 35{\cdot}5 :: 10{\cdot}50055 : 7{\cdot}25682$$

and—

$$783{\cdot}73656 = 10{\cdot}50055\, x + 372{\cdot}769525$$

whence—

$$x = \frac{410{\cdot}967035}{10{\cdot}50055} = 39{\cdot}13.$$

—WM. JOHN GREY, F.C.S., Gateshead-on-Tyne.

[56000.]—**Chemical Problems.**—1. It must be taken for granted that the at. w. of silver is known to be 108. The formula, AgCl denotes that 108 parts by weight of silver are combined with $x$ parts by weight of chlorine.

Weight of AgCl 121·4993gms.
" Ag 91·4620 "
" Cl 30·0373 "

The question now is: If 91·4620 parts by weight of Ag combine with 30·0373 parts of Cl, how many parts will 108 parts of Ag combine with?

$$\frac{30{\cdot}0373 \times 108}{91{\cdot}4620} = 35{\cdot}4645$$

Therefore, 35·4645 is the at. wt. of chlorine. 2. In this case the reaction which takes place is represented by the following equation—

$$AgNO_3 + KCl = AgCl + KNO_3$$

by which we see that the Cl of the KCl combines with the Ag of the $AgNO_3$, and the fact that a surplus of silver is left shows that all the Cl has been displaced. Find how much Ag was used.

Silver taken 10·51995gms.
" left.. ·01945 "
10·50055

Taking the at. wt. of Ag = 108 and Cl = 35·4645, find the actual weight of Cl used. If 108gms. of Ag combine with 35·4645gms. of Cl, 10·50055gms. of Ag will combine with

$$\frac{35{\cdot}4645 \times 10{\cdot}50055}{108} = 3{\cdot}44811\text{gms. Cl.}$$

Again, Weight of KCl used 7·25682
" Cl " 3·44811
" K " 3·80871

If 3·44811gms. Cl combine with 3·80871gms. of K, 35·4645gms. of Cl will combine with

$$\frac{3{\cdot}80871 \times 35{\cdot}4645}{3{\cdot}44811} = 39{\cdot}1733$$

Therefore, 39·1733 is the at. wt. of potassium.—SALVO JURE.

[56002.]—**Planing Machine.**—You will find on p. 553 of the number in which your query occurs that I gave 25s. as the cost of planing the bed, and on p. 512 the cost of the bed, costing 36s., and its weight 3cwt. The standards are also given on p, 467 as weighing 125lb. each, and as costing 10s. or 12s. per cwt. The table also is given on p. 468 as weighing 180lb. The weight and probable cost of all the larger castings will also be given in due course. In assuming certain rates of cost, a margin must necessarily be allowed, owing to the difference in prices in different districts. Scarcely two firms charge alike, and the dearer are often the cheapest in the end. The best castings are wanted for a light machine, and I should not expect to get these under 10s. or 12s., while some of the smaller stuff will cost 14s. or 16s. One penny per superficial inch is a common charge for planing; but by making a contract bargain for the whole of the work, you might get it done at a considerable reduction.—J. H.

[56003.]—**Chimney Stacks.**—I have seen a great number of chimneys serving as uptakes for the exhaust steam, and having no visible cracks. In others not having the exhaust steam, my attention has been directed to serious cracks and flaws. I look for the substantial opinion of "ours" in regard to this question.—YAMA.

[56004.]—**To "Invicta."**—I think you hardly realise the simplicity of the question. I will, however, briefly explain it, and you will, I think, see the whole principle at a glance. Supposing you move the piston in your 12in. cylinder down for 6in., the air (supposing there was neither clearance nor passage way) would be compressed to 15lb.; supposing the piston is further lowered so that the air is compressed into a space of 4in., you would then have raised the pressure to 45, because you have compressed the air into a third of its normal volume; therefore, you may follow the rule I now give, which is as follows: Air compressed into half its bulk is equal to 15lb., to $\frac{1}{3}$rd three times or 45lb., to $\frac{1}{4}$th four times or 60lb., to $\frac{1}{6}$th six times or 90lb., and if to $\frac{1}{12}$th, or a compression of twelve times the pressure, would equal 180lb. Is this what you want to know?—Invicta.

[56005.]—**Oil-gas Generator.**—To "Invicta" or "R. A."—I have not the back numbers by me, but I feel pretty sure I have seen this discussed before; I would suggest, however, a single-acting cylinder, with a compressing pump, driven by a crank or other device. In my humble opinion, the Clerk engine is superior to the Tangye, owing to the fact that the compression and explosion are not in the same cylinder with the piston only between; not only so, but if this was not an advantage, surely the new Crossley twin engine would have a gland, and thus obviate the screw cylinder. I should certainly use the Fletcher's generator, and with a vertical engine see no reason why the plan should not succeed. I will try and obtain some further information on the subject and let you know.—Invicta.

[56006.]—**To Mr. Bottone and Others.**—I do not know King, Mendham's pattern No. 3, so I cannot advise exactly. I should say approximately 7lb. No. 16 on the fields, and ½lb. No. 20 on the armature. Three quart bichromates would work it: six ditto would do better still.—S. Bottone.

[56007.]—**Dynamo.**—To Mr. Bottone.—Your calculations are quite correct. If I might suggest, however, I would advise for such a large machine that the ring be kept a little lighter, and the space between the cogs a little shallower, say 1in. instead of 1½in. This allows the wire and the core to come nearer the pole pieces of the F.M.—S. Bottone.

[56014.]—**Internal Gear Wheels.**—Give me proper data, and I will strike out your teeth correctly for you. "Pitch of wheel 5in., pinion about 4in." is impossible. Please state pitch and number of teeth in wheel and pinion respectively, or pitch and diameter, which you like.—J. H.

[56016.] — **Chemical Pipelights.** — I have seen potassium sold in the streets for this purpose. A small piece is screwed up in a strip of paper, and when this is moistened with water the paper takes fire. I have also seen phosphide of calcium used. This is kept in tinfoil. A small piece when wetted with water decomposes and produces a flame, the reaction being shown by the equation—

$$Ca_2P_2 + 2H_2O = 2CaO + 2PH_2.$$

—Geo. A. Walton.

[56016.]—**Chemical Pipelights.**—I guess this must have been done with a little piece of sodium or potassium at the end of the paper, which would ignite on being dipped into water, and so light the paper. They would have to be made shortly before use, however, and the paper would have to be arranged so as not to get wet before the metal was alight.—R. A. R. Bennett.

[56017.]—**Ferrier and Soulier's Plates.**—To S. Bottone.—These are simply albumenised plates. Make an iodised albumen by whisking the whites of two or three new-laid eggs with a mixture of 15 grains potassium iodide and 5 grains of potassium bromide to each egg. Allow the froth to subside in a dry place free from dust. Pour off the clear solution. Coat plates, as with collodion; set on levelled slab to dry. When dry, expose to a heat of about 120° Fahr. to coagulate the albumen. Go into a dark room; sensitise in a bath of nitrate of silver solution 60 grs. to the ounce. Can be used wet or dry. If the latter, must be washed in several changes of water before drying. Expose 50 times as long as collodion. Develop with gallic or pyrogallic acid, well restrained with acetic acid. —S. Bottone.

[56020.]—**Leather Hams.**—The leather is sewn on the outside. You cannot bleach the leather. You may whiten it as much as you like by using a little of "Probert's breeches paste," which can be had of a saddler; or you may dissolve a little soap, and scrape some pipeclay in it till it is of creamy thickness; apply it with a bit of flannel or old toothbrush.—Verax.

[56021.]—**Home-Made Tents.**—I have had some experience with these, and would advise no application to be used to render the cloth waterproof. Use the material known as Government Duck, sew with seaming twine, the seams being double. (If you do not know how to do this write again.) The top angle of tent should not be greater than 60°, and then it will be quite water-tight. Make ground-sheet of same material; saturate it with water, spread on a table or board, and rub in linseed oil and boiled oil, equal parts, with a nail-brush. Use as little oil as possible, but enough to cover every part. Hang up to dry in open air for three or four days, and repeat process three or four times. Wet the sheet before oiling each time. After this give one coat each side with boiled oil without water. Do not mix soap or beeswax with oil, as is often recommended. Although it accelerates the process it does not produce so good a result.—Geo. A. Walton.

[56022.]—**Engines.**—Your query is incomplete. You must give us the diameter and length of stroke of the several pistons. If they are all equal, nothing is gained by altering the valves to ¾ cut-off. —Yama.

[56023.]—**Pattern-Making.**—There is a set of articles just commenced (Feb. 20) on the making of a set of patterns for a 3¼in. cylinder engine, which I should think would contain just what you require. There are also drawings of core-boxes on p. 449 in the number for July 20, 1883.—J. H.

[56025.]—**Trueing Grindstone.**—I really think it is too bad of your correspondent to make this request. The apparatus he mentions is a patented machine and the private property of a firm of manufacturers; yet, in spite of this, Mr. Williams requests some other correspondent to give him details of its construction, with the object presumably of making one for himself, and thereby infringing on the patent rights of the proprietors. If your correspondent did not know of its being a patent, it, of course, alters the case; but I think Ransome's catalogue calls it "Trier's patent." Or, perhaps he is not aware that he would still be infringing the patent if he only made one for his own use; but this does not alter the case, as no one but the proprietor of the patent or his authorised manufacturer has the right to make one for any purpose whatever. I have noticed similar tendencies on the part of others of your correspondents, and think they ought to be reprobated. I may say that we have the machine in use at our works, and find it a very useful one; but we should as soon have thought of making one for our own use as we should of any one making any of our patent machines for theirs. The machine may be bought for a small sum from any tool dealer, it being well known in the market. —Marcus.

[56026.]—**Engine.**—To "Invicta."—I will endeavour to get the necessary information for you in a few days. It is not my property—simply was asked to experiment with it, and get it as perfect as possible for the firm who are about to put it in the market. It is practically entirely of cast iron, and the experimental engine certainly runs most satisfactorily. One of these motors is now driving the electric light at a private house with the utmost satisfaction to the owners. It seems to me just the thing for amateurs.—Invicta.

[56027.]—**Lubricant for Small Machinery.** —Why does not "Microcycle" state what the machinery is, and then one could advise him what lubricant to use with advantage? If for clock or watch proceed as follows:—Cool olive oil till the stearine settles; decant the oleine and place in it some pieces of old lead. The lead oxide removes the free oleic acid and leaves nearly pure oleine. Rangoon oil, to be had of gunsmiths, is good for some small machines. Castor oil is also used for small machines where the motion is light and slow. —Geo. A. Walton.

[56027.]—**Lubricant for Small Machinery.** —I have used Stauffer's lubricant for some time in conjunction with his lubricators, and found it answer well.—Volt.

[56030.]—**Lead Burning.**—"Beginner" had better send some stamps to the publisher, and he will forward the back numbers containing most concise directions. To answer the question fully would take up too much room, and would only be a repetition of same.—Volt.

## UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list and send what information they can for the benefit of their fellow contributors.*

55480. Wheels on Screw-cutting Lathe, p. 375.
55484. Water Pressure, 375.

55686. Beetle's Eye as Lens, p. 462.
55687. Fan for Chaff Cutter, 462.
55702. Watch Pivot Holes, 462.
55703. Logarithm Ratio, 462.
55705. Casting Brass in Steel Moulds, 462.
55717. Agricultural Arithmetic, 463.
55720. Reviving Leather, 463.
55731. Flute Making, 463.
55739. Mining, 464.
55743. Analysis of German Silver, 463.
55744. Moulds for Stoneware Goods, 463.

## QUERIES.

[56031.]—**Reservoirs.**—What thickness of boiler-plate would be required in reservoirs, 6ft. in diameter, and 12ft. long, to withstand an outside pressure of from 10lb. to 14lb. per square inch, constant?—J. G., Bristol.

[56032.]—**Enamelling Steam-Gauge Dials.**—Could any reader kindly give me any information how to enamel steam-gauge dials, and what to use, and the kind of ink or paint to mark the figures with?—P. W.

[56033.]—**Shocking Coil.**—I have made a shocking coil with electro-magnet (contact breaker) with two layers of No. 18 c.c., and 16 layers of No. 36 silk covered. It gives too strong a shock. Kindly inform me how to remedy the same, so as to enable it to increase gradually. It is insulated with thin paraffined paper, and I use one pint cell, Bunsen, to excite it with. How can I regulate it—if possible, kindly state how?—S. D.

[56034.]—**Boiler for Engine**—I have a cylinder, 1in. bore, by 2in. stroke, and wish to make a boiler for it What size and thickness must it be, made of sheet iron, to stand about 50lb. pressure, and to supply plenty of steam? Should also be glad of any hints as to bending plates and flanges; boiler of ordinary vertical type;—how many tubes will it require? I thought about 18in. by 9in., with crown of boiler flanged inwards, so as to form smoke-box.—Yrrep.

[56035.]—**Books on Veterinary Medicine.**—Can anyone give me information as to the most recent and best works on equine medicine and pathology?—A. H. S.

[56036.]—**Steam Boiler.**—A boiler 20ft. long, 6ft. diameter, two tubes 2ft. 3in., firegrate in proportion What quantity of water should it evaporate at atmospheric pressure, that is to say, discharging into the open air without any pressure?—J. G., Bristol.

[56037.]—**Induction Coil.**—Would some electrical reader kindly explain the folllowing?—I have made an induction coil on a wooden bobbin, 8in. long, by 1in. core, diameter of ends, 4in. I have used two layers No. 16 c.c. for primary, and 3lb. No. 26 c.c. for secondary. The core is of thin iron wire. I do not know the gauge, but it is that used for fastening on the corks in lemonade bottles. On connecting to two Bunsen cells; carbons, 5in. by 1in. by ⅜in.; outer cells, 5in. by 4in. diameter, I get but comparatively faint shocks. I should like this explained, also how to make and connect condenser?—W. G. Glasgow.

[56038.]—**Restringing Grand Piano.**—Will any of your musical readers be kind enough to instruct me how to put strings on a Broadwood piano grand? There are no holes in the pegs. Every time I have tried, the wire unlaps off peg.—Old Musician.

[56039.]—**Explanation Wanted.**—On working the calculations out of governor, 44079, published July 15th, 1881, page 457, on line sixth under diagram, 8·6in. + 2in. = 10·6in., but I fail to see how it equals 0·9in. Also an explanation of the remaining part of the working, viz.:—

$$\frac{r^2}{\cdot 9} v^2 = 75, v = 8\cdot 7$$

—A Constant Reader.

[56040.]—**Knocking in Gas-Engine.**—Can any reader of the "E.M." tell me the cause of a half h.p. Otto gas-engine making a knocking noise in the crank every time there is an explosion? I might say it is a new engine—not had three months' wear?—kindly oblige.—One in a fix.

[56041.]—**Gun-Metal.**—Would feel obliged if any of your numerous correspondents would give me the percentages of the different metals necessary to produce gun-metal, that will resist the effect of a 3 per cent. solution of sulphuric acid?—D. Clifton.

[56042.]—**Voltmeter.**—To Mr. Paul Ward.—Some time ago you kindly gave me directions for above. I asked you to give a sketch of same, but I did not get any answer to my query. I suppose it missed you. Can you oblige now?—Volt.

[56043.]—**Engraving with Acid.**—I wish to engrave some figures and lines on bright steel with acid, and shall be obliged if some correspondent who has had experience in such work will kindly answer the following questions:—1. What kind of coating should be applied, and how should it be applied? 2. What kind of style is best for writing? 3. Should the article, when prepared, be plunged in the acid, or will it suffice to lay the acid on the parts to be acted upon? 4. What acids, or dilutions of acids, answer best?—Acier.

[56044.]—**Baths.**—Would some experienced plumber inform me what is the greatest practical horizontal distance that baths could be supplied with hot water from boiler attached to a large cooking range? Kindly state greatest horizontal distance, the baths being on first and second floors, one over another.—Stop-Cock.

[56045.]—**Lantern Lamps.**—Does a four-wick refulgent lamp, such as is advertised in this paper, give an appreciable increase of light over a three-wick one, when using 4in. condensers, and a slide of 2¼in. diameter? I believe there was a query touching four-wick lamps in these columns some time ago; but I have searched many back numbers to no purpose.—Exhibitor.

[56046.]—**Turning Spindle.**—After having turned a spindle as far up as I can get, still leaving a little to come off the end where the driver was on, I have changed centres. How is it that the spindle does not run true now?—Apprentice.

[56047.]—**G. B. Paper Enlargements.**—While thanking those who so kindly answered my former query, may I ask them to help me in this? What I want especially to know is:—1. Can really good enlargements be done with a ¼-plate apparatus, such as Lancaster's Le Merveilleux, by using a paraffin lamp? 2. Should the lamps be placed as close to the negative as possible? 3. Should the hole be cut out the same size as opening of shutter of dark slide? 4. Should the stop be removed from the lens while focussing? I perceive that a very small part of the picture in the centre was bright, and the rest shady.

5. How long should the developing be continued, supposing the image appears in about 20sec.? I make my developer from saturated solution of new oxa. potash, and pro. sul. iron. My picture when finished was far from being clear and white. Will over-exposure cause the paper to go black? I should also much like to know what harm is done to a negative if kept in the developer too long.—J. W.

[56048.]—**Burning Bricks on Wet Ground.**—I have just built three Newcastle kilns on filled-in meadow land, but I have a difficulty; I find that steam is constantly being drawn up whilst the bricks are burning, and on opening I always find about one third in the centre, crushed or steamed to dust. Is it possible for water to be drawn up from the meadow to do this mischief, and would, say 6in. of concrete in the bottom or floor, stop the water from spoiling the bricks, and if so, would any other effect be produced?—BRICKMAKER.

[56049.]—**Ventilation of Laundry.**—Can anyone of your readers give me any reliable information respecting the ventilation of the drying rooms of a laundry. I am in the greatest difficulty with one at present? Should the provisions be made at top or bottom, sides or centre, of the room, to carry off the foul and damp air?—LAUNDRY MAN.

[56050.]—**Platinotype Paper.**—In a number of the ENGLISH MECHANIC, Mr. W. J. Lancaster gives some brief particulars of platinotype printing; would he or some other reader kindly state proportions of chemicals for sensitising paper, and whether such must be previously salted, the same as for silver prints? Also whether the cost of process is less or more than silver prints?—C. W. S.

[56051.]—**Gramme Dynamo Machine.**—I have castings all framed up, for a 600-light machine. Will some electrician kindly inform me the size of wire for the ring, and also for the field-magnets? I want to have it shunt wound for incandescent lamps, also to charge accumulators; what might be the E.M.F. and ampères?—NEW SUBSCRIBER.

[56052.]—**Kerosene Lantern.**—Supposing a lantern in which kerosene is burned, should be thrown down—would there be any danger of the oil taking fire, and if so, what should be done to put it out? It would be useful to know the best method of putting out any of this class of oils, should they take fire, or set fire to other things; water is not suitable, I believe.—BRICKWALL.

[56053.]—**Singing Noises in the Head.**—In No. 1008, page 448 (reply 55842) Mr. T. R. Allinson, L.R.C.P., gives an extract of lecture from a gentleman on this subject, in which he says:—"lost noise in head, from which mother suffered many years, and I four or five." From the remarks with this from T. R. Allinson, it would appear he had given some advice to the gentleman. Would Mr. Allinson kindly repeat that advice to one who has not merely suffered four or five years, but 35 years, from this distressing complaint, as he says he has "got much and valuable information on the diet cure."—ARVONIA.

[56054.]—**Hardening Lock Springs.**—Could any reader tell me the way to harden lock springs?—and oblige.—ANXIOUS.

[56055.]—**Diazo Salicylic Acid Sulphate.**—Can any reader of this journal kindly inform me where I can obtain diazo salicylic acid sulphate? I have tried various places in London, and have been supplied at various times with salicylic acid—salicylous acid—salicylic acid dialised for it, but fail to get diazo salicylic acid sulphate, which I want. Is it a complicated process to make it?—C. W. S.

[56056.]—**Photographic Lenses.**—Would Mr. W. J. Lancaster, or some other reader, kindly say what would be the result of shifting the lenses of a 45deg. rapid symmetrical or 90deg. wide angle rectilinear, nearer to, or farther from the diaphragms, and also, in theory, what would be the result of thickening the glasses, keeping the outsides to the same radius? What is the radius required in a glass for a 45deg., and also a 90deg. single lens?—C. W. S.

[56057.]—**Ornamental Bricks, &c.**—Will any kind reader of "Ours" tell me how the cornice bricks, square panels, &c., so much used now, are made? I have made some with wood patterns and screw press; but patterns are so expensive to have made. Is there any special machinery for them, or are they made from plaster casts? How can I tell terracotta from clay; is there any particular difference—if so, what is it?—BRICKMAKER.

[56058.]—**Tires.**—Will any of your readers kindly inform me, through your columns, the average mileage that a 2½ Bessemer steel tire will run before becoming worn out?—NOGOW.

[56059.]—**Geneva Watch.**—I have a watch which, when kept still goes all right and keeps good time, but if carried in the pocket it frequently stops when taken out to be looked at. This is especially the case when nearly run down. It seems as if the impulse from the escape wheel is hardly enough to carry the wheel to the end of its beat, and let another tooth pass. Does this indicate too weak a mainspring—or what? The watch is thoroughly clean.—LL. B. A.

[56060.]—**Nickel.**—Suppose you have power and suitable lathes running at about 2,000 per minute, how would you surface or prepare and polish, when nickel plated, the following class of goods? Iron castings, say stove fronts, and wrought iron and steel, brass, soft metal such as pewter, &c. Kindly state best kind of glazers, wheels, bobs, &c., and polishing material to use?—F.

[56061.]—**Specific Gravity.**—In the determination of a vapour density by Gay Lussac's method, the following data were obtained: Weight of substance, 0·1163grm.; observed volume of vapour, 50·77 cubic c.m.; temperature of bath, 215 deg. C.; height of barometer, 755·5mm.; difference of height of mercury inside and outside of tube, 80·0mm.; height of spermacete or oil. Column reduced to millimètres of mercury, 16·9mm.; Required the specific gravity of the vapour, the density of hydrogen being taken as unity; also the weight of one litre at 0deg. C., and 760mm. bar. pressure?—Z.

[56062.]—**Chemical.**—Required the percentage composition, observed and calculated, vapour density, and formula of a body which gave the following analytical results: (a) 0·4245grm. yielded 0·5670grm. of carbonic acid and 0·3025grm. of water. (b) 0·1810 yielded 0·3855grm. of silver chloride and 0·0165grm. of metallic silver. (c) Determination of vapour density according to Gay-Lussac's method: Weight of substance employed, 0·0808grm.; temperature of the air, 8deg. C.; height of barometer, 789mm.; temperature of vapour, 50 deg. C.; volume 46·2 cubic centimètres. Difference of level, 140·5mm.; coefficient expansion of mercury, 0·0001815; coefficient of cubical expansion of glass, 0·0000262.—Z.

[56063.]—**Brazing Bicycle Forks.**—Will one of your readers kindly inform me how to braze together the forks of a bicycle?—AMATEUR.

[56064.]—**Troublesome Battery.**—1. Would some reader of the "E. M." give me some information that may lead me to discover what is the matter with my battery? Any suggestion would be gladly received. It is a six-cell Leclanché doing principally bell work, and its fault is the zinc poles get covered with some white matter and fibres growing from it, which, in time gets so thick the bells will not ring at all; then I scrape all the white matter off and return the poles at once again into the cells, and the battery is as strong as ever, but in a week they are as bad ever. I have tried amalgamation. Also, is it of any use recharging new porous pots with the carbon plate, and charge from the old pots of a Leclanché battery?—J. PARSONS.

[56065.]—**Tricycle Spokes.**—I recently bought a Cheylesmore, secondhand, in very fine condition except that the nickel-plating has peeled off the spokes and hubs in many places, and these parts are consideraby rusted. What is best to do with it? I have thought of painting the spokes and hubs with some suitable paint or enamel. Is there not a Harrington's enamel, and is it suitable? What colour is it, and how applied? Any advice will be gratefully received. I am far away in the north of Scotland, so must do the job myself.—C. W. B.

[56066.]—**Gas Purifier.**—Can any reader of "ours" suggest a plan by which gas can be purified and its illuminating powers increased, at the same consumption, or at less, if possible, than at present? Something after the principle of the Albo Carbon burner, in shape of a cylinder or box, to be fixed on service pipe just above meter.—J. B. C.

[56067.]—**Embossing on Brass.**—Will some reader inform me upon what substance embossing in brass is done, and also what thickness of sheet brass is most used? I have tried pitch, but it seems too brittle.—C. W. BACH.

[56068.]—**Adjusting Telescope in Dumpy Level.**—Would any experienced surveyor or mathematical instrument maker explain how telescope is adjusted for collimation in a dumpy level, and can it be done after bubble tube has been adjusted?—D. S.

[56069.]—**Photo. Amateur.**—Will some authority on this matter inform me what sizes the diaphragms require to be for a Ross's portrait lens, working at 7in. focus, so that each size smaller will require double the exposure of the previous one? I have a table (in Burton's book), but do not understand the decimals. Also whether four are sufficient?—P. A.

[56070.]—**G. E. Engines.**—Will "B." kindly give the numbers, date, and makers of the tanks he describes in letter 23872, and state whether the leading and trailing wheels have radial axle boxes or not? It seems probable they have.—W. B. P.

[56071.]—**L. and N. W. Engines.**—Wanted boiler and firebox dimensions and heating surface, also distribution of weight, of Ramsbottom's 6ft. coupled engines? W. B. P.

[56072.]—**Road Locomotive.**—Would it be practicable to run the ordinary road locomotive engine on rails, provided the wheels were properly grooved in the centre or flanged to fit on the rails, the width between the wheels being the same as the rail gauge? The thought is suggested by the proposed Suakim and Berber railroad. It would save expense, delay, and trouble if the wheels of portable engines were made very concave to run on soft soil and with a groove to enable them to run on rails where the soil might be too soft to carry the weight without them. The wheels of the rolling stock must be made to match.—LLOVER.

[56073.]—**Clock Query.**—To "FIZ FIG," or "WATCHMAKER'S APPRENTICE."—Having an old clock case I made a new movement, to go a month, to fit it, with dead beat escapement and 7lb. pendulum ball, but find it wants a tremendous weight to drive it, for pattern I had a German in the house which went remarkably well with a 10lb. weight. Every depth is correct and everything free. Would it go with less weight if I put a recoil escapement, and would you give me the rule to find weight (not in Algebra), as the only plan I know is to hang on extra weight till it goes? If any of "ours" could help me they will greatly oblige a—YOUNG AMATEUR.

[56074.]—**Photography.**—Gelatino bromide paper can be prepared in such a way as to colour rapidly on exposure to light, thus forming an indicator of the photo-intensity of the light on any particular day. Please give the best method.—VOLVOX.

[56075.]—**Hot-Air Engine.**—I have a strong horizontal slide-valve steam-engine, but no boiler. I want to make a hot-air engine of it: will you please say if air pump should be double acting? I am going to make pump piston with two rings on, same as engine piston—will that be right? What bore and stroke should air pump be?—engine cylinder is 4in. bore 8in. stroke. What size and strength of metal should air receiver be to bear the proper pressure and be safe? It will be cast iron, and be kept hot in a small furnace built of firebricks. A simple sketch of air pump and air receiver will oblige—MECHANIC.

[56076.]—**Rope Pulleys.**—Would any of the readers inform me if it is possible to get a motion with rope pulleys at right angles to each other, and how to place them?—GRANITE CITY.

[56077.]—**Specific Heat.**—From what height must a block of ice at 0deg. C. fall that the heat generated by its collision with the earth shall be just competent to melt it? From what height must it fall that the heat generated may be sufficient to convert it into steam?—Z.

[56078.]—**Green's Economiser.**—Can any reader tell me how to put a new pipe and bottom into a Green's Economiser?—ONE IN A FIX.

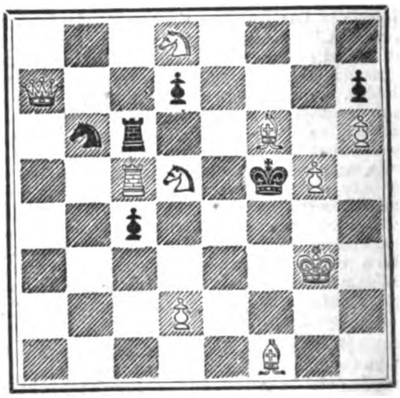
## CHESS.

ALL Communications for this department must be addressed to J. PIERCE, Llandwrog, Carnarvon.

### PROBLEM DCCCCXXIX.—By DR. GOLD.

(From his collection).

*Black.*



*White.* [10+6

White to play and mate in two moves.

SOLUTION TO 927.

| *White.* | *Black.* |
|---|---|
| 1. B-Q 8 | 1. P-KKt 4 (best) |
| 2. Q-KKt 4 | 2. Kt takes Q |
| 3. R-KR 8 mate | |

With a view to obtaining, if possible, a sufficient number of problems for the tourney, we propose extending the time of entry to March 31. If more are not sent in, it will have to be abandoned. The solution tourney will therefore begin with first number after that date.

### NOTICES TO CORRESPONDENTS.

CORRECT solutions to 927 by E. Rosling, J. Hughes, Raymond, C. Meiklejohn, E. S., E. Stanley Follwell (very poor), Rev. W. Anderson (old Romney), J. E. Piper; to 926 by S. L. Chivers.

R. HOLSTER.—We have pleasure in entering your name. No payment is necessary. Get Cook's Synopsis of the Openings, and take every opportunity of playing with better players than yourself.

C. MEIKLEJOHN.—The solution was duly received and was correct. We are sorry for omission in not acknowledging receipt. The competition is for solving problems. There is also a Problem Tourney.

J. Hughes.—What you point out is to be regretted, but it is beyond our control.

TOURNEY Problems received from Respice Finem, and Tessie.

CHESS STRUCK.—Sealed envelope, but no problems.

ENGLISH MECHANIC Chess Tourney game between Mr. W. Nash (White), and Mr. G. H. Mainwaring (Black).

1. P-K 4, P-K 4 / 2. P-KB 4, P takes P / 3. B-B 4. Q-R 5 (ch) / 4. K-B sq. P-KKt 4 / 5. Kt-QB 3, B-Kt 2 / 6. P-Q 4, Kt-K 2 / 7. Kt-B 3, Q-R 4 / 8. P-K R 4, P-K R 3 / 9. K-Kt sq, P-Kt 5 10. Kt-K sq, P-Q B 4 / 11. Kt-Kt 5, B takes P (ch) / 12. Kt takes B, P takes Kt / 13. Q takes P, P-B 3 (a) / 14. B takes P, Q Kt-B 3 / 15 Q-Q 6 (b), Kt-Kt 3 (c) / 16. Kt-Q 3, R-B sq (d) / 17. R-Q sq, P-Kt 6 / 18 Kt-Q B 5, Kt (B 3)-K 4 / 19. B takes Kt, Q takes R (e) / 20. Kt takes Kt P, Q takes Kt P (f) / 21. Q takes Kt P, Q takes Kt / 22. Q takes Kt (ch), K-Q sq / 23. Q takes B P, Q-Kt 3 (ch) / 24. K-R 2, R-K sq / 25. Q-B 4, B-Kt 2 / 26. R-Q 6, Q-B 4 / 27 B-Q 5, R-Q Kt sq / 28. R-Q sq, K-B sq / 29. R-Q 4, B-R 3 (g) / 30. Q takes P, R-Kt 3 / 31. R takes R, P takes R (h) / 32. R-Q R 4, R-B sq / 33. Q-Q 4, Q K 2 / 34. P-K Kt 3, B-Kt 2 / 35. B takes B (ch), K-Q sq / 36. Q takes Kt P (ch), K-K sq / 37. B-Q 5, Resigns.

NOTES BY MR. NASH.

(a) I do not think this was the best move. I prefer R-Kt sq.

(b) This move gives White a decided advantage.

(c) P-Kt 3, threatening to exchange Queens and giving the Black Bishop an opening, would, I think, have been better.

(d) This seems necessary now to protect the Bishop's pawn.

(e) 19. Kt takes R would have given him a better chance of a draw. There would then have followed 20. Kt-K 6, P takes Kt / 21. B takes P, Q takes R (ch) (best) / 22. Q takes Q, B takes B / and although I could have won two more pawns, I should have had some trouble to win the game.

(f) As good perhaps as anything, for if 20. . . Q takes KP / 21. Q takes QP (ch), B takes Q / 22. Kt-Q 6 (ch), &c.

(g) If 29. . . . B takes B / then 30. P takes B.

(h) If 31. . . . Q takes R 32, Q takes Q, P takes Q / 33. P Kt 4.

A CHINESE torpedo boat has been recently launched at Ningpo. Its speed is said to be 19 knots per hour.

# ANSWERS TO CORRESPONDENTS.

*⁂ All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

## HINTS TO CORRESPONDENTS.

**1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.**

**⁂ Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.**

## BACK NUMBERS.

WE receive so many queries asking for directions how to make many instruments and appliances which have been fully described in back volumes that we have compiled a list, which we shall insert in this column at intervals, of those most frequently sent, and as the numbers are still in stock, new subscribers should consult the list before sending their questions.

Batteries: Nos. 715, 718, 734, 741.
Bellows camera: No. 897.
Bookbinding: Nos. 613, 770.
Coils, induction: Nos. 832, 885
Coils, medical: Nos. 844, 898.
Copying processes: Nos. 750, 753, 761, 762.
Electric machines: Nos. 628, 759, 840.
Electro-magnets: Nos. 756, 772, 783, 864, 872.
Electro-plating: No. 833.
Lacquers: Nos. 622, 866.
Magneto-electric machine: Nos. 783, 826.
Pattern Making: Nos, 938, 941, 943, 945, 948, 950, 952, 954, 955, 956, 958, 959, 962, 963, 965, 969, 973, 974, 978, 981, 986, 989, 993, 995, 998, 1,000, 1,001, 1,0(3 1,004, 1,008, 1,009, 1.010.
Silver-plating: Nos. 830, 868, 870, 874.
Telephones: Nos. 695, 747, 828, 853, 865.
Varnishes: 478, 619, 675, 691, 723, 775.

## A NEW VOLUME.

THIS number is the first of Vol. XLI. Readers willing to oblige us by recommending "Ours" to new subscribers should do so now, when a new volume is commencing. The index to Vol. XL. will be published *on March 20*, and cases and bound volumes will *be on sale* shortly after. Readers desirous of making up their sets for binding the past volume are recommended to do so at once, as the back numbers soon run out of print.

**The following are the initials, &c., of letters to hand up to Wednesday evening, March 4, and unacknowledged elsewhere:—**

COL. SIR FRANCIS FESTING.—E. P. Alexander.—C. Tayler.—A. F. Stevenson.—T. Taylor.—Rev. J. Lamont.—F. H. Holmes.—Rev. J. B. Annesley.—W. F. Fisher.—G. D. Neill.—H. King.—Sir Rowland Stephenson.—C. S. Stock.—Resultant Force.—G. Jackson.—T. Plunkett.—J. C. Baker.—Pump.—Dens.—Four of Us.—G. H. B.—Calix.—G. Rowlands.—Amateur.—Sulphur.—C. W.—H. J. S.—Belgian.—F. M. C.—Annie.—Athos.—W. H. Elphick.—Ham.—A Fellow of the Royal Astronomical Society.—Thompson.—E. M. Nelson.—Baffled.—Arvonia.—Englethwaite.

AN OLD SUBSCRIBER. (You should consult a medical man; but you will find treatment for diabetes in Vol. XXXV. pp. 310, 478, 529; Vol. XXXII. pp. 17, 71, 117; and especially as concerns diet in Vol. XXXI. pp. 504, 528, 552, 599. A diet of absolutely nothing but skim milk has been found very useful, but in so serious a malady skilled advice should be sought.)—GREY HAIR. (Take litharge 1 part, starch 2, fresh-slaked lime 2, all in fine powder, and thoroughly dry; mix, and keep in a stoppered bottle. If the hair was black, mix this powder with water; if brown, with milk. Rub it into a thin paste, and smear it on the hair, which must be previously well cleansed with soap and water and dried. Work the paste well round the roots and on every part of the hair, and cover it with several thicknesses of paper thoroughly damped or an oilskin cap. In about three or four hours the powder may be rubbed off.)—C. H. (The solar day is longer than the sidereal because the sun appears to move about 1° per day from W. to E.; a solar day is the interval that elapses between two transits of a given meridian by the sun; a sidereal day is the time of one complete revolution of the firmament or the time between two transits of a fixed star. Mean time is that indicated by a carefully-regulated clock; a sundial gives apparent time. As to the "universal day," see recent back numbers. That is not likely to be adopted, but the mere mention has led to much confusion of thought, as you have discovered in the blunders of the *Times* correspondent.)—PORTABLE. (Use some of the anti-incrustators which you will find advertised.)—BLACKSMITH. (Dr. Percy's "Metallurgy of Iron and Steel," John Murray, is a standard work; but you will find an account of Bessemer steel-making in many works and cyclopædias.)—INDIARUBBER. (We believe it is cut up and masticated in the machine and subjected to the action of steam, when much of the sulphur and other materials separate; but you cannot get "pure" rubber from it.)—SHUNT. (The title of "professor" is legitimately held only when applied to someone who occupies a "chair" at some university or other recognised institute for teaching; but there is nothing to prevent a man dubbing himself "professor"—of hair-cutting, of legerdemain, or anything else. 2. We do not recognise it by name. 3. Because with the shunt machine there is no likelihood of the accumulators overpowering and reversing the dynamo. The name is sufficient, but to save trouble put Charing-cross.)—C. S. V. BROWN. (For simple accumulators see p. 28, No. 1,016. Pocket batteries are generally used.)—UNCLE SAM. (Chisels and graving tools; bed either block of beech or slab of lead. 2. Galvanising implies the use of zinc. Frequently described. Pickle in acid liquor; rinse well, dry quickly, and immerse in a bath of zinc covered with layer of sal-ammoniac.)—J. BANCROFT. (We cannot republish old matter while the back numbers containing it can still be purchased. We should have to treble the size of our paper to answer fully all the questions that reach us every week, especially requests for recipes that are given in many text-books.)—W. J. G. (Short sight can be remedied by the use of spectacles when the subject is young. Open-air occupations are naturally conducive to a cure.)—C. C. (See No. 896, p. 253, and various replies in back volumes.)—E. F. (See previous answer.)—ACID. (Look through recent back numbers, or the forthcoming index. Recipes for lacquers have been frequently given, but as a rule it is much cheaper to buy them.)—X. (The one mistake has been explained, and we cannot afford space for your personal exculpation. If you will refer to p. 277, Vol. XXXIX., you will see that you have made a mistake; you misunderstand the legal meaning of the words "use" and "experiment." You may make a patented invention for the purpose of "experiment," but you must not "use" it in the ordinary sense of that term.)—E. R. T. (There is no work of the kind: that is why we devote so much space to questions in connection with the subject.)—NIKO. (We believe it is supplied only to yearly subscribers; but apply to Messrs. Trübner, Ludgate-hill, E.C.)—RUB. (We answered you before. You cannot make them without apparatus and the prepared materials, and you can obtain full instructions with them. The method has been described in back volumes.)—QUERIST. (See back numbers, or communicate with the secretary of the Cyclists' Touring Club.)—C. H. (Query inadmissible. See the advertisement columns and the index of Vol. XXXIX., under head Gas Engines.)—VENTO. (Did you boil the tar and pitch until all the moisture was out? If not, try again. Full directions in back numbers—No. 995, p. 155, for instance.)—ORDERIC VITAL. (Thanks. The paper is in preparation, as we intend to give at least the substance of it.)—C. J. E. (Yes, it will do. Permission must be obtained of the Commissioners of Works for taking photographs in the royal parks, but no order is necessary in the case of public buildings. As far as the latter are concerned, for reasons which can be readily understood, it would be as well to have satisfactory credentials in your pocket—might save a little inconvenience.)—W. T. (The Sanitary Institute, 74A, Margaret-street, W. Particulars can be had of the Secretary.)—TROUBLED ONE. (You want the white face only temporarily, we suppose. Any druggist will supply you with suitable preparations; or if you can get hold of a "dresser" at one of the theatres he would explain how to make up for any part.)—S. T. G. (Look up your back numbers, and don't talk about working a "dynimo" by a heavy weight with a 20ft. drop.)—GRAMEN. (The best way is by means of the clamps, specially designed for such purposes. 2. Could be done, but what would be the object? 3. If you mean telephones, see back numbers. 4. An inch and a half or two inches. 5. Full directions for making phonograph in Vol. XXVII. p. 157.)—W. PAGE. (Yes, quite possible. See the indices for multiplex or quadruplex telegraphy, the latter fully described and illustrated by a diagram in No. 542.)—INQUIRER. (Any bookseller will supply you with French newspapers and books.)—J. K. S. (It does not make any difference where the subscription is paid. 1. It means so much per ton. 2. One foot of inch square bar iron weighs 3·3lb. 3. The price of a cwt. lump would depend on where it was bought. 4. Ten per cent. more will do. 5. It is absurd to ask "what sized steel rope would be strong enough to support one cwt." A piece of piano wire will do that. 6. Pitman's.)—BEGINNER. (In some of the drawing books, or in such papers as the *Engineer*, which occasionally publishes working drawings. 2. We do not know whether any one publishes them; but join one of the Science and Art classes.)—J. HALES. (Perhaps the articles were not thoroughly clean; but as you do not say what solutions and battery power were employed, we can only refer you to back numbers. Coat the articles of lead with copper by immersing in strong solution of sulphate of copper and touching with an iron rod; then plate on the copper.)—CONFECTIONER. (The only way is to put in silvered glass. You cannot readily silver the glass already in the frames, though an expert might possibly succeed if you could induce him to undertake such a job. It would, however, cost more than replacing with silvered glass.)—GAMMADION. (No. 20 cotton-covered would do. 2. We know of no book of the kind. Read back numbers. 3. There is nothing to prevent you propelling a tricycle by electricity. It is the speed that is limited.)—E. L. (Why must it be coated? Silk is the best thing; but we think the ordinary leads as manufactured for tropical countries would do.)—ETRISCION. (See Hints No. 4, and consult the advertisements. The Daniell battery will be best for such work, and the magnets may have cores of 3-16in. iron 1½in. long, wound with No. 26.)—A. B. C. (The size varies with the pitch of reed. A good channel frame for a set of 8ft. reeds runs from 4⅜in. to ⅜in. for lengths by 1¼in. to 0in. for depths. The width depends on the keys.)—AMATEUR. (You must have a light in the roof and one in the side. See the indices; but the wisest plan is to take a lesson from existing studios.)—ONE WHO IS TRYING TO IMPROVE IN THE WORK. (The apparatus for making rubber stamps can be obtained from advertisers.)—SUFFERER. (If you would study the laws of health, take plenty of exercise in the open air, and not fancy you are ill; you would probably soon get better.)—SPINNER. (No room for spinning wheel; but you will find one in back volumes. 2. There is nothing very special in such a trap. Copy the familiar mouse or rat trap on a larger scale. 3. Use Indian ink and paint it on; but most people find it cheaper to buy such paper.)—TINMAN. (If the burner is properly constructed, and the flame regulated, there is neither smoke nor smell. Your arrangement would, of course give more heating surface, but in itself would not remedy the smoke nuisance.)—BOSCO. (Directions for making all kinds of batteries have been given over and over again. For such a purpose a Daniell would be best.)—AMATEUR. (Steel reeds are best, but there is no quick way of filing them. It is because a great deal of labour has to be expended on them that they cost so much. They are not voiced in the proper sense of the term. Look through the indices for reference to the subject. We do not understand what is meant by the scale used in tuning.)—L. DENIS. (We shall be glad of the proffered description of the dry-plate camera for outside work.)

**Dr. Carter Moffat's Ammoniaphone** (Harness' Patent). This excellent invention for strengthening and improving the voice, and for curing ASTHMA, BRONCHITIS, and all pulmonary affections, of which a full description, illustrated by a sectional view of the instrument, appeared in the ENGLISH MECHANIC for Dec. 26th, has been secured by the Medical Battery Co., 205, Regent-street, London, W. Its efficacy is vouched for by the highest medical, scientific, and social authorities, and Dr. Carter Moffat attends daily at 205, Regent-street, London, W., to demonstrate its extraordinary utility. Residents at a distance should write for "The History of the Ammoniaphone," sent post free to any address. Dr. Carter Moffat's Ammoniaphone will be sent post free to any address on receipt of P.O.O. or cheque value 21s., and payable to C. B. HARNESS. The Medical Battery Co., 205, Regent-street, London, W.—[ADVT.]

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**Advertisements must reach the office by 1 p.m. on Wednesday to insure insertion in the following Friday's number.**

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**Holloway's Pills.**—These Pills cleanse the vital fluid from all contaminations, and by that means strengthen and invigorate the whole system, healthily stimulate the sluggish organs, repress over-excited action, and establish order of circulation and secretion throughout every part of the body. The balsamic nature of Holloway's Pills exercises marvellous power in giving tone o debilitated and nervous constitutions.

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Wanted, "**Spon's Dictionary of Engineering**," mechanical movements. Exchange.—A. C. Bell, Metallurgist, Main-road, Bexley Heath.

**Pedometer**, in silver cases, and perfect condition. Exchange up to 25s. Cash 15s.—M. E. B., 152, Grove-street, Liverpool.

Wanted, back-geared **Headstock**, or lathe parts, in exchange for double gun, books, and other articles.—R. Walker, junior, Balance-street, Uttoxeter.

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Wanted, "**The Electrician**," or "Electrical Review," in exchange for "Iron," "Colliery Guardian," or Mining Journal."—E. H. Davies, Ebnal Lodge, Oswestry.

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Wanted, second-hand **Pump**, complete with eccentric, for 2 h.-p. boiler. Exchange.—Hy. Cox, junior, Wells, Somt.

I will give **Astronomical Books** in exchange for a good muzzle-loading gun of good make.—Apply, Sydney Pocklington, 9, Pelham-street, Newark.

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**Folding Tailboard**, with side wing and winch screw, for ½-plate camera; plate box for ½ and ¼-plates, stereo camera, magnesium lamp, retouching desk, takes any size or shape up to ½-plate; cutting board, for cutting glass plates photo sizes. What offers?—W. R. Simpson, Lowestoft.

Lever **Watch**, silver face, gold figures and flowers. Wanted, Ross's Rapid Symmetrical for ½-plate.—W. R. Simpson, Lowestoft.

Musical Mechanical **Monkey Playing Harp**, plays two tunes, cost 5 guineas. What offers? Makes splendid attraction for shop window. Photo 4 stamps.—W. R. Simpson, Lowestoft.

Wood body **Enlarging Lantern**, 4½in. condenser, bellows front, no front lens, 2-wick paraffin lamp. What offers?—W. R. Simpson, Lowestoft.

Concert **Flute**, 8 keys, holes bushed, value £2; Piccolo 6s. Wanted, carpenter's tools, bicycle, or anything useful.—J. B. Lock, Martock.

Owing to death of late owner, I will Exchange old **Violoncello and Bow**, played in church 60 years ago, for a 52in. Bicycle, suit learner, or offers.—Alfred Gilders, Brightlingsea, Essex.

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Pair achromatic **Binoculars**, theatre, field, and marine powers, cost 4 guineas November last. Bill shown. 52in. bicycle wanted.—111, Fort-street, South Shields.

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Wanted, **Lathe Wheel**, 24in. dia., 4 speeds, grooved 1¼in. bore. Exchange Heavy Flywheel, 30in. dia., 1¼ bore.—C. L. Gurden, Highcross, Leicester.

**Cornet**, by Distin, London, in good playing condition, two tones and Card Holder. Exchange Violin, Clarionet, or offers.—Teague, Roundwell-street, South Petherton, Ilminster.

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"**English Mechanic**," 38lb. weight, fair condition, Exchange for good Violin to suit a boy, or Violoncello.—F. G. F., 16, Carlton-street, Cheltenham.

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"**English Mechanic**," Vols. XXX., XXXI., XXXII., XXXIII., complete, except two numbers. XXXIV., XXXV., XXXVI. incomplete. "Design and Work," Vols. IV., V., VI., VII., complete. VIII., IX., X., 8 numbers lost. Smyth's "Sidereal Chromatics." Exchange Coloured View Lantern Slides.—Z., 7, Myrtle-street, Hoxton, N.

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## THE SIXPENNY SALE COLUMN.

*Advertisements are inserted in this column at the rate of 6d. for the first 16 words, and 6d. for every succeeding 8 words.*

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**Electric Depot**, 10, Deansgate, Manchester.—Electric Breast Pins, 25s. Electric Bells, 4s. Induction Coils, 8s.—Millar, Proprietor.

Special **Amateur's List** of Castings and Finished Parts of our Motors and Dynamos, 1 stamp.—Cuttriss and Co., Leeds.

**Sheet-Iron Punchings** for laminated armatures.—Cuttriss and Co., Leeds.

**Lathes! Lathes!** Cheapest and best. List two stamps. Nothing equal at price.—Robinson, Somerset road, Sheffield.

**Notice to Woodworkers.**—At the Floral Hall, Covent Garden, the Architects' and Builders' Exhibition, March 3rd to 7th, our new patent hand and treadle circular saw, drilling, dovetailing, grooving, fret-cutting. Every woodworker should see this.—Britannia Co., Colchester.

New **Fret Saw**, with 20in. fixed arm, vertical and very rapid stroke, square wood table extends all the way, adapted for cabinetmakers and advanced fret cutters.—Britannia Co.

**Lathe Heads**, nearly new, with hardened steel mandrels and collars, 4in., 50s.; 5in., 70s. Backgeared Heads, 4in., 80s.; 5in., 98s.—Britannia Co.

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**Invalid Set Bell**, battery, pear push, stained and polished, pine case, carriage paid, 10s. 6d.—Franklin.

Wholesale **Bell and Battery** Maker, Indicators, Induction Coils. Carbons. Terminals, Wires, &c.—Franklin. Volta Works, 41, Sherman-road, Reading.

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**Electric Bells** at trade price; Metallic base, Platinum contacts, silk wire, post free 3s. 6d.—Harris and Co.

The **Phœnix Bell Set**, Bell, Battery, Push, and 12 yards double wire, post free 8s.—Harris and Co.

Set of **Castings** for Motor (Chaster's), 6s.—HARRIS and Co., 172, Railway-approach, Shepherd's-bush, London, W.

**Edward W. Drury**, Hull, manufacturer of all kinds of glass bottles, wire, and Chemicals.

**Electrical Machine**, 38in. plate. Height, over 6ft. Very cheap. Photo sent.—Moody Bell, Cheltenham.

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For sale, a fine model **Locomotive**, 3ft. 6in. long by 13in. wide, stands 1ft. 6in. high to top of boiler; all motions from footplate; it is a powerful and beautifully made engine. Price £5. Photo.—Geo. F. North, 2, Marlborough-place, Brighton.

A first-class pair Launch **Engines**, quite new, cylinders 6in. diameter, stroke 8in., steel crank, &c., stand 3ft. 6in. high by about 2ft. 1in. square, on bed plate. Price £60; cost nearly double.—Geo. F. North, 2, Marlborough-place, Brighton.

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Write for Hindle's **List** of Electrical Apparatus, free; all parts for amateur construction.—Irwell Vale, Helmshore.

Easy **Music** for String Bands, 8d.; Band Parts, 6d —Musical Director, 39, Chapel-street, Whitehaven.

**Lathes**, several new and second-hand, from 2½in. to 8in. centres, for sale, cheap, to clear.—W. S. Brown, Halesworth.

**Lathe Parts**.—Wheels, Cranks, Standards, Beds, Headstocks.—Apply, stating wants, to W. S. Brown, Halesworth.

**Slide-Rests**, new and second-hand, from 2½in. to 8in. at greatly reduced prices to clear.—W. S. Brown, Halesworth.

**Hand Shaping Machine**, about 5in. stroke, price £4 only.—W. S. Brown, Halesworth.

**Parallel Vices** for Shapers or Planers, several very cheap.—W. S. Brown, Halesworth.

**Engines**, Boilers, &c., two or three for sale.—State requirements to W. S. Brown, Lathe Works, Halesworth.

**Dynamo** and other insulated Wires at wholesale prices. Reduced list free.—Maw, 8, Clayland-road, London, S.W.

**Gas Engines**.—1-man, £16; 1½-man, £20 cash, delivered, equal new, six months' guarantee.—Barker, Scholefield-street, Birmingham.

**Sewing Machines**, Thomas, new, cost £10 10s; offered £2 10s. Howe Leather Machines, cost £9, offered £2 5s. Singer's Medium, cost £7 10s., offered £2 10s. Exchanged if not approved.—Clayton, Magdalen street, Colchester.

**Lathe** for sale, new, six-inch centre, traversing mandrel, 5 feet bed, 6 steel screw guides, compound slide rest, hand rest and tees, by the late James Munro.—On view at J. Lewis, 2, New Oxford-street. Price £35.

**Messrs. Oppermann Bros.** beg to announce that they have the following goods for sale, prior to stocktaking, at greatly reduced prices:—One 5-light Experimental Dynamo, £7; two 12 do. do., £20 each; one 25 do. do., £30; one 34 do. do., £35; one 50 do. do., £40; one 100 do. alternating do., £70; one 300 do. alternating do., £150; one 6 arc dynamo, £60. Several arc machines of from one to four-arc lights; also some 5, 6, 7, and 8 inch double endless belt, at less than cost; and sixteen Cabath accumulators at 35s. each.—172, St. John-street, Clerkenwell, E.C.

**Lathes**, Planing Machines, Lathe Shaping Machines, Drilling Machines, Milling Machines, and various other tools.—W. R. Smelt.

**New List** of above in separate parts, rough or finished; also for machine work on lathe parts, is in preparation. Notice given when ready.—W. R. Smelt.

**Patterns of Combination Machine** in progress, comprising lathe, shaper, milling machine, slotting and drilling.—W. R. Smelt.

**Lathes and Separate Parts**, rough and finished, or with machine work done, forgings, &c. See revised list.—W. R. Smelt.

**Turning, Boring, Screw-cutting**, Planing, Forgings, Patternmaking, to order. Models for inventors and patentees.—W. R. Smelt.

Send 1 stamp for **Revised Lathe List**.—W. R. Smelt, Engineer, 7, Goldsmith's-row, Gough-square, E.C.

Separate **Pedal Organs**, for harmoniums and American organs, from £3.—G. Fryer, 17, Richardson-street, Swansea.

**C. Pilkington**, 32, Sackville-street, Piccadilly, W., Magic Lantern Artist and Photographic Colourist.

Magic Lantern **Photograph Colouring**, finely and artistically done, 12s. per dozen. Special terms to the trade on application.—C. Pilkington, 37, Sackville-street, W.

**Castings**.—Half horse-power, Vertical, Horizontal, or Launch Engine Castings, ports in cylinders. Complete sets Castings and Forgings, 12s. 6d. One horse power, 25s.—Tomlin, Highfield terrace, Barnsley.

**Castings**.—Bench Drilling Machine Castings, 3s. 6d. set. ;small Brass Engine Castings, 2s. 6d. set.—Tomlin, Highfield-terrace, Barnsley.

**Castings**.—Half horse-power, 9s. 6d. set, ports in cylinders, horizontal, launch, or vertical. Send for price list, designs and particulars of perfected castings, free.—I. Tomlin, Engineer, Highfield-terrace, Barnsley, Yorkshire.

**French Polishing**, Staining, Varnishing, and Painting. 122 receipts or trade secrets, with full instructions and details, free 1s. (Genuine.)—I. Tomlin, 23, Highfield-terrace, Barnsley, Yorkshire.

**Microscopes and Apparatus**.—R. G. Mason (from J. Swift), manufacturing Optician to the trade; Binocular Microscopes, Stand, and Stage Condensers, Spot Lenses, Polariscopes, and other apparatus. Repairs and alterations. All kinds of mounting materials.—24, Park-road, Clapham, London, S.W.

"**See-saw**" **Waltz**, 4s.; reduced price, 1s. 6d. post free.—William Lea, 50 and 52, Church-street, Liverpool.

"**Hypatia**" **Waltz**, 4s.; reduced price, 1s. 6d. post free.—William Lea, 50 and 52, Church-street, Liverpool.

20s. worth of best **Songs and Pieces**, post free, 1s. 2d.—William Lea, Church-street, Liverpool.

**Pattern Making**, every description. Estimates free.—J. Bostock, General Pattern Maker, Park-street, Derby.

"Home" **Washer and Mangle** combined, never used, cost £6 6s., sent free £4 4s.—Bostock, Park-street, Derby.

**Chemicals and Apparatus** at lowest prices. Stamp for reply.—Greenwood, Chemist, Lozells, Birmingham.

Loughboro' Dry Plate Company's **Instantaneous** or Rapid Emulsion, 8s. 6d. pint; ¼-plates 18s. gross, with instructions. Carriage paid. Splendid quality.—302, Coldharbour-lane, S.W.

**Lathe**, back-geared slide and surfacing, 14½in. centre, by 2ft. bed, £21.—79, Dudley-road, West Bromwich.

Combined **Engines and Boilers**, 2, 2½, and 3-horse, low prices.—79, Dudley-road, West Bromwich.

Bateman's 2½in. **Astronomical** (achromatic), nearly new, four eyepieces, garden stand, cost 95s., price 35s.—Below.

**Engine and Boiler**, cylinder 2in. bore, 3½ stroke, good condition. Photo, 2 stamps. 32s.—Below.

**Microscope**, four powers, capital instrument, 28s.; cost 63s. Stamp reply.—Robson, 73, Rosoman-street, Clerkenwell, London.

**Parts of Tricycle**, rubber-tired wheels, roller bearings, &c.—Wallace, 33, College-street, Liverpool-road, N.

**Brass Name Plate**, 9 by 4½, engraved plain or fancy, 4s. 6d., carriage free.—E. F. Broadbent, Grenfell-avenue, Maidenhead.

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The English Mechanic
AND WORLD OF SCIENCE AND ART
*FRIDAY, MARCH* 13, 1885.

## COMPLEXITY IN MACHINERY.

IT is often asserted that a piece of machinery or apparatus is "too complicated," and therefore not to be trusted; but if the judge who thus glibly condemns is subjected to a little cross-examination, it is soon discovered that his idea of complexity will not bear a critical examination. It is a demonstrable fact that with the progress of invention, and for that matter, of civilisation itself, machines have tended to become more complicated, but this very complication is a proof of their greater efficiency; for, otherwise, the law of the survival of the fittest would have relegated them to the scrap-heap. When, then, we hear a piece of apparatus condemned because it is apparently complicated, we must first determine what is meant by the term; and, secondly, whether the parts of the machine are really so entangled together as to lead to frequent derangements. A locomotive may be taken as an instance of so-called "complicated" apparatus; but it is matter of common knowledge that it is an efficient machine, and no one now ventures to speak of it as "too complicated." The subject was brought prominently forward at a meeting of the Society of Arts last week, when Mr. Hiram Maxim described his wonderfully complex automatic gun, and Prof. H. S. Hele-Shaw read a paper on the evolution of machines. With an increase in the number of parts in any given apparatus there is necessarily an increase in the number of points at which failure may possibly occur; but the doctrine of evolution applied to machines shows that increased complexity is simply a synonym for increased certainty of action. Prof. Hele-Shaw has compiled a table showing the number of parts belonging to the propelling machinery of a first-class Atlantic steamer, and very formidable the figures look in that shape, when we find that the engine has 6,000 separate pieces, and count up all the bolts, nuts, pins, rivets, &c., used in the engine and boiler; but no mechanic considers the term "complicated" applicable. If Watt had been commissioned to achieve a similar result, he would have found it necessary, in his day, to multiply the number of engines, merely to obtain the requisite power, and his machinery would have been correctly designated as complicated. Denys Papin, so long ago as 1690, suggested the use of the cylinder and piston, but afterwards employed, or endeavoured to employ, the design of Savery, because of the difficulty in "making these large cylinders," of which he had had experience. The complicated machinery of our engine shops has removed Papin's difficulty, and, as we know, the evolution of machines is still progressing. Humphrey Potter complicated the steam-engine when, to save himself personal trouble, he fixed his strings so that the engine should work the valves automatically, and those who took up Potter's idea made the machine still more complex by their improvements. Watt left us the steam-engine in a far more complicated state than he found it; but, except in a few details, no improvement which has resulted in simplification has been made; for the removal of the condenser, necessary as it is in some cases, reduces the efficiency of the machine as a heat engine. The few details in which simplification has replaced complexity are found in those portions which were of much trouble to Watt, for the reason that he could not find materials or skill to make what he required; but in these instances the complexity is removed to the workshop, in which the steam-engine was the forerunner of improved tools. A steam-engine of the reciprocating type is, however, a complex machine in the sense that a backward and forward motion is first produced in order to attain a rotative one; but it is certain that the engine which will give the rotary motion at once will be more complicated than the well-known type. This point gave rise to an interesting discussion, for Prof. Hele-Shaw had stated in his paper that machines had not only been unsuccessful because proper materials had not been forthcoming, but also because attempts at improvement had been made upon wrong principles. A striking example of that, he said, is furnished by the immense number of unsuccessful rotary engines, which are the outcome of false views of the value of simplicity in a machine. It is proceeding in a wrong direction not only on machinal grounds, but also because it is opposed, on certain general principles, to the best method of employing steam as a working agent; it is, as Reuleaux puts it, "One example of that tendency to aim rather at what we might call the *bravado* in machine construction than at the attainment of practically useful results." Rotary engines have, however, proved successful in a measure, under suitable conditions, and the chairman, Sir F. Bramwell, expressed the opinion that those who had attempted to solve the problem deserved thanks, which brought from Prof. Hele-Shaw the explanation that he was not referring to the efforts to make rotary engines, but to the way in which those efforts had been made through ignorance of the principles applicable. He believes the Tower spherical engine, a marvellous piece of mechanism, is really a success; but it is so because the inventor had struck out a new line. The motor, though externally simple, is really made up of elaborate arrangements, and requires thirty-two figures to completely explain its action and various parts: hence it might be looked upon as a very complicated machine, whereas its complexity is necessary to its efficiency, and renders it perhaps the best of the rotary type. What is true of the steam-engine is true of other machines: evolution leads to complexity, and complexity to greater efficiency. Compare the Martini-Henry with the old Matchlock, and the Gatling with the Maxim gun. The latter carries the cartridge to its place, locks it in, fires it, withdraws the case, and ejects it—all by the force of the recoil; it will, in fact, when once started, go on firing until some portion breaks down, or the supply of cartridges is stopped. But Mr. Maxim properly objects to the term "complicated" being applied to his gun; it might have been made to load and fire itself, without so much of what is called complication; but the arrangements were introduced in order to allow of the magazine being placed under instead of over the gun. This question of complexity is well exemplified in the case of the lathe. To what a complicated machine has the pole-lathe developed, not only in itself, but in its accessories also! What has been evolved from the simple corn-mill of the time of Mithridates (circa 80 B.C.) we see in the "high-grinding" mills, which are almost absolutely necessary to deal with the hard wheats of Hungary and some parts of the United States. Clocks and watches, too, become more complicated as they attain a higher degree of efficiency, and the clumsy printing press of Franklin's time has become the complicated machine which can now be seen in many newspaper offices. With an increased number of parts, there is necessarily an increased liability to derangement; but that is out of all proportion to the increased efficiency of the apparatus, for modern presses now print millions of copies to the hundreds of their older prototypes. We see at one end a roll of paper, at the other we find the printed copies of a newspaper tumbled into a basket, folded ready for the wrapper on which the address is written; but no one who comprehends the machine calls it "complicated." To quote Herbert Spencer's phraseology, "Evolution is a change from an indefinite, incoherent homogeneity, to a definite, coherent heterogeneity, through continuous differentiations and integrations." That phrase will, no doubt, be clearly comprehended by those whose objection to the most efficient railway brake is expressed in the simple, self-satisfying opinion that it is "too complicated." They do not ask whether it is efficient, whether it does the work it is intended to do; but looking only to the number of its parts, they conceive the idea that it is too complicated, and cannot be successfully utilised in practice. A student of Reuleaux's "Kinematics of Machinery"—that is one who comprehends the analysis of machines as a chemist understands the composition of the various substances which come beneath his ken,—would never speak of a machine as being "too complicated," when the very complexity is necessary to attain the efficiency aimed at by the designer, for he would see, as Herbert Spencer sees in connection with progress generally, that "throughout that rearrangement of parts which constitutes evolution, we must nowhere expect to see the change from one position to another effected by one continuous movement in one direction. We shall everywhere find a periodicity of action and reaction, backward and forward motion, of which progress is a differential result." The analysis of machines is the science which really underlies invention: it teaches the simplification of parts and their combination into a complex whole—the "definite coherent heterogeneity" of Herbert Spencer.

## ENGINE-MAKING AT HOME.—III.

### The Cylinder.

EVERYONE who has the slightest acquaintance with the mysteries of engineering design is aware of the fact that very much which passes current for theoretical design is really empiricism—that is, the result of rules deduced roughly from actual practice; and further, that proportions are sometimes given to pieces of mechanism utterly in excess of those demanded by the resisting strength of materials, proportions decided in point of fact by considerations of convenience rather than of actual strength. Water pipes and steam cylinders are cases in point. If we calculate the actual thickness of metal necessary to resist a pressure of 50lb. of steam in a cylinder of 3¼in. bore, we shall find that theoretically a thickness of ·03in. will give us, not only sufficient for strength, but allow us a factor of safety of 10 besides. We know, of course, that it would be impossible to make castings of that thickness for any practical use, so we take an empirical rule suited for moderately sized cylinders:

$$T = \cdot 06\ D + \cdot 2$$

Where T = thickess, D = bore; and we find that this gives us:

$$\cdot 06 \times 3\cdot 25 + \cdot 2 = \cdot 395\text{in.}$$

or a trifle over ⅜in.

Well, we know that this thickness is rather out of proportion to so small a bore;—that if the cylinder were one or two inches bigger, ⅜in. would still be thick enough. But if we lessen the metal very much we run the risk of an unsound or brittle casting, or a casting too hard to bore. So we take the fraction of an inch next below our calculated thickness, that is 5/16in., and feel sure that we have ample thickness in our cylinder, allowing a ⅛in. for reboring at some future time, if necessary.

The area of the steam-ports requires a little attention, and should maintain some definite relation to the piston speed. Steam does not travel, and is not capable of travelling, at an indefinite or infinite rate of speed, as some may imagine; neither is it capable of forcing its way

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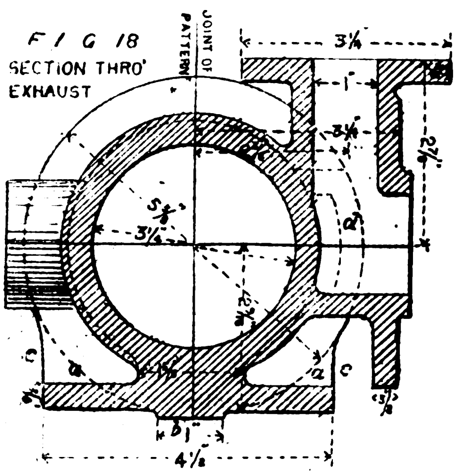
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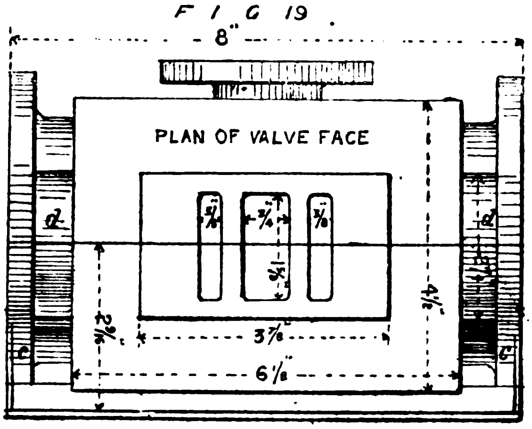
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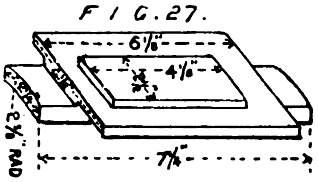
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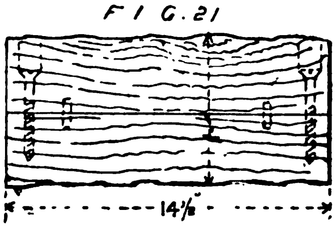
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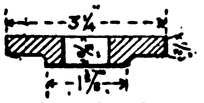
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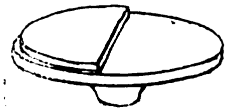
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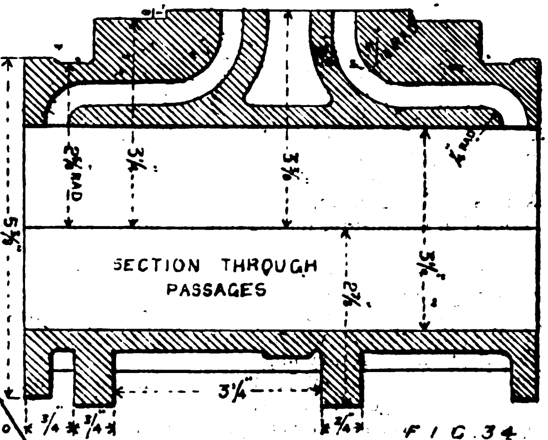
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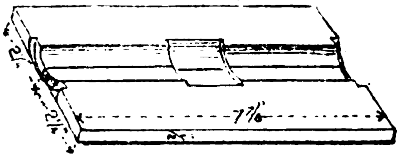
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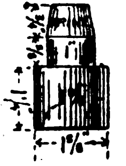
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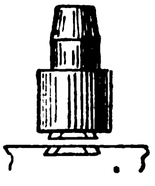
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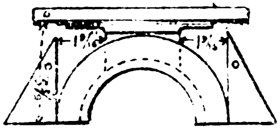
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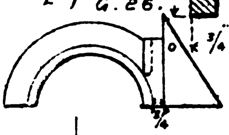
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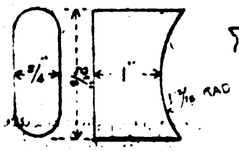
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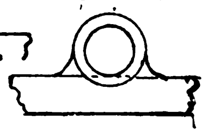
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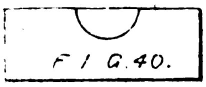
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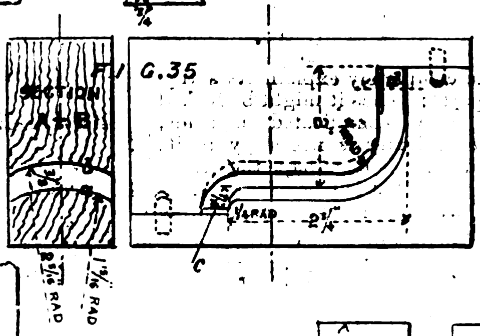
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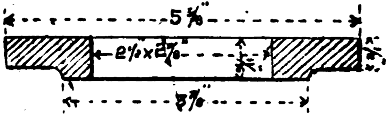
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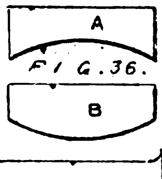
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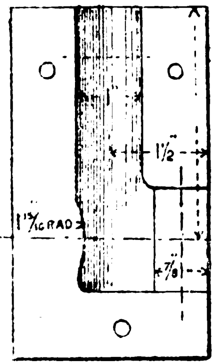
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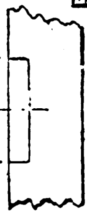
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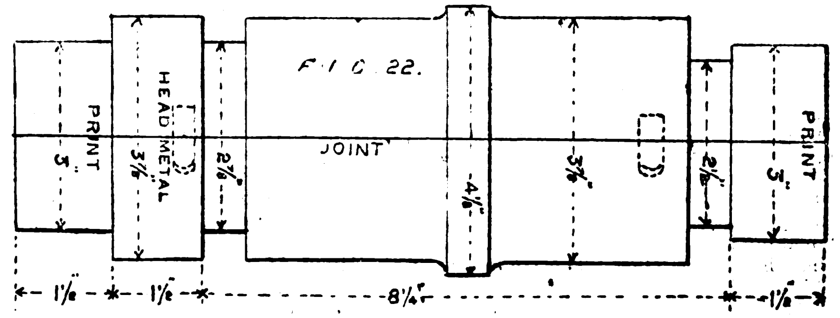
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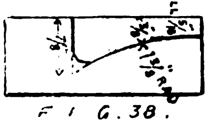


FIG. 38.

through a narrow passage without loss of pressure by friction, any more than water is capable of travelling through narrow pipes without its pressure being reduced thereby. Hence steam ports should be large enough—that is, should bear such a due relation to the piston area, and to its velocity, that the full force of the steam shall be exerted. Thus a common rule is to make the area of the port equal to ·057 area of the piston in a high-pressure engine, presumably of moderate speed, such ratios varying with the speeds in different engines. Taking, therefore, the port area as ·055 of the piston area, with a piston velocity of 300ft. per minute, then—

$$·055 \times 8·2 = ·4510 \text{ area of port.}$$

Let us make the length of the ports equal to half the cylinder diam. = 1⅝in. (quite arbitrary). Then: $\frac{1·625}{·4510} = ·36$ width of port, say ⅜in. The exhaust will be double this, or 1⅝in. by ¾in. Length of stroke is an arbitrary dimension sometimes taken at twice the bore, often less. I have made it a little less than twice—viz., 6¼in. The flange thickness may be $\frac{4}{3}$ of the cylinder thickness:

$$·3125 \times \tfrac{4}{3} = ·4166, \text{ or say } \tfrac{3}{8}\text{in.}$$

Having settled these more important dimensions, let us go to work, draw out our cylinder to full size, and make it.

"Lagging up" is the usual method adopted in making cylinders of moderate dimensions, but in this instance we turn from solid stuff. We shall joint, of course, for the convenience of the moulder, and the joint will run in the direction shown in Fig. 18. To include the "head metal" and prints we shall require two blocks, roughly, 14½in. by 4½in. by 2¼in., and these we shall dowel together with two dowels, fitting tightly into the joint of one half, loosely into the joint of the other. Supposing we have no centre plates, the cylinder being small, we can screw together in the manner shown in Fig. 21, using 2½in. screws, and letting their heads down through a centre-bit hole, so that we can turn the 3in. prints without running foul of them. Rough down, using a turning gouge, and (saving those who are adepts at turning, and prefer the side chisel) scrape the body to a finish with a firmer chisel, to 3⅞in. diam.—the belt standing ⅛in. above this. Fig. 22 gives all the finished dimensions of the *pattern*. 8¼in. over the faces of the flange recesses allows for turning, and 3in. diameter of prints allows ¼in for boring. The 1⅜in. grooves allow for the facings of the flanges and the hollows at their backs. The prints at the ends of this pattern are made as shown—parallel.

Prepare two flanges, which need not be dowelled together in this case; the body being already dowelled—saw out four half-circles 5¾in. diam. by 1⅜in. thick (rough dimensions). Plane one face and the joint edge of each true, and screw upon a true wood face chuck (Fig. 23) first bringing the edge of one half flange against a line drawn across the centre of the plate, and screwing it fast with two wood screws put in from the back, afterwards bringing the edge of the other half-flange to that of the first, and screwing it in like fashion. Bore and turn to dimensions (Fig. 24). The flanges should just be thrust tight by the hand into their grooves, and need not be screwed or bradded.

For the cylinder foot prepare two pieces, $7\frac{7}{8}$in. by $2\frac{1}{4}$in. by 1in. thick, all finished dimensions. Guage two corresponding edges to $\frac{3}{4}$in., and placing them together, mark a portion of a $3\frac{7}{8}$in. circle on the ends, cutting these gauge lines. Work through this curve with a paring gouge or round plane, and cut out portions besides to fit over the belt of the cylinder, and over its flanges, the ends of the curves being also rounded a little to fit the hollows of the flanges (Fig. 25). At this stage take the cylinder body apart, and laying the half containing the dowel *holes* on a true board, check one half of the foot, with a set square (Fig. 26), and if not at right angles, or if, as is most probable, it does not bed properly, chalk the cylinder and ease the foot where required. When fitted, screw in place, put the other half of the cylinder in position and get its half-foot also to correspond with the first. Then unscrew, rebate, and hollow the back (Fig. 18, *a*, *a*), and replace finally. The joggle on the face (Fig. 18, *b*) will not appear till the casting is planed, when the feet, being planed back on each side, will leave it standing above.

Small brackets (Fig. 18, 19, *c*, *c*) will be fitted between feet and flange, $\frac{5}{16}$in. thick—$\frac{3}{16}$in. because they shall stand back $\frac{1}{16}$in. from the faces of the flanges when the latter are turned. Fit in with gouge and chisel, glue and brad. In glueing portions of patterns together, be sparing of glue, for if you get it in superfluous amount working out of the joints in the sand. the mould will become torn and damaged thereby. A very small quantity of glue, moreover, will suffice to make a strong joint if the latter is close fitting.

We come now to the provision for steam ways. The first piece we shall require will be a block $7\frac{1}{4}$in. by $2\frac{1}{4}$in. by $1\frac{1}{8}$in. (finished dimensions) to form the metal round the passages (Figs. 18 and 19, *d*, *d*, *d*). Strike the curve of the cylinder on each end of this, and work until it fits round the body between the flanges, taking care not to reduce the thickness below the $1\frac{1}{8}$in. on the edges. Prepare a piece for the steam-chest face $6\frac{1}{8}$in. by $4\frac{1}{4}$in. by $1\frac{1}{8}$in. (finished), to include the hollow on the back, and dowel it centrally upon the passage block on the opposite face to that just curved, being particularly careful to keep the edges of each parallel up and down (Fig. 27). At this stage it will be well to fasten the passage block in position to be sure that our height is correct, and that it is both parallel with the joint and central with the cylinder body. To do this, lay the joint of the cylinder on a true board, and placing the saddle piece with its flange on the back, try with set squares held against the flanges (Fig. 28), until we get equal dimensions from the latter to the passage body, viz.: $1\frac{9}{16}$in. Then lay a straight-edge across the face of the flange, and whichever way it is turned up or down, or across, we should measure alike, $3\frac{3}{8}$in., from face of flange to joint of pattern. If we find that it is out of parallel, a shaving or two must be taken off the *joint* of the passage block where necessary. When all is correct, set the block by running a couple of screws through it into the body.

Beyond the ends of the flange (Fig. 19, 27) the passage block follows the curve of the passage core with a radius struck from the centre of the cylinder—viz., $2\frac{3}{8}$in. Work this with a chisel, and let it merge into the flange with $\frac{1}{4}$in. hollow. Then the flange edges standing out beyond the block at the sides, have to be gauged to $\frac{1}{2}$in. thick, and these also will merge into the block with $\frac{1}{4}$in. hollows.

Lastly, upon the flange add the valve facing, $4\frac{1}{8}$in. by $2\frac{1}{2}$in. by $\frac{1}{8}$in., and upon this again brad three prints for the passages (Fig. 19). The middle print will measure $1\frac{5}{8}$in by $\frac{13}{16}$, the two passage prints $1\frac{3}{8}$in. by $\frac{9}{16}$in., and all alike will be, say, $\frac{3}{8}$in thick. The exhaust print will be fastened on exactly in the middle of the facing, and the two port prints $\frac{3}{8}$in. away on each side. These dimensions, of course, are measured on those faces of the prints which go against the flange, and their ends and sides both taper away from those dimensions—say, $\frac{1}{32}$in. Note that the ports are slightly rounded in the corners. This is to prevent the face of the valve from being cut and grooved. The corners of the prints will therefore be rounded similarly. The exhaust branch is turned to dimensions (Fig. 29), and its flange is turned without a joint, and slips over the print just easily (Fig. 30). Then the branch is cut to fit against the steam-chest flange (Fig. 31), until its centre measures $2\frac{3}{8}$in. from the centre of the cylinder (Fig. 18), and a couple of small hollows are glued in to fill up the angular space (Fig. 32). We do not screw this branch permanently in place, for then the moulder would have to lift away the sand above it with a "drawback," which is neither necessary nor desirable in this instance. So we make a sliding dovetail in hard wood, screw it on the end of the branch, and let it slide in a corresponding groove cut in the side of the passage block (Fig. 33.) This cannot shift during the ramming up, and when the cylinder body is lifted out, the branch is afterwards withdrawn into the space left by the body, leaving the flange behind. A piece of flat loam cake, which the moulder has taken the precaution to lay against the face of the branch flange, is now removed, and into its space the flange is drawn, the cake being replaced after the mould is finished. The above is one of the few instances where a sliding dovetail is preferable to "wires" in loose pieces.

Prepare two blocks to Fig. 34 for pump facings, and fasten them upon cylinder in positions shown in Fig. 20.

The passage core box need not be built up as in the case of a large cylinder, but can be made from two blocks of solid wood dowelled together and worked according to dimensions in Fig. 35. The curve section *a* is worked to a $1\frac{13}{16}$in. radius with concave templet A (Fig. 36); that marked *b* is worked to a $2\frac{5}{16}$in. radius, with convex templet B. The thin strips $1\frac{3}{8}$ by $\frac{1}{8}$ by $\frac{1}{32}$ give the chipping allowance on the edges of the ports. The curved portion, C, fits the cylinder core, and the portion, D, without the dotted line, drops into the print. The exhaust core box will be made to the dimensions of Fig. 37, which represents one half laid open in the joint (Figs. 38, 39, 40), showing the sections across the centre line, and at the two ends.

Too much pains cannot be taken with these core boxes, since a small amount of error where we have but $\frac{5}{16}$in. of metal may readily reduce that metal below its proper thickness, and then the probabilities are that we shall get the casting spongy in those places, and that the air holes will make an opening from one passage into another. Such casualties do sometimes occur even in larger cylinders than ours. Therefore, use templets, and be sure that lengths of passages and curves of same are correct. Hollows need not be put in the boxes to match the rounding of the prints—the moulder seeing the prints rounded will rub the cores to match. No provision is wanted for the central core.

I have said nothing about taper. In so small a pattern we can ignore that. Yet even in this a pattern-maker would put taper by mere force of habit, taking just one extra shaving off the lower portions of the work, or bearing harder there when glass-papering. At any rate, the difference, though imperceptible with the rule, can be detected by calipers, and is sufficient to allow ease of delivery from the sand.

## TELEGRAPHING TO AND FROM TRAINS IN MOTION.

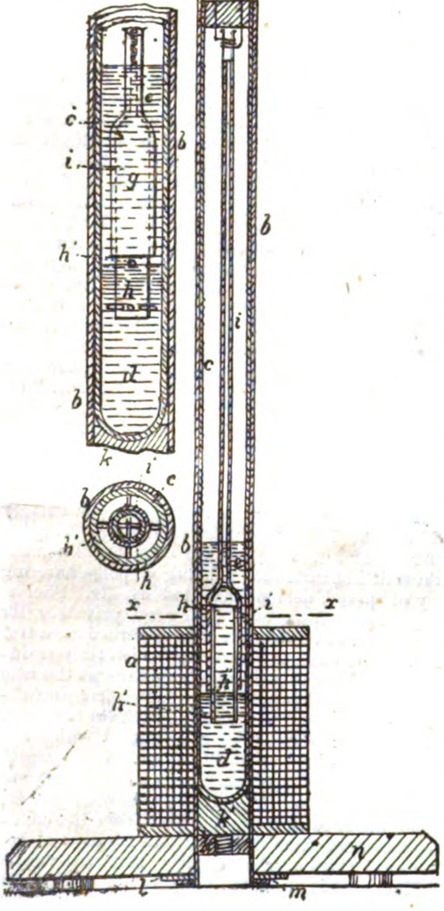
WHAT promises to become an historical event in railway signalling was witnessed last month on the New York, New Haven, and Hartford Railroad, when the system of communicating between moving trains and the stations along their route, invented by Mr. Lucius J. Phelps, was successfully experimented with. It will be remembered that several inventors have already turned their attention to this subject, and there are not a few more or less feasible schemes which, judging by appearances, will be heard of no more now that Mr. Phelps has discovered a means of utilising an induced current instead of having an "electric rail" to convey the current. His conductor consists of a No. 12 American gauge insulated wire, which is placed in a 3-8in. groove made in string-pieces 2in. square in section, and covered up with a lid 3-8in. thick. The string-pieces are mounted on blocks nailed to the sleepers, midway between the metals, so as to bring the wooden trough containing the conductor to the same level as the rails. At crossings, the wire is inclosed in stout rubber tube and carried under the crossing rails, —the rubber tube entering the wooden box or trough at both ends for a short distance to guard against damp and injury. At level crossings, where ordinary wheeled vehicles pass over the metals, the conductor is carried in strong wrought iron tubing, which is securely fastened to the sleepers. In order that the experiments might thoroughly test the merits of the invention, a portion of line was chosen on which there are two drawbridges for crossing rivers, 26 switch or other rail crossings, and 47 places where the public highway has to be provided for. The circuit with station instruments is completed in the usual way by means of ordinary telegraph wires. In cases where the induction current is used, it is advisable to have the wires parallel for as long a distance as possible, and comparatively close to one another. For that reason the new telegraph car carries a 2in. iron pipe suspended 7in. above the level of the rails. In this pipe is a rubber tube $1\frac{1}{4}$in. in diameter, containing 90 convolutions of No. 14 (A.G.) copper wire, single-braided and paraffined, so connected as to form a continuous circuit about a mile and a half long, and presenting about three-quarters of a mile of wire parallel to the primary line wire between the rials. The return portion of the coil is taken back through a rubber pipe which runs up to the roof of the car, with the object of removing it as far as possible from the lower branch. The terminals of the car, or secondary, circuit are taken to a key for transmitting, thence through the back contact to a delicate polarised relay devised by Mr. Phelps, which acts as the receiving instrument through an ordinary sounder placed on a sounding-box above the glass shade covering the relay. The car is fitted with a battery of five cells, one of which is used to work the local sounder, the other four to transmit messages. The current passes from the front contact of the Morse key through the coil, and through a "buzzer" or rapid current breaker, which causes a humming noise resembling that of the bee. This "buzzing" is, of course, broken up into Morse characters by the key, and they are received at the station in a telephone. Messages are sent from the station to the train by a battery of about 12 cells, capable of giving a current of about $1\frac{1}{2}$ ampère over the line, the transmitting instrument being a pole-changing key of special design invented by Mr. Phelps. Experiments have been going on privately for some time, but on what was regarded as a test trial before experts, words were distinctly transmitted while the train was travelling at the rate of 25 miles an hour, a heavy snowstorm prevailing all the time. Messages have, however, been clearly and unerringly transmitted while the train was travelling at 40 miles. It is worth noting that on one occasion, when, owing to some repairs to a trestle bridge, the line wire was for some distance actually four feet from the coil, a message sent from that spot was received at the terminal station, the signals being perfectly distinct. It is much too early to assert that the system will be available under all conditions; but it has been proved and tested: the remainder can be left to the developments of the future.

## MILLER'S NEW ELECTRIC METER.

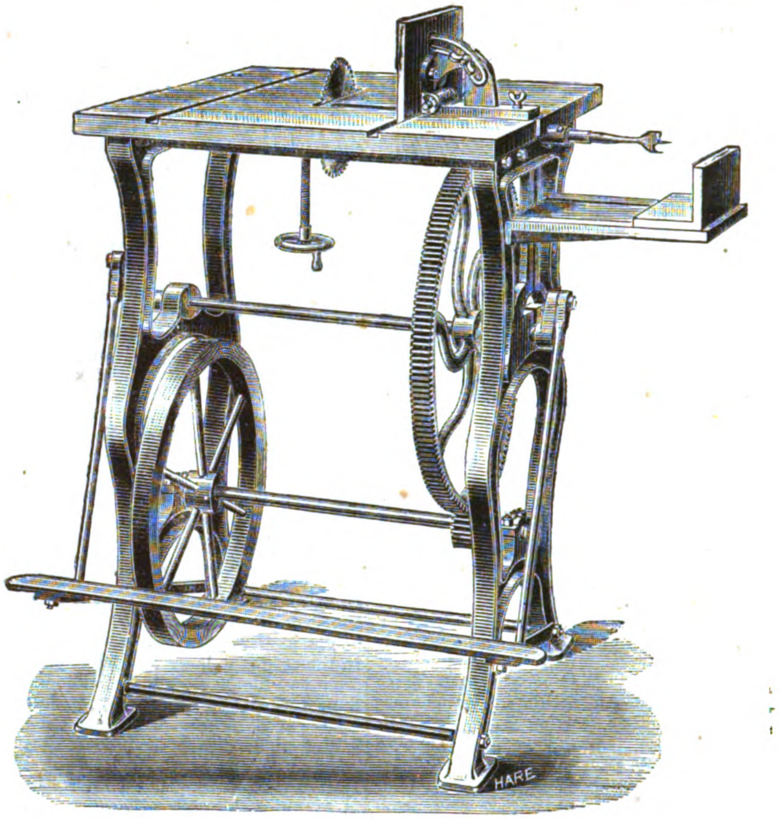
SOME improvements in electric meters have been recently patented by Mr. L. B. Miller, of Bolan-street, Battersea, S.W., which are applicable for instruments intended to measure ampères, volts, or volt-ampères. At the lower end of a vertical brass tube a coil or coils of insulated wire is wound, having the ends connected to suitable terminal screws fixed in a circular wooden base. Inside the brass tube (which has its sides cut away for the greater part of its length) there is a closely-fitting glass tube closed at its lower end by fusion. At the bottom of the glass tube, where it is within the wire solenoid, there is a small quantity of mercury, and over this some alcohol coloured red. Floating in the mercury and alcohol is the plunger of the instrument, the construction of which is as follows:—A small piece of sheet charcoal iron, thin and extremely soft, is bent into a tube. This forms the core of the solenoid. A piece of glass tube similar to a thermometer tube, but not so thick, is fused to the top of a short length of glass tube of such an internal diameter that the iron core will just fit into it and project a short distance underneath. Into the bottom of the iron core are fixed four small guides to keep the plunger central. The core and the glass surrounding form "the plunger," and the prolongation of the glass upwards the "indicating tube." The level at which it will float is found, and there a small hole is made through the iron or through both iron and glass. In order to increase the buoyancy of the plunger the patentee sometimes surrounds the iron core below the glass with a small ring of ebonite. The top of the outer glass tube is closed, either by fusion or with an indiarubber stopper, having previously formed a small guide of twisted wire to keep the top of the indicating tube at the centre of the outer glass tube. The spirit cannot, therefore, evaporate, and the instrument may be easily transported, and even inverted, without being damaged or disarranged.

The action is as follows:—When the current passes round the solenoid the iron core of the plunger is attracted towards the centre of the solenoid. Directly it commences to move downwards the small hole or valve at the junction line between the spirit and the mercury is covered up by the latter, and the spirit inside the plunger, having no exit, is forced up the bore of the indicating tube for a distance depending on the power of the current to drag down the iron and glass against the buoyancy of the mercury and spirit, a small movement of the plunger necessarily causing a large rise of the spirit in the fine tube. The patentee has found by experiment that if the core is about two-thirds of its length within the solenoid, and moves only through a small distance, the rise of the spirit as shown on a conveniently placed scale is proportional to the current strength when the glass and core are quite cylindrical and the iron very soft and thin. If these conditions are not fulfilled the readings will not be proportional, but must each be marked separately on the instrument. If, however, some other non-magnetic material, such as ebonite, is used instead of the glass, it may be turned till its shape is made such that the distance it will be pulled down is strictly proportional to the current strength. Therefore, by constructing a core in the manner described, that floats in mercury or, preferably, in mercury and a lighter fluid that will act as a lubricant, a vertical movement that is strictly proportional to current strength may always be obtained, and this movement may be utilised in various forms of electrical measuring instruments.

FIG. 2. FIG. 1.



When the instrument is required to measure ampères, the solenoid is covered with a few turns of thick wire placed in the main circuit; when volts are to be measured, thin wire offering a high resistance is used, and placed as a shunt to the main circuit; and when volt-ampères are to be measured, the solenoid is either wound with both main and shunt wires, or the selenoid with the main wire and the core with the shunt wire, protecting the latter from the mercury by guttapercha, and making suitable flexible connections. Fig. 1 is a central vertical section of part of the instrument, and Fig. 2 shows details drawn to an enlarged scale, the lower portion being section on line *x*—*x*, Fig. 1. Referring to the drawings, *a* is the solenoid, *b* the protecting brass tube, *c* the outer glass tube, *d* the mercury, *e* the alcohol, *h* the iron core, $h^1$ the iron guides in the core *h*× the small hole in the core at the junction line between the mercury and the spirit, *i* the glass portion of the plunger, *j* the indicating tube, *k* a screw for regulating the position of the iron core, $k^1$ a piece of ebonite interposed between the screw *k* and the bottom of the tube, *l* a washer interposed between the nut *m* and the base of the instrument *n*.



## BRITANNIA COMPANY'S FOOT-POWER CIRCULAR SAW.

AT the Architectural and Building Trades Exhibition, recently held under the auspices of the Society of Architects at the Floral Hall, Covent-garden, the Britannia Company exhibited their newly-patented circular saw, which is shown in the annexed illustration. This machine is, in reality, a combination tool especially adapted for pattern makers, cabinet makers, joiners, picture frame makers, and all workers in wood. The gear gives a speed on the saw spindle of 1,500 revolutions per minute with ordinary treading, and the machine runs so easily that the saw will actually cut 3ft. 8in. of 1in. mahogany after the foot is removed from the treadle, and with a saw of the requisite size, hard wood up to 4in. thick can be cut. Grooving is done by the use of a thick saw set on the skew with washers, and fret-cutting can be done by removing a portion of the table, and attaching a cam to the spindle in place of the circular saw, the fret-saw being suspended from an arm overhead. Curves can be cut in pine or mahogany 4in. thick. Dowelling and drilling can be accomplished by the appliances shown on the right-hand side, the machine being powerful enough to bore up to 2in. in diameter. With suitable saws common picture-frame mouldings can be mitred up without any planing, and by the aid of the adjustable guide all sorts of saw-cuts can be made. The machine will be on view at the Building Trades Exhibition, and will be publicly tested; but meantime, having examined it, we can say that it is an economical and very useful tool.

## HARDENED AND TEMPERED GLASS.

IN Vol XXII. page 599, we gave an account of the experiments made by Mr. F. Siemens, of Dresden, in the hardening and tempering of glass, a subject which, just at the time had attracted much attention in consequence of the introduction of the De la Bastie toughened glass. A short experience with the latter sufficed to show that by dipping the hot glass in a bath of oil a state of tension was set up amongst the molecules, and the so-called "toughening" was frequently found to be only a deceptive hardening. Since that time Mr. Siemens has been steadily pursuing his investigations, and has now achieved so much success that he recently read a paper before the Applied Chemistry Section of the Society of Arts, from which we make the following extracts:—

Having satisfied himself by a series of experiments of the true cause of the spontaneous fracture of glass, Mr. Siemens invented processes of manufacture by means of which glass may be thoroughly toughened, or, as he prefers to call it, hardened. The principle upon which the processes depend consists in cooling the glass, not in proportion to its surface, but to its volume or capacity for heat. The method employed will be readily understood by considering a sheet of uniform thickness, which, after having been heated uniformly to a sufficient degree, must be cooled on the surfaces of its two parallel sides only, leaving the edges uncooled. This is done by placing the heated sheet of glass between two cold slabs of suitable material, prepared in a peculiar manner. Uniform cooling of the whole sheet is thus secured, no matter what its shape, because the edges are not subject to the cooling influence caused by the surfaces between which the glass is placed. The plan adopted for various articles varies with their shapes; but it is on the principle of uniform heating and cooling that the author's processes of manufacturing hard glass are based.

Of these, the two principal are known as press-hardening and casting; but, besides these, there is a third, theoretically less perfect than the others, viz., semi-hardening or hard-tempering; this, though less important, may be advantageously employed where presses would be unsuitable, and casting impossible or difficult, as in the case of bottles, lamp chimneys, &c.

Press-hardened glass has now been made, with constantly-increasing success, for six years. The articles are mainly of plate and sheet glass, either flat or bent into a variety of shapes. Besides plain work, decorated sheets, such as signboards with enamelled inscriptions, figures, and other ornaments, form an important part of the goods produced; the process, as already stated, is, therefore, one of manufacture (the goods receiving through it their definite shape and decoration), and not simply one of hardening or toughening. The glass is so hard that the diamond will not touch it, and it cannot, therefore, be cut or bent after manufacture; it may however be polished, etched, and slightly ground; its strength is at least eight times that of ordinary glass.

The process of manufacture is as follows:—The glass is first cut in the ordinary way to the requisite shape and dimensions, and is then exposed to the radiant heat of a peculiarly-constructed furnace until quite soft; as soon as it has attained the necessary temperature, it is placed between cold metal plates, to be cooled down with a rapidity which varies with the thickness of the glass, but is in any case very great. The heating and cooling of sheet glass of ordinary thickness last altogether a minute and a half, a minute being the length of the heating, and half a minute that of the cooling operation. It is a remarkable circumstance that glass may be thus heated and cooled in so short a space of time without either cracking or breaking; this is altogether due in the case of the operation of heating to the uniform temperature of the furnace, and to the heat being produced entirely by radiation; should these conditions not be fulfilled, the glass would break to a certainty. As regards the success of the cooling operation, this depends upon the uniform temperature of the glass before it is cooled, and upon that of the metal plates between which it is placed whilst being cooled. This uniformity of temperature, and the total absence of draught, which would cause irregular cooling, are the conditions under which the whole operation can be carried on with assured success.

The surface of the metal plates, or moulds used for the presses, may be so prepared as to produce more or less cooling effect on the glass as required. If the glass is to be hardened to a very high degree, the metallic surfaces must be of very high heat-conducting power, such as copper, and must be left quite bare; the glass must also be raised to a very high temperature, as it would otherwise crack during cooling. If it is proposed to harden the glass to a lower degree, surfaces of iron are used, this metal not being so good a conductor of heat as copper, whilst the temperature of the glass is also kept lower. By covering the surfaces of the iron presses with wire gauze, their cooling effect may be reduced to any required extent, so that a certain amount of hardening may be produced without rendering it necessary to heat the glass to such a temperature as to make it difficult to handle, or to cause it to stick to the furnace bed. If a still lower degree of hardening is proposed, the faces of the presses may be covered with asbestos paper, or even clay slabs may be employed.

Semi-hardened glass is made in the same large radiation furnaces as press-hardened, by means of the hard-tempering process, of which the following is a description:—Finished articles, which are of a shape to which presses cannot be easily applied, such as bottles, are heated up to a temperature short of softening; each one is then placed in a casing of sheet iron, which is so arranged that the heated article shall not touch the inner sides of the casing. In order to effect this, the casing is provided with internal projecting ribs, which retain the glass article in position, touching it only at very few points. The casing with the heated article of glass within it is allowed to cool in the open air. Whenever it is a difficult matter to handle the heated glass, instead of placing it hot into the casing, the casing with the glass inside it is inserted in the heating furnace for the requisite time, and then allowed to cool as before described.

The third and last process to be described, which Mr. Siemens considers the most valuable of the three, is a peculiar mode of casting hard glass. This has not yet been introduced on a manufacturing scale, but the experimental castings produced have turned out to be quite satisfactory in every way. They consist of floor plates, grindstones, pulleys, tramway sleepers, and various ornamental work.

Hard cast glass is manufactured in the following manner. Glass, melted in a tank furnace, is tapped into moulds, as with iron castings. The process thus far resembles that carried on in an iron foundry, but differs from it, inasmuch as a special material is used in place of sand, and that the mould and the glass inside it are heated and cooled together. The material or mixture to be used in place of sand must be selected so as to have, as nearly as possible, the same conductivity and capacity for heat as glass; in such a case, the glass and mould forming, as it were, one homogeneous body, the glass will cool without cracking, even if the cooling process is comparatively quick, which is quite necessary if hard glass is to be produced. Glass cast in this way may have almost any variety of form and inequality of thickness. In the last respect this process differs entirely from those previously described, in which only glass of uniform thickness can be dealt with. If care be taken that the surface of the glass does not approach the outer casing of the mould, it does not much matter how the cooling is effected. The great point is that the mould and glass should be brought to a uniformly high temperature, which should be rather above that at which press-hardened glass is made. When fully heated, the mould is taken from the furnace and allowed to cool in the open air, which generally acts quickly enough to produce a good hardening effect upon the glass within. When cold, the mould is opened, and the glass removed.

It will be readily understood, from the descriptions given, that the three processes differ so materially from one another, that hardly any resemblance remains to show that they are merely different ways of treating differently-shaped articles, in carrying out the principle of keeping the whole body of the glass at a uniform temperature during the operations of heating and cooling.

The De la Bastie process, as well as the ordinary tempering processes employed, fail in not being founded on the principle set forth; glass toughened by the De la Bastie process being cooled in a fluid bath, and ordinary glass in kilns, the cooling action is most active on the portions offering the largest surfaces to the cooling influence, and hence in the one case there is a strong tension or strain in the molecules, which causes them to break up spontaneously; and in the other case, to counteract that tendency, it is necessary that the glass should be cooled very slowly.

In the discussion which followed the reading of the paper Mr. E. A. Cowper said thanks were due to Mr. Siemens for bringing forward this new manufacture in a practical form. Several of the drinking bottles he had seen for some years past, and they were very much liked because they were clean; tea could be put in them one day and beer another. The question of cutting with a diamond was a very curious one. You could scratch the surface of some of these sheets, but you could not cut it; it would not split through as common glass did. Probably that was due to common glass being in a state of tension, which, when relieved by a scratch, caused the glass to fly right through; so that even plate-glass ¼in. thick would succumb to the slightest scratch of a diamond $\frac{1}{100}$in. deep. With this glass you could not do that. The castings would be an important new manufacture. The tempering was not so thoroughly carried out in this case as in the hardening of glass in other forms, but it was sufficiently hard to serve as sleepers for tramways and railway chairs for electric railways. He thought also architects would welcome this as a means of obtaining articles of various tints, whereas they at present had to search for different stones. By this process they could obtain them, to any extent, in various tints, and in any form, by casting.

Mr. Ludwig Mond said: As a chemist, he might remark that, when the question of glass turned up, it was found to be now practically the same substance chemically that it was at the time of the Phœnicians. He certainly thought it would repay the chemist to attack the question from the chemical point of view, and see what could be done, not by mechanical processes—by heating and cooling—but by attempting to produce new chemical compounds which should possess the qualities desired.

Mr. Siemens remarked that the glass tuning-fork, which was found to be very resonant, could not be produced at all in ordinary glass in a mould, as it would be sure to crack. It could only be produced by pouring it into a mould formed of a material having the same heat-conducting power.

In answer to some remarks, Mr. Siemens said his process and that of De la Bastie could scarcely be compared, because the latter was merely a toughtening process, whilst his was one of manufacture, by means of which he shaped and hardened the glass in a single operation, either by means of presses, or casting into moulds, and in a new manner. The De la Bastie process was only an additional operation, applied after the article was finished, to toughen it; but even for that purpose it was wrong, inasmuch as the cooling influence acted in proportion to the surface, whereas it ought to act in proportion to the bulk of the glass. Those parts which exposed much surface to the cooling influence, cooled more quickly than those of less surface, and, consequently, there would be unequal cooling, which should be avoided.

The chairman, Prof. Dewar, remarked that specimens of De la Bastie's glass, examined by the polariscope, exhibited the existence of enormous strains, and he should like to know whether the Siemens glass showed anything of the kind, to which Mr. Siemens replied that it did show something of that nature, but not much.

## THE EXPERIMENTS ON FRICTION.

COMMENTING on the recent experiments in connection with friction, the *Engineer* says:—If it can be shown that bearings do not give any trouble now, and use very small quantities of oil, it may be asked, what does it matter whether the coefficient of friction is 0·01 or 0·001? It is a noteworthy fact that, although the Institution of Mechanical Engineers set these experiments on foot, its members seem to be quite content to place the results on record in their *Transactions*, and do nothing more. Surely they are worth a better and fuller discussion than they have yet received. The most troublesome class of bearings with which the engineer has to do are those of marine engines. It seems to be quite impossible to work them cool without employing quantities of cold water. The crack racers of the Atlantic—such, for example, as the *Arizona* or the *Oregon*—have spray pipes fitted over the crank pits; and from these a deluge of water is distributed during the whole run. The water is never shut off, save for a moment when a man feels the bearings to ascertain if they are running cool. There is besides a 2in. hose always ready for action. Why should all this be necessary? It may be said that the great heat of the engine-room tends to make the bearings hot. But the crank shaft stage in such ships as we are speaking of is not hot at all. The cylinders are away far up overhead. The boiler-rooms are shut off by the bulkhead. We have felt chilly in the crank-room, as it may be called, of one of these great ships. Why is it, again, that the bearings of a locomotive hardly ever heat? It may be taken as proved that if a locomotive is properly designed and properly worked, there will be no trouble from hot bearings; yet the loads per square inch of surface are very heavy indeed. Take, for example, a big end brass; the bearing will be 4in. long and 8in. in diameter, the pressure on it with a 17in. cylinder and 120lb. pressure will be 27,240lb.; the bearing surface will be—allowing one-third of the total surface to take the strain—33in., let us say. Thus the load per square inch will be 825lb., which is much more than is usually deemed safe. In small stationary engines, on the other hand, we constantly find that the bearings give a great deal of trouble. Why is this? Have the experiments of Mr. Towers thrown any light on the subject, or helped us to the reason why? We think not, or rather, we should say, that engineers as a body think not, for we still have hot bearings, Mr. Towers to the contrary notwithstanding. Our own explanation of hot bearings is that they are in nearly all cases due to some bending or pinching action. Heating can be set up by a very minute cause, and once it is started, it will go on. In one out of many cases, in fact, which have come under our knowledge, where a crank pin heated persistently, the evil was due entirely to the circumstance that the crankshaft was too weak, and bent and whipped under the strain. It will constantly be found that crankshafts will run quite cool, unless the bearings are so far screwed down that the crankshaft has very little play. In other words, absence of "knock" and heating go together. The received explanation of this is that when the brasses are a loose fit the oil gets between the surfaces. This may be a partial explanation, but not a complete one, because it leaves the fact unexplained that bearings will not invariably heat because they are screwed up. When hot bearings are normal to an engine, we believe—we had almost said we know—that something is out of square; there is want of truth and accuracy. A slack brass is simply a crude expedient for obviating this difficulty. It permits the rubbing surfaces to play about and adjust themselves to each other. No properly-designed, properly-lubricated bearing wants to run hot. If it heats, it is driven to it, so to speak, against its principles. One reason why a locomotive runs cool is that provision is made for a great deal of self-adjustment. This is necessary in a machine which runs over a comparatively uneven and crooked surface. There is elasticity, and this serves a useful purpose. We too often find, however, in steam machinery that a partial and very mischievous elasticity is introduced by the employment of parts too small and light for their work. James Watt and the early engineers could not have got on at all if they had not made special provision for want of accuracy in workmanship. Thus the connecting rod was always connected to the beam end by one universal joint, and very often there was another at the crank shaft end of the rod. The piston-rod and parallel motion, and the beam and the air-pump rod, were all mutually accommodating. The result was that these old engines are running, many of them, to this day.

Returning once more to Mr. Towers's experiments, we ask for information as to whether anyone is acting on the discoveries—for they are nothing else—and if so, with what results? We confess that we have failed to discover anyone who is the better in any respect for them. This ought not to be the case. Everyone says that they are of great value; is it wrong to ask of what value? Are they worth something to the community in a pecuniary sense? if not, why not? Nothing is more to be deplored, we think, in engineering than that the intelligent, costly, and successful labours of a member of the profession should be thrown away.

It reminds us of the work done by Government committees, who take evidence and pursue investigations, extending over months, it may be years. Finally they report. But nothing comes of the report.

## THE CHEMICAL NATURE OF COTTON.*

CELLULAR filaments, turgid with nutrient and astringent juices, springing from the nearly ripened seed and intertwining in a seeming tangled mass; soon lengthening and becoming hard and ligneous; then the remnant of the sap dries up within them, and they shrivel to flattened, twisted, sear (and sometimes yellow), lifeless—*cotton fibres.* The chemistry of cotton began with the art of dyeing, in India; the ancient Egyptians were skilled in dyeing *al-quton*; they were not required to reconcile the cotton with coal-tar colours. A knowledge of the physical structure and chemical constitution of the cotton fibre does not explain its indifference to most dyes, nor can its affinity for a certain few colouring matters be understood, because it does not appear to form chemical concombinations with these: they can be readily removed, leaving the fibre unchanged. The ripe fruit of the cotton-plant (Gossypium, from the Arabic *goz*, a soft substance) is a large capsule containing a mass of the filaments which envelop and adhere to the seeds. The fibres from different species of the plant vary in length, thickness, flexibility, tensile strength, and colour; the diameters are from $\frac{1}{800}$ to $\frac{1}{2500}$th of an inch, and the lengths from 0·77 to 1·80in.; the mean diameter of Sea Island cotton fibres is $\frac{1}{1362}$nd of an inch, and the average length 1·60 inches; some cottons are highly coloured, like the so-called *Nankin*, and the whitest contains some natural colouring matter, which is of the same character in all cottons, and consists of two bodies, one freely soluble in alcohol, the other not. Clean cotton is nearly pure *cellulose*; the associated substances are in varying and exceedingly small proportion, and may be removed by means of hot alkalies, dilute acids, and ether; the bodies obtained by this treatment are found to consist of waxy, albuminoid, and colouring matters; ulmic, pectic, and fatty acids; calcium and sodium sulphates; and ferric, silicic, and aluminium oxides, with traces of potash and magnesium phosphate. The ulmic acid, perhaps, results from the action of the chemical agents on woody tissue (not cellulose), and in like manner the pectic acid may be formed from insoluble pectose.

Cellulose is the principal material in the structure of plants; the natural process of its formation and its relations to allied bodies constitute one of the most interesting studies in science. The formula of pure cellulose is $C_6H_{10}O_5$, or $C_{18}H_{30}O_{15}$; therefore it is composed of carbon and the elements of water, or, empirically, it may be said to consist of carbon and water. It is isomeric with dextrine and starch, and differs from natural gum and the sugars (glucoses and saccharoses) only in the relative quantities of water elements. By simple chemical means cellulose may be changed to gum, to starch, and to sugar; by natural process the plant converts starch, gum, and sugar one into the other or into cellulose, according to the requirements of its different parts. Are these changes produced simply by alteration of molecular structure? "The theory of atomicity . . . . interprets the most complicated cases of isomerism"—with exceptions. We know that the vital principle of the plant directs the formation of tubes of cellulose, as conduits of the sweet sap from which they are produced; that the same saccharine juice deposits gum and, in the seed, starch, and that this starch, in the new growth, by the stimulation of diastase, changes itself to the forms of gum, and sugar, and cellulose, exhibiting in matter phenomena that suggest the convertibility of the different forms of energy; but we cannot explain these transmutations, nor do we understand why the presence of a small quantity of acid should convert a handful of old rags into an equal weight of sugar.

How do plants produce these bodies, composed of carbon with hydrogen and oxygen in the same relative proportions as in water? The hydrogen can only come from water: the plant obtains that through its roots, and as it does not receive oxygen from the air, water may also furnish that element, while, under the influence of light, the leaves absorb carbon dioxide, the source of the carbon. The plant now has water and carbon from which to form its starch, gum, sugar, and cellulose. By resolution of the carbon dioxide, and directly combining carbon and water? The process of eremacausis, or natural decay of woody fibre, would indicate this. It consists essentially in evolution of water and oxidation of carbon, with reproduction of carbon dioxide. But another consideration forbids this view. Not only do plants form bodies composed of carbon, hydrogen, and oxygen, but they also produce waxes, caoutchouc, essential oils, and resins, consisting of carbon and hydrogen, and containing little or no oxygen; therefore, the plant must have the power to decompose water, and appropriate only the hydrogen. Hence, it seems possible that the cellulose and allied bodies are produced by the combination of hydrogen from water with carbon dioxide, the oxygen of the water being emitted.

Although cellulose is so readily convertible to gum, starch, and sugar, it resists chemical action in the stomach, and is as innutritious as clay. It is scarcely attacked by dilute acids and alkalies, but strong sulphuric acid and zinc chloride change its physical character; "parchment paper" and "vulcanised fibre" are respectively produced by these agents. A solvent of cellulose is obtainable by dissolving cupric carbonate (formed by precipitation from the sulphate) in ammonia; it easily dissolves cotton, particularly so-called "absorbent cotton," and acids precipitate the cellulose in flocculent form.

Remarkable changes are effected in the nature of the cellulose or cotton by the action of concentrated nitric or mixed nitric and sulphuric acids; hydrogen is removed, and the radical nitryl ($NO_2$) substituted, with formation of pyroxylins or varieties of nitro-cellulose. True "gun-cotton" or trinitrocellulose, $C_6H_7(NO_2)_3O_5$, is made with the more concentrated acids, while acids containing more water yield less highly nitrated or "soluble" pyroxylins, which are used in the manufacture of collodion, celluloid, zylonite, &c. To determine whether the alteration of structure and chemical nature of the cotton fibre had developed affinity for aniline colours, a few tests were made with pyroxylins; ordinary rosaniline dyes were used, and the trisulphoacid of rosaniline (Holliday's acid magenta); the trinitrocellulose rejected the dyes, while the partially nitrated cotton retained the colours after washing with soap and water. A way to make cotton receptive of colours, without the use of mordants, and means of rendering it less combustible, of removing the harshness of inferior grades, and of bleaching it cheaply without injury to the fibre, are desiderata that have engaged the attention of many chemists. An increased affinity for dyes may be imparted by preparatory treatment with hot dilute alkali, which removes most of the waxy and fatty matters, and notably alters the shape and dimensions of the fibre; it contracts in length, and approximates to the form of a simple round tube, with a clear hollow from end to end.

Cotton may be distinguished from other vegetable fibres, such as flax and hemp, with the microscope, and from wool and silk by simple chemical tests—for example, hot dilute alkaline solution does not affect cotton, but quickly dissolves the animal products; a solution of the trinitrophenol picric acid dyes wool and silk a permanent yellow, but washes away from cotton, leaving it white; or instead of the dye, dilute nitric acid may be used, which produces picric acid from the animal substance; a hot solution of mercuric nitrate imparts a red colour to wool and silk, but leaves the cotton unchanged; by boiling cotton with dilute hydrochloric acid it becomes rotten, while wool and silk are not thereby changed; a solution of lead monoxide in dilute alkali blackens wool, but not cotton; a solution of zinc chloride dissolves away silk from cellulose, &c.

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*By E. DWIGHT KENDALL, in the *Scientific American.*

## DODGES FOR AMATEUR PHOTOGRAPHERS.*

ANYONE owning a fret saw can make vignetting boards with ease. Mark out the shape of vignette required on a piece of half-inch soft pine. Set the saw-table on a bevel and cut out. Cut about three, taking care to mark each one from the smallest end of the hole of the board last cut. Tack together with 1¼in. brads, and cover the top (the smallest end) with tissue paper.

I recently required a dish to silver some paper on, and none could be obtained near where I live. I made a dish in the following manner: First cut out out a block of wood the exact size and thickness of dish required. Then take a sheet of cartridge paper, paste it with flour paste, and rub in the paste well letting the paper be thoroughly soaked with it. Then place the paper evenly on the wooden block, turn down the edges smoothly, and double the corners back, rubbing them down well. Be very particular with the first sheet, because if you get that smooth, the rest is easy. Follow with another sheet of cartridge paper, turning the surplus of slack paper at the corners the opposite direction to the last. Follow with five or six sheets of old newspapers in the same way, and cap with another sheet of cartridge. Put the block with the paper on it into an oven and bake till dry. Then take out the block and trim the edges. Paint the outside of the paper dish with varnish. Pour some varnish inside the dish and let it soak in, and then pour off the surplus. Bake in the oven again. After the varnish is hard and dry warm the dish until it is hot enough to melt paraffin wax. Pour some melted paraffin into it, and tilt it about till the bottom and sides are evenly covered; pour off the surplus, and when dry you can use for toning, developing, or even silvering paper. Of course the above is only recommended as a substitute for glass or porcelain when the latter cannot be readily obtained. *Paraffin* alone may be used if you like. I use the Scovill japanned developing trays, and find it advantageous to varnish them with thick shellac varnish now and then.

I use 5 by 4 plates in my 5 by 8 camera. Get out some slips of ⅛in. walnut, 5in. long by 2in. wide. Slip one piece down the grooves for the plate, then the plate, then another slip. This prevents reflection. I also use a mask fitting into the back of the camera; but this is not absolutely necessary.

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* By FRED. WHITEHEAD, in the *Photographic Times* (New York).

## SCIENTIFIC SOCIETIES.

### CHEMICAL SOCIETY.

AT the meeting of this Society, held on February 19th, Dr. W. H. Perkin, F.R.S., President, in the chair, papers were read as follows:—"On Benzoylacetic Acid and some of its Derivatives." Part II. By Dr. W. H. Perkin, jun. "On Toughened Filter-paper." By E. E. H. Francis, in which it was stated that filter-paper which has been immersed in nitric acid, rel. den. 1·42, and washed with water, is remarkably toughened, the product being pervious to liquids, and quite different from parchment paper made with sulphuric acid. Such paper can be washed and rubbed without damage, like a piece of linen. The paper contracts in size under the treatment and the ash is diminished; it undergoes a slight decrease in weight and contains no nitrogen. Whereas a loop formed from a strip 25mm. wide of ordinary Swedish paper gave way when weighted with 100grams. to 150grams. a similar loop of toughened paper bore a weight of about 1·5 kilo. The toughened paper can be used with the vacuum pump in ordinary funnels without extra support, and fits sufficiently closely to prevent undue access of air, which is not the case with parchment paper. An admirable way of preparing filters for the pump is to dip only the apex of the folded paper into nitric acid and then wash with water; the weak part is thus effectually toughened. "The Detection and Estimation of Iodine." By Ernest H. Cook, B.Sc. (London). The usual tests for iodine when existing as an iodide are rendered somewhat difficult by the circumstances that nitrous acid liberates bromine as well as iodine; while if an excess of chlorine be employed, colourless chlorides of bromine and iodine are formed. These difficulties become of importance when it is desired to detect small quantities of iodides in the presence of comparatively large quantities of bromides, or when a quantitative estimation is to be made of the iodine. To avoid these difficulties, the author proposes to use hydrogen peroxide, which is added to an acetic acid solution. Under these circumstances, the whole of the iodine is separated from the iodide, while bromides and chlorides are unaffected. Details of the methods of employing the test for qualitative and quantitative purposes are given: in the latter case, the iodine is extracted by means of $CHCl_3$, the solution is washed with a little water to remove hydrogen peroxide, and the tritation of the iodine then performed in the usual manner. "Note on Methylene Chlor-iodide." By Prof. J. Sakurai. "A Quick Method for the Estimation of Phosphoric Acid in Fertilisers." By J. S. Wells, Columbia College. Finding the ammonium molybdate method too long and tedious when many analyses of fertilisers had to be done, the author has adapted Joule's citric-acid method as a gravimetric process. He employs two solutions: A, consisting of citric acid 900grams., ammonia solution (rel. den. 0·92) 1,400cc., water 500cc.; and B, a strong solution of magnesium citrate. 1gram. of the fertiliser is fused with sodium carbonate and nitrate, dissolved in nitric acid, and the silica filtered off. To the filtrate some of solution A is added, and the whole allowed to stand for half an hour; enough of solution B is then added to precipitate the phosphoric acid. For the author's experiments, a test solution was made up of sodium phosphate, calcium chloride, and ammonia-iron alum, so as to contain $P_2O_5$, 19·83 per cent., CaO, 25 per cent., $Fe_2O_3$, 3 per cent.; equal portions were taken for analysis, the comparison of his results with theory being given in a table. "On the Luminosity of Methane." By Lewis T. Wright, Assoc. M.I.C.E. Pure methane was prepared by Gladstone and Tribe's method by the action of the copper-zinc couple on methyl iodide. The gas was obtained free from methyl iodide vapour by passing it through tubes fixed in a horizontal position and packed with copper-zinc, which was kept moistened with alcohol, the alcohol vapour being removed by scrubbing with sulphuric acid. It was burned in a London Argand burner, the chimney of which was fitted with a cap for the purpose of limiting the air supply to the quantity most favourable to the development of luminosity. The methane flame was compared with a Methven Standard burner supplied with 18-candle gas—i.e., with a light equal to two sperm Parliamentary candles. The results obtained were—

| Rate of consumption per hour corrected to 60° F. and 30" B. cub. ft. | Candles observed. | Candles per 5 cub. ft. per hour calculated. |
|---|---|---|
| 2·78 | 2·9 | 5·20 |
| 4·46 | 4·6 | 5·15 |

"On the Oxides of Nitrogen." By Prof. W. Ramsay and J. Tudor Cundall. In this research it is shown—1. That the green or blue liquid obtained by the action of arsenious anhydride on nitric acid consists of a mixture of nitrous anhydride and nitric peroxide, in proportions depending on the strength of the nitric acid and the temperature at which the volatile liquid is condensed. 2. That if a dehydrating agent, such as sulphuric acid, be present in sufficient quantity, the distillate consists of pure peroxide, and that this process is by far the most convenient one for the preparation of the peroxide. 3. That if oxygen be passed over the blue liquid, the vapours condensed in a freezing mixture are still blue or green; a great excess of oxygen is necessary to effect conversion from nitrous anhydride into peroxide. 4. That when excess of nitric oxide is passed along with the peroxide into a cooled bulb, the trioxide is produced, the amount of trioxide depending on the temperature of the condenser. 5. The vapour-density of a liquid of a deep blue colour, containing about 30 per cent. of trioxide and 70 per cent. of peroxide, shows that the trioxide cannot exist in the gaseous state, but at once dissociates into nitric oxide and peroxide on changing to gas. The theoretical vapour-density of such a mixture was calculated from a formula deduced from the second law of thermodynamics by I. Willard Gibbs, which shows the relations between temperature, pressure, and vapour-density of the mixture of $NO_2$ and $N_2O_4$ in the gaseous peroxide; and it was found that the vapour-densities of a mixture of ($NO_2 + N_2O_4$) [partly present in the original liquid as peroxide, partly formed by the decomposition of the $N_2O_3$ present into NO and ($NO_2 + N_2O_4$)] with the NO produced by the decomposition of the $N_2O_3$, calculated by means of Gibbs' formula, are identical, within limits of experimental error, with those obtained by direct experiment. 6. The presence or absence of moisture does not appear to affect the reaction between NO and $O_2$. 7. It is probable that $N_2O_3$ undergoes dissociation with rise of temperature, even while liquid. Dr. Armstrong said that he had listened to the paper with great interest, as he had made numerous experiments on the subject, and had long been of opinion that $N_2O_2$ did not exist, at all events as gas. The authors' observations, whereby they were led to this conclusion, were of considerable importance, and it was to be hoped that ere long confirmatory evidence, that would more directly appeal to chemists, would be forthcoming. It was noteworthy that there was no recorded evidence proving the existence of $N_2O_3$ as gas. Gay-Lussac's experiments, published in 1816, showed that nitric oxide and oxygen only reacted in the proportions to form $N_2O_4$, and that reaction in proportions corresponding with the production of $N_2O_3$ only took place in presence of alkali. The method adopted by the authors did not suffice to prove the existence of $N_2O_3$, even as liquid, and their results could be equally well interpreted on the assumption that they were dealing with a solution of NO in $N_2O_4$. It was to be expected that $N_2O_4$ would be a good solvent of NO, as it appeared to be the rule that bodies which are related are easily miscible, phosphorus, for example, being very soluble in $PCl_3$, and sulphur in $CS_2$ and $S_2Cl_2$. One observation made by the authors did, however, support their view—viz., the observation that the blue liquid was with great difficulty oxidised by passing oxygen into it. In all his experiments, Dr. Armstrong had found that the reactions attributed to $N_2O_3$ could be equally well effected by a mixture of $N_2O_4$ and NO. As to the action of arsenious oxide on nitric acid, in his opinion, *nitrous acid* was *the* product, and the manner in which this underwent change entirely depended on the conditions. In dilute solution, NO would be produced in accordance with the equation: $3HNO_2 = 2NO + HNO_3 + H_2O$; but in presence of nitric acid the reaction $HNO_2 + HNO_3 = N_2O_4 + H_2O$ would take place, and would more and more preponderate the less the amount of water present. The addition of sulphuric acid would of necessity favour the latter mode of change. When $N_2O_4$ is passed into sulphuric acid, nitrosyl sulphate and nitric acid are formed; in presence of NO, the latter is reduced to nitrous acid, which also forms nitrosyl sulphate with the sulphuric acid, so that a mixture of NO and $N_2O_4$ in proper proportions precisely acts as though it were $N_2O_3$. Prof. Ramsay, in reply, said that he thought the production of a blue liquid on passing a colourless gas into a brown liquid was good evidence of the production of a distinct compound. (Peligot's experiments render it highly probable that the blue colour results from the introduction of traces of water.—H. E. A.) Numerous cases could be cited of the non-existence of compounds as gas which were well known as liquids or solids—chloral-hydrate, for example.

## WESTERN MICROSCOPICAL CLUB.

THIS club held its meeting on Monday week at the house of Mr. Francis P. Pascoe, F.L.S., St. Stephen's-square, Bayswater. The subject of "Parasitic Insects," many of which illustrate in a remarkable way the law of degradation which to-day figures so largely in religious apologetics as well as in scientific treatises, was the topic of the evening. Mr. Pascoe began by stating that his remarks were confined to insect parasites living at the expense of animal organisms. Any aberration from the normal form in such insects was due to an arrest of development, and not, as in the crustacean epizoa, to morphological change. Insect parasites might be divided into, firstly, those which pass their whole lives on their host—such as bird, pig, and ordinary lice (degraded forms of hemiptera), nycteribia—a spider-like, wingless form, living on bats (braula) (bee-louse), sheep-ticks, and fleas (permanently parasitical on cats, dogs, &c.), belonging to the diptera; and, secondly, those which pass only a part of their lives in their hosts. Of these the female of the chigoe, the only example, is free when young. Full of eggs, she burrows in the human foot (generally a negro's), and, unless extracted, there passes the remainder of her life. In the stylopidæ (bee parasites), the male is free as soon as it assumes its perfect state, the female remaining to give birth to another generation. But the most numerous of all are those in which both sexes pass the three earlier stages of their existence as parasites. Some deposit their eggs in the eggs of other insects—polynemæ on dragon-flies, ophioneuri on the white cabbage butterfly's, &c. The female of a sitaris (one of our autumnal beetles) lays its eggs in the galleries of a bee (anthophora). For six or seven months the larvæ, "active little creatures with six legs," remain in the lethargic state, and, consequently, without food. But the moment the anthophora lays an egg, the sitaris larva "springs upon it," and in the empty shell undergoes its first transformation, changing into a "fleshy grub," consuming the honey the bee had stored for its own young. In the botflies, another set, the females lay their eggs where they may be swallowed by their host, and passing the larva and pupa stages in the digestive organs, are voided in the imago state. The third set, laying their eggs mostly in caterpillars, only emerge after they have completely eaten all but the skin of their victims. They belong mostly to the hymenopterous families, ichneumonidæ, proctotrypidæ, and chalcididæ (including about 2,200 British species), and the dipterous tachina and its allies. An anomalous beetle—rhipidius—is parasitical on the cockroach. In conclusion, the speaker called the attention of the meeting to some photographs sent by Mr. Curteis, especially to one which might have passed for a representation of a polyzoon, though it was merely a cluster of the eggs of a bird-parasite.

The members then visited Mr. Pascoe's biological museum, and saw many preserved specimens of the various animals upon which the parasites prey. Mr. A. D. Michael exhibited, amongst other specimens under the microscope, a beautiful slide of Ornithornia avicularia, a curious two-winged parasite having other bird-parasites attached to it. Mr. E. Bartlett showed some curious living aphides. The parasite that gave rise to the itch disease, known as Sarcoptes scabei, was shown in its various stages of development by Mr. G. C. Karop. Under a very sharp German microscope, by Leitz, Mr. E. M. Nelson exhibited, by means of an ingenious and very inexpensive condenser lately devised by him, the punctured markings within the reticulations of the diatom Triceratium septangulatum. This was accomplished with only a two-thirds object-glass. The next meeting of the club will take place on April 13, at the house of Mr. H. V. Tebbs. Subject, "Crystals under Polarised Light."

**Bicycles and Tricycles.**—Mr. Devey, of Wolverhampton, has found it necessary to take larger premises, and has accordingly removed to "The Ashes," where, in addition to putting down the best machines procurable for the manufacture of "cycles," he has also laid a good track, on which every bicycle and tricycle can be thoroughly tested before it leaves the works. Mr. Devey's list of "fittings" will be useful to amateurs desirous of constructing machines for themselves.

As in the case of the Health Exhibition last year, the exhibitors at the coming Inventions Exhibition are to aid in the selection of the juries.

## SCIENTIFIC NEWS.

THE annular eclipse of the sun on the 16th inst. will not be visible in Europe, but will be well observed in North America, where the central line will pass over Lake Winnipeg and through Nebraska and Oregon. Mr. Ellery, of the Melbourne Observatory, is organising a small expedition to observe the total eclipse of the sun which takes place on the 8th of September next. The path of totality lies almost entirely over the South Pacific, and New Zealand is the only land whence the total eclipse will be visible. Its duration will not exceed two minutes and a half. The partial eclipse of the moon on the 30th inst. will be invisible in this country, as the moon does not rise at Greenwich until she has cleared the earth's shadow. She may, however, be observed slightly obscured by the penumbra.

Prof. T. G. Bonney, president of the Geological Society, will resign his post as secretary of the British Association after the Aberdeen meeting, mainly because the work demands more time than he can spare.

At a recent meeting of the Physical Society Mr. J. C. McConnell presented two notes on the use of the Nicol prism, in which he referred to the error in measuring a rotation of the plane of polarisation due to the axis of rotation of the prism not being parallel to the emergent light. The second note dealt with a new method of obtaining the zero reading of a Nicol circle. This is often defined as the reading when the plane of polarisation is parallel to the axis of rotation of the table of a spectrometer. A Nicol is fixed on the table, the light quenched by turning the Nicol circle, and the reading taken. The table is then rotated through 180deg., the light quenched, and the reading taken again. The mean of the two readings gives the results required. It was described how the error due to the want of symmetry of the Nicol might be found and eliminated. Mr. H. G. Madan exhibited and described some new forms of polarising prisms. The first of these is by M. Bertrand, and has been described by him (*Comptes Rendus*, September 29th, 1884). The other prisms shown were a similar one by M. Bertrand, described in the same paper; a double-image prism by Ahrens, described in the *Phil. Mag.* for January, 1885; and a modification of the latter by Mr. Madan. Mr. L. Wright pointed out, as a practical objection to M. Bertrand's prism, that it was very doubtful whether a glass could be obtained of so high a density as to possess a refractive index of 1·658, and at the same time be colourless and unaffected by the atmosphere. The principle of M. Bertrand's prism, too, was not new.

The ordinary general meeting of the Institution of Mechanical Engineers will be held on March 20, at 25, Great George-street, Westminster. The following papers will be read and discussed, as far as time will admit:—"On Recent Improvements in Wood-cutting Machinery," by Mr. George Richards, of Manchester (adjourned discussion); "Description of the Tower Spherical Engine," by Mr. R. Hammersley Heenan, of Manchester; "On the History of Paddle-wheel Steam Navigation," by Mr. Henry Sandham, of London.

The Statistical Society proposes to celebrate its jubilee on June 22 and 23 next.

In connection with the Exhibition of Inventions and Musical Instruments, it is not intended to issue special handbooks; but the various sections of the catalogue will have prefaces written by, amongst others, such authorities as Prof. O. Lodge for electricity, Mr. G. Snelus for fuel, furnaces, &c., Prof. Carey Foster for philosophical instruments and apparatus, and Mr. Vernon Harcourt for gas and other illuminants. Exhibitors of musical instruments will be allowed to give demonstrations of the tone of their exhibits on one day in each week. In connection with the railway companies, it is intended to use a map, time-table, and guide book, and make such arrangements as will enable residents within a radius of 20 miles to reach the exhibition without rebooking.

Messrs. O. Salvin, F.R.S., and F. Du Cane Godman, F.R.S., have presented to the Natural History Museum two valuable collections. One collection, presented on certain conditions, comprises the entire series of American birds brought together by those gentlemen, numbering upwards of 20,000 specimens, and illustrating more than any other collection in existence the life-history and geographical distribution of the birds of tropical America. No labour or expense has been spared in the formation of this splendid group of ornithological rarities. The other gift, which is unconditional, comprises a very fine collection of Central American coleoptera of the families of Cicindelidæ and Carabidæ. It contains 969 species, and, moreover, 7,678 examples, of which more than 400 are types of new species described in the work entitled "Biologia Centrali-American," now in course of publication by Messrs. Salvin and Godman. To this collection will be ultimately added, by gift, the remaining families of coleoptera, with other etomological specimens.

Mr. J. Mayall, jun., states that the ruling machine by which the late Herr F. A. Nobert, of Barth, Prussia, produced his extraordinarily fine rulings on glass, and about the construction of which there has been much mystery ever since the rulings were first brought to public notice at the Exhibition of 1851, has recently been acquired by Mr. Frank Crisp, secretary of the Royal Microscopical Society. The machine was exhibited at the meeting of the society last Wednesday. The diamond points and the memorandum book relating to them have also been acquired by Mr. Crisp, so that we may shortly expect an explanation of Nobert's methods.

Mr. Ellis Lever, of Bowdon, who recently offered a prize of £500 for a perfect safety-lamp for miners, has informed Mr. Thomas Burt, M.P., that he now offers a similar sum as a premium for the invention or discovery of an economical, efficient, and safe substitute for gunpowder and other explosives employed in the getting of coal. It would seem from this that the water cartridges and the lime cartridges are either not efficient or not economical.

It is said that an American who has recently been to Europe promises to produce a sensation among both gas and electric light companies in the United States. It is probable that the new light is a cheap water-gas used with magnesia burner-caps on the system of Clamond, which we illustrated on p. 444, Vol. XXXVI.

With reference to the article on natural gas (p. 1) it should be mentioned that it sometimes causes explosions. In spite of wrought-iron pipes with screwed joints, the gas escaped recently into some cellars in Pittsburgh, and becoming ignited, wrecked four houses and injured twenty persons. The Fuel Gas Co. are laying alongside their pipes a line of drainpipes in a stratum of charcoal which surrounds both. The gas which escapes finds its way into the drainpipe, and at intervals is burnt at a lamp-post escape-pipe—the flame often being three or four feet high. Another company places the gaspipe within a larger one, which is used as the supply-pipe for dwelling-houses — the leakage being found sufficient.

According to some experiments by M. Olszewski, liquid oxygen vaporising under a pressure of one atmosphere gives a temperature of – 181·4° C. With nitrogen a temperature of – 225° C was recorded under low pressure, the surface solidifying, while with liquid carbon monoxide the lowest temperature was – 220·5 C.

M. Dieulafait, in a paper presented to the Paris Academy of Sciences, states that the Equisetaceæ and other typical plants of the Carboniferous age, contain a much larger percentage of sulphur than those of the present time—a fact which he thinks affords an explanation of the presence of sulphur and sulphate of lime in coal, and indicates the plants from which it was formed.

Professor Hermann's apparatus for the valuation of lubricants consists of a perfectly cylindrical shaft, about 10cm. in length, supported in two journals carried by a branched support, which turns on a hinge, so that the shaft can be adjusted at an angle of 5° to 10° to the horizon; the upper end of the shaft carries a handle, whereby it can be rotated. To use the apparatus, a bent piece of the same metal as that to which the lubricant is to be applied, is placed astride of the shaft, and suitably weighted, and the number of turns of the handle requisite to cause it to slide along the shaft for a given distance with various lubrication are noted. The greater the distance travelled for a given number of revolutions of the shaft the more efficient the lubrication.

## LETTERS TO THE EDITOR.

*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

*All Cheques and Post-office Orders to be made payable to* J. Passmore Edwards.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

### THE APPARENT ENLARGEMENT OF CELESTIAL OBJECTS AS THEY APPROACH THE HORIZON—HANDBOOK OF THE MAPS OF THE ORDNANCE SURVEY—THE ORIGIN OF MAN—THETA ORIONIS AND DIVERS DOUBLE STARS—THE DOUBLE TELESCOPE—"NAM NUNC MORES NIHIL FACIUNT QUOD LICET, NISI QUOD LUBET."

[23918.]—A communication of very great scientific importance has been made within a recent period to the Académie Royale de Belgique, by M. Paul Stroobant, upon a subject which has excited the attention of astronomers and physicists from the time of Al Hassan, nearly 900 years ago, down to the present day. I refer to the apparent enlargement of the constellations, and of the discs of the sun and moon as they approach the horizon. The explanations hitherto given of this phenomenon, though, in the case of two of them, sufficing to explain it, have always been felt to lack something, and to be more or less unsatisfactory; and hence M. Stroobant's novel and ingenious investigation of this curious question cannot fail to possess interest to all who have devoted any attention to it. As the Belgian savant points out, four principal hypotheses have been devised to explain this appearance. The first assumes that the heavenly body is magnified by atmospheric refraction. This we may dismiss at once as nonsense. Refraction close to the horizon (or anywhere else in the sky) can never increase the diameter of an object. On the contrary, when the sun has just risen, or is in the act of setting, refraction *diminishes* his vertical diameter, leaving his horizontal one intact. The second hypothesis is that of Al Hassan himself, who attributed the apparent enlargement of the rising or setting constellations to the apparent figure of the celestial vault, of which he alleged the part touching the earth at the horizon seemed more distant from us than the zenith by a whole radius of the earth; and that, hence, intuitively regarding the sky overhead as much closer to us than that conterminous with the horizon, we fancy an object to be of greater dimensions when, subtending only the same angle, it is on that horizon. But, as M. Stroobant points out, we have no proof that the sun and moon look farther off; and, moreover, while from experience we can correct fallacious impressions of size derived from the diminution of angular magnitude in the case of terrestrial objects, we have no such experience to guide us in the case of the heavenly bodies. And this brings us to hypothesis No. three, which assumes that we not only derive a notion of the great distance of the sun or moon from us by observing them with a multitude of objects between us and them, but we get an irresistible idea of their size by comparing it with those objects. In answer to this, M. Stroobant bids us smoke a piece of glass lightly, but sufficiently to hide the landscape when the sun is setting, and then to regard him under that aspect. He will actually look bigger than when compared by the unaided eye with intervening terrestrial objects. Moreover, the sun and moon appear just as large on the sea horizon where there is nothing to compare them with. The fourth hypothesis assumes that as the sun or moon approaches the horizon it becomes less luminous, and hence looks farther off. This explanation M. Stroobant regards as containing a germ of truth, though by no means the whole truth, inasmuch that he alleges that in foggy weather the sun, when quite close to the horizon, does appear notably larger than he does when the sky is free from vapour. Having thus cleared the way, M. Stroobant proceeds to describe the remarkably ingenious experiments (first suggested by M. Houzeau) by which he believes that he has succeeded in showing that an actual physiological cause exists for the strange optical illusion we are discussing. I need only refer here to the final form these experiments took. In an absolutely darkened room he contrived an arrangement by the aid of which two electric stars were attached to the ceiling about 8in. apart. On a level with his eye were two similar stars, the distance between which could be increased or diminished at pleasure. The apparatus was so arranged that the distance of the observer's eye from both pairs of stars was identical. Now comes the remarkable thing. When the observer carefully adjusted the distance of the pair of stars on a level with his eye so that it should be apparently precisely equal to that of the pair in his zenith, it was found on measurement that the horizontal pair *were less than 6½in. apart* (or as given by M. Stroobant), calling the distance of the stars on the ceiling 100, that of those apparently subtending an identical angle at the height of the eye was only 81·5! Another observer made it 79·5. With this pregnant result to guide him, the author of the pamphlet now before me proceeded to carry out his researches among the stars themselves, selecting pairs at sensibly equal distances in the horizon and zenith, and afterwards measuring their real angular separation on one of Niesten's celestial globes. In this way, as the result of a number of observations, he discovered that the mean of the interval between stars on the horizon is 79·7, that of pairs in the zenith being, as before, 100. How M. Stroobant applies this strange physiological effect (in conjunction with the decrease of brilliancy invariably consequent on the thickness and light-arresting haze of the horizontal strata of air) to explain the apparent enlargement of sun, moon, and constellations, when on the horizon, everybody interested in the matter should go to his excellent brochure to learn. It is very well worth reading indeed.

Now that so many tourists in the British Islands employ the Maps of the Ordnance Survey, and especially now that the really beautiful 1in. reproductions of the 6in. map is coming out (but far too slowly, by the way) in instalments, I would venture to suggest that the Department might, with considerable advantage, issue a sixpenny or shilling pamphlet, describing the projection employed, the method of taking latitudes and longitudes off the map, and so on. It would very materially increase the usefulness of these maps to a considerable proportion of their purchasers, and would, I should fancy, command a pretty extensive sale. If this should meet the eye of Colonel Stotherd, I hope that he will not be above taking the hint contained in it.

I cannot help feeling that if "O. J. L." (let. 23874, Vol. XL. p. 559) will read the (so-called) "Mosaic" account of the creation with the same attention, and in the same spirit that he would study, say, Green's "Short History of the English People," he will discover that his attempted reconciliation reconciles nothing. In Genesis iv. 2, we find the two sons of the alleged first man and woman engaged in agricultural pursuits, which obviously indicates a very considerable advance in civilisation; primitive man being, as is notorious, a *hunter* and a nomad. The "lake-men" were the earliest inhabitants of the earth among whom we find any traces of agricultural operations. They are referred to the Bronze and Polished Stone ages. Besides, the very chronology and the genealogies to which the writer of the account commits himself, show the utterly mythical character of the whole story. As a simple illustration, read Genesis v., and note (from vv. 21-22) that Methuselah must have survived the Flood!

Mr. Ruthven (letter 23892, p. 10) can hardly do better than consult Mr. Sadler's letter (23891) immediately preceding his, for a reply to the question with which he commences. With reference to Mira Ceti, I presume that he is referring to Smyth's distant companion, of which, in the "Bedford Catalogue," the position angle is given as 88·9°, and the distance as 116″. I can find no record of ζ Tauri as a double star at all. The latest measures of 80 Tauri in my possession are those of Mr. S. W. Burnham in 1879, when the postion angle was 7·4° and the distance 0·57″; nor can I find any later measures of O.Σ. 98 than those by Schiaparelli in 1877, pos. ang. 209·9° and dist. 0·98″. There are three stars marked respectively $\delta^1$, $\delta^2$, and $\delta^3$ in Taurus. If ever it is fine again (which, at this present writing seems at least doubtful), I will try to identify the pair in this constellation. Since writing these lines I have made the attempt, and wholly failed to do so; a remark equally applicable to Mr. R.'s stars near 135 Tauri. He must give the R A.'s and Dec.'s of these objects.

Inasmuch as "Montmartre" (letter 23896, p. 10) personally appeals to me, I may say shortly that the area of the half of an 8in. object-glass would be very approximately 25·13in., and that of a 3⅝in. objective with a ⅝in. segment removed 8·51in. The gain in light, then, by the employment of the large object-glass must be apparent at once. I think it is quite possible, though, that the definition might be slightly finer with the smaller lenses.

Let me hasten to disabuse the mind of anyone and everyone who may by any conceivable possibility have been led into the supposition that Mr. Ledger (letter 23898) is the author of the letters signed "A Fellow of the Royal Astronomical Society" in these columns; and to testify that not only is he not the writer, but that he is not in the smallest degree in my confidence; in short, that I have never been indebted to him in the remotest degree for one single thought, idea, or suggestion that I have ever penned here. Besides, unless my memory is more than usually treacherous, my first letter appeared in Vol. I. of the English Mechanic in the year 1865, while Mr. Ledger's right to adopt my now familiar signature dates from Feb. 11, 1876. With regard to the particular matter which at present exercises him, I would just say that, if, instead of treating the question in the quasi-jocular spirit in which I did, I had characterised the conduct of the (present) Astronomer Royal in persistently attempting to pack the R. A. S. Council with his subordinates at Greenwich, in the language it deserves, I should, just conceivably, have done something really to justify the diatribe of your correspondent. Writing, as I do anonymously, I am guilty of no egotism, in using his own words, and saying that, merely as a matter of fact, I happen to be "a gentleman, *both* by birth and education," and that, alike by pedigree and social rank, I am in a position to know what is due to my station, at least as well as he can possibly teach me. His peroration might well be passed over in silence, but for the fact that it may conceivably mislead a few people who do not know precisely what it was that I attacked. By all means "let all that is said about science be gently said, with good taste and kindly feeling." No one would more heartily say Amen to this than I should. But it is a solecism to describe the electioneering arts employed to pack our governing body, as *science*, and a mere prostitution of that holy word to use it in any such connection. "You cannot," said the first Napoleon, "make omelettes without breaking eggs"; and if notice is to be drawn to a real abuse, it can only be so drawn by language which shall arrest attention. It must be an evil thing for any society to have a man gradually acquiring paramount authority in its management by the introduction of a number of his own subordinates. Be his scientific acquirements what they may (and I, for one, have invariably given my ungrudging testimony to their extent), I believe Mr. Christie to have shown, in more than one way, his singular unfitness to occupy a prominent part in the management of the Royal Astronomical Society; and, that being so, *I*, having the interests of *astronomy* at heart, rather than those of any of Mr. Ledger's or Mr. Christie's friends, have felt compelled to utter the plain truth. Were I to contradict at the time, and on the spot, any statement made by Mr. Ledger from his own pulpit, I should righteously subject myself to a pretty severe penalty under 23 and 24 Vic. c. 32, s. 2. He can, however, advance no cognate claim, to speak ex-cathedrâ here, or to teach me either what to say or how to say it.

**A Fellow of the Royal Astronomical Society.**

## ENCKE'S DIVISION IN SATURN'S RING.

[23919.]—Whilst observing with a 7½in. refractor on the night of 22nd December, 1881, I distinctly saw the division in the outer ring known as Encke's division. It was fairly conspicuous round the ansæ, but from these points rapidly disappeared. From the accounts of various observers, it would seem as if these openings in the rings were subject to variability.

**T. R. Clapham.**

## SOLAR PROMINENCES.

[23920.]—Amateur astronomers possessing only small optical means are often discouraged when reading accounts of observations made by the aid of much larger and more perfect instruments. Something can be done, however, by small means, and I have lately been attacking solar prominences by the aid of a 3¼ o.g. telescope equatorially mounted, and a 5-prism, direct-vision spectroscope, about 18in. long of good dispersive power, the definition of the o.g, being also excellent. Living far away from a well-appointed observatory, my first difficulty was how to attach the spectroscope to the telescope. I devised and had an adapter made, where A (Fig. 1) is a bar 9in. long, at one end of which is a hollow screw, B, which fits the end of the slipping tube of the telescope. At the other end is fixed a clip, C, which carries the spectroscope in such a way that the sun's image can be sharply focussed on the slitplate, which is never covered from view. Selecting a period of great solar activity in September, 1884, I fixed the spectroscope on to the telescope, adding to the dew cap a counterpoising weight and sharply focussed line F. I then placed the slit tangentially to the following limb of the sun's image, which was carefully focussed on the slit-plate, keeping the slit just "off" the limb by means of a fine, slow motion screw in R.A. on the equatoreal. The dark line F was, of course, reversed, and seen as a bright line, in which I soon detected what appeared as a wave-like motion from side to side. I then opened the slit of the spectroscope to nearly its widest, admitting the flood of light very carefully by means of the R.A. screw, and distinctly observed the form of the cloud-like head of a prominence in shape like as at A (Fig. 2), a smaller one B being close to it. I watched these for upwards of half an hour, when A gradually became smaller and smaller, and, as well as B, vanished from sight. The diameter of the sun's image as given by a 3¼ o.g. is necessarily small, consequently, the views of prominences obtained by such small means are shorn of the grandeur displayed by much more powerful optical appliances; but that their forms can be seen by the aid of such means as I have described is, I think, sufficient encouragement for the amateur to attempt them.

FIG. 1

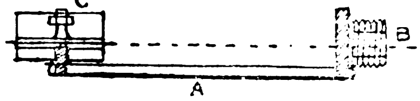
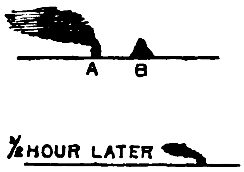


FIG. 2

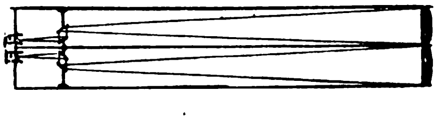


**T. R. Clapham.**

Austwick Hall, Clapham, Lancaster,
3rd March.

## DOUBLE TELESCOPES.

[23921.]—Referring to recent letters by your correspondent "Montmartre" as to double telescopes, would it not do to use two flats or reflectors for the purpose of bringing the image formed by two object glasses to the proper distance from each other to suit the eyes, as shown on the sketch inclosed, which is a section of telescope so constructed. It seems impossible that such a plan as this has not been tried; but if it has, will some correspondent kindly give the reason why it will not do?



**Thompson.**

## OBSERVATORY.

[23922.]—I was technically incorrect in my last letter (23897) in implying that, in the construction of the revolving apparatus in the great dome at Vienna, the live ring and flanged wheels were not used. The fact is both are used, but in such a way as to get all the advantages without the defects of those arrangements, as usually adopted. The usual "live ring" consists of a system of wheels, of which the axles are fixed between two concentric hoops or plates of iron, forming a double ring, so that the wheels and ring revolve together. These generally run in a groove on the wall-plate of the observatory, and a corresponding groove in the base of the dome. In this arrangement, any alteration in the shape of the dome is liable to cause a jam. The same may apply to flanged wheels, which may be caused from the want of power of adjustment in case of warping of the roof or dome.

In Mr. Grubb's construction at Vienna, the live ring consists of 20 sets of wheels, three abreast on the same axle, forming a continuous ring as usual. The outer and inner wheels revolve on two rails or projections on the wall-plate. The inner wheel is double flanged, to keep the ring from running off the rail. The outer wheel, without flange, runs on a rail, also on the wall-plate, and the central wheel without flanges, and which does not touch the wall-plate, carries the dome, the flat rail or projection below the dome simply resting upon it without any flange. We see here that there is no possibility of a change of shape in the dome causing a jam. The dome is kept in its place by a system of lateral, or, as we should call them, vertical rollers attached to the dome, and running against or near the trued inner edge of the wall-plate, and these are capable of adjustment as required. This is exactly the same principle as that described in my last, as the plan adopted in my observatory, the live ring of course not being required.

Fordingbridge. **T. Westlake.**

## THE STATE OF MAN.

[23923.]—Will "Priam" kindly say upon what authority he states that the tradition of creation, &c., was unknown to Moses, and was brought back by the Jews from Babylon? I have read of this before, but have never seen it stated whence this theory originated.

If creation in six days was a Babylonian tradition, how did it originate? Whether it was a poetic fiction of Moses or of some Babylonian historian, the period of six days, with the rest upon the seventh, is at least a curious fancy. If Moses gave to Israel the Ten Commandments, which I do not think is generally disputed, whence came the fourth, in which the creation is so distinctly referred to?

W. J. Grey, F.C.S., does, I think, considerably overthrow my theory about primitive man, as I conceive that a city could hardly have been built by a savage race with no tools and less knowledge of the arts of construction.

The whole subject of primæval man is highly interesting, intensely difficult, and almost hopelessly inexplicable, especially when variety of type —not merely in colour, but in the very skull formation—has to be taken into consideration. Here "Ex uno disce omnes" will not stand.

**O. J. L.**

[23924.]—Will "Priam" (letter 23902) kindly give the authorities for the very interesting statements he makes relative to the two first chapters of Genesis?

**B. F.**

[23925.]—Why does "Priam" waste space in your pages with his suggestions? Of course, the story of Adam and Eve is Mosaic, and all the objectors in the world cannot dispute it. Does "Priam" think that his anonymous opinion will suffice to supersede the testimony of the highest authorities of the last 6,000 years?

**John Hampden.**

[23926.]—The pages of the English Mechanic are not suited to a theological discussion, but I may, perhaps, be permitted to suggest to "Priam" that in the Commandments given by Moses, the creation of the earth in six days (or periods) is alluded to (Ex. xx. 11), and that he was, therefore, acquainted with the "legend" or "ballad," as "Priam" calls it. Whether the account of the Creation is superior "in *grammar* and imagery" to many other parts of the Pentateuch is a question which competent Hebrew scholars would probably decide differently from your correspondent. I will not enter into the *quæstio vexata* of the date of the Pentateuch; but anyone wishing to study the subject would find ample proofs that these books were written long before the return of the Jews from captivity.

**Otter.**

## THE STATE OF MAN.—TO "O. J. L."

[23927.]—I do not answer you just in the form you ask, and yet, I think it is what you require. Scripture chronology, as commonly accepted, is certainly *not* utterly and hopelessly at fault, as you suppose; the fault lies with the scientists in *not* putting events in their proper form and order. Allow me to explain. I presume you are aware that during geological times climatic changes were produced by the *internal heat of the earth* and *not by the sun*; and, I suppose, you are also well acquainted with Laplace's nebular hypothesis of the solar system? Well, place God at the helm of affairs, and you have in all probability the way the world was brought into existence, though for a long space of time afterwards too intensely hot to permit of life, or even of water, in which, according to geology, the first dawn of life appeared, and which was succeeded successively, as further cooling took place, by higher forms and types until, as is well known, a glacial period put an end to it all by the world becoming frozen desolate and *dead*. It is after this period that man appears, at least there is no *reliable* record of his earlier appearance, and not likely to be in face of the Scripture narrative, for the *present* world is a re-creation from the *past* Critically examine Gen. i., and you will see in v. 2, "the earth was without form and void." The original Hebrew word is, I believe, tolu, or loose atoms; or, in other words, it was chaotic, formless, utterly unsuitable for life in any way, and empty, but in existence. And it adds, "And darkness was upon the face of the deep." So you will see that this present world was *not* created out of nothing, as is usually supposed, but that it is really a re-creation from the old dead geological world which it follows in point of time; and the reason why geological times are not mentioned in the Scripture is simply because it commences only with man's advent; so that your question as to man's condition after the Fall takes its proper place, as a matter of course, when viewed in this light. I may say that the word translated "lights" in Gen. i. 16, is essentially different from that translated "light" in v. 3, and that it means an *instrument* of light to reflect the light to us, the light having been made first and then put into the instrument; and I think that I am correct in saying that it is pretty well understood now that light has always been in existence, in a more or less perfect state, *independent* of the sun; so that probably the light of the geological times was in accordance with the times, and not as perfect as now. There is much that might have been added to this, but as it would have been more theological than scientific, it would not have been suitable for the pages of the MECHANIC. In conclusion, I may say that in the *Christian Million* of a week or two since it is stated that an astronomer of some note is about to give a series of lectures, and amongst other things will give proof that there was *no* moon until the fourth day of creation—ours, of course; and by the Transit of Venus also prove that there have been weeks of seven days ever since creation, so that Gen. i. 2, should probably read, "And (*after the ages foregone*) the earth was without form, and void, &c.," that is to say, the geological ages. **J. H.**

## BEES.

[23928.]—SUCH of our readers as are interested in bee-keeping may be glad to know that much loss of life may be avoided by having the space immediately in front of the hive, and, if possible, for some little way on each side of it, covered with a layer of "slack" (the refuse of coal). This material, by absorbing the warmth of the sun, maintains a higher temperature than earth or gravel, and keeps a dry surface, and thus enables many a labourer, exhausted by a distant journey, or blown down by a rough wind, to rise again and regain the hive. I do not know that there is any novelty in the plan, but am sure that it is successful. **T. W. Webb.**

## VIOLINS.

[23929.]—"ORDERIC VITAL" asks: "When we read accounts of the fine qualities of tone attained by the old masters, are we to believe that every violin made by the Amatis, &c., is an excellent instrument?" The reply to this question cannot be too emphatic. Most certainly not. Only a small proportion of these instruments possess those high qualities of tone which have made their maker's name famous. The tone of many of them is nothing more than "ordinary." It has always been the case in fiddle-making that some instruments have turned out well and others the reverse. Stradivarius lived to the age of about 90, and as he worked from the age of 24, he must have made a large number of instruments. No doubt the best have survived (these survivors varying in quality), and the rest have gone to the wall. Time and use will improve every instrument, but will never make a bad fiddle a good one; and a new fiddle, if good, will show itself to be good from the very first, though nothing but time and use will mature the tone. It is true that no one has been able to improve on the model of Stradivarius. There is no definite standard of size for the fiddle. All the great makers made in two or three different sizes; but the "Grand" model of Stradivarius is generally considered to give the best combination of good qualities. The curves of the belly and back are not spherical in any violin, and vary very considerably with different makers. "Orderic Vital" may rest assured that it is next to impossible to think of any alteration or improvement in the violin which has not already been thought of and tried. Instruments of the best makers have been dissected, measured, and faithfully copied times without number, and with very varying results, the chief being that no one has yet succeeded in rivalling the originals. The Cremona violins will not, however, last for ever, and we shall have sooner or later to fall back on more modern instruments. Charles Reade, the author, in a pamphlet entitled "A Lost Art Revived," says, "The fiddles of Cremona gained their reputation by superior tone; but they hold it now mainly by their beauty. For 30 years past violins have been made equal in model to the *chef-d'œuvres* of Cremona, and stronger in wood than Stradivarius, and more scientific than Guarnerius in thicknesses." Although this is perfectly true, it must be borne in mind that these instruments will require the maturing effects of the lapse of 100 years or so before they can equal (if they ever do) the best of the Cremonas. In the mean time a picked few of the instruments of the great makers stand out in proud distinction as possessing a quality of tone superior to all others. A Stradivarius possessing the highest qualities of tone, and in good preservation as regards wood and varnish, will always command an ever-increasingly high price. Happy is the man who, I will not say, has his quiver full of them, but happy is the man who is the possessor of *one* of them; for nothing is easier than to pay anything under £1,000, and to find that you have *not* got one of them after all. **A Country Parson.**

## REFLECTING TELESCOPES FOR DAY USE.

[23930.]—WITH reference to Dr. Royston-Pigott's interesting "Notes on the Cassegrain" (page 3, Vol. XLI.), I must say that I think he is not right in recommending reflecting telescopes for day use, more especially for coastguardsmen. Some time ago I experimented with a small Gregorian as a portable hand telescope, and found it a great nuisance. To begin with, the mirrors *would* get out of adjustment when the telescope was carried about, and I much doubt the capability of a coastguardsman to adjust them. Then it was wonderful how fast the speculum metal tarnished with everyday use, and I should say the silver-on-glass would tarnish almost quicker, judging from my own experience with such mirrors. When the telescope was first taken out of doors, and a strong wind happened to be blowing, the mirrors would dull every time a blast of air entered the tube, till they had assumed the out-door temperature. And suppose the coastguard to be furnished with silver-on-glass Gregorians, where would Dr. Royston-Pigott propose to have the mirrors resilvered when tarnished, and would he keep a duplicate stock to issue while the operation was going on? I fear it would be pretty expensive.

I quite agree that the ordinary Coastguard telescope is a marvel of clumsiness and worthlessness; but the Royal Artillery garrison stations are furnished in most places with really admirable refractors, which define so well that I have ere now used them with astronomical eyepieces on simple objects, such as lunar occultations and sunspots, and the way in which the British gunner treats these instruments is heartrending. If the day be hazy, and he cannot see well, he unscrews the object glass and polishes it on his jacket, with marvellous effect. I would give a reflector about two hours of existence in the hands of an untrained man.

To conclude, I do not think reflecting telescopes will ever supplant refractors for day use, even in skilled hands, and I speak from experience.

Tynemouth. **Garrison Gunner.**

## BORT.

[23931.]—I WANTED to point out the difference between the gem diamond, bort, carbonado or carbonate.

The gem diamond is a perfect crystal, either white or coloured, provided, if coloured, the colour is equal all over. Hence you may have a black or yellow or blue gem diamond.

*Bort* is generally applied to crystal, which is discoloured, i.e., not white, and yet not with an equal distribution of colour so that it is not classed as a gem. But bort, by the dictionary, is sometimes applied to splinters, either of the pure gem or the impure crystal.

Diamond dust is either the dust from rubbing one stone against the other, as in diamond cutting (diamond cut diamond), or it is the stuff (dust) produced by pounding (in a special apparatus) pieces of the gem or of the discoloured crystal called bort.

Now, corbonado or carbonate, though of the same origin (viz., carbon) as the gem diamond and bort, is not a real crystal. It is described as amorphous. Now, this carbonado is (or used to be) much cheaper than the bort, and was used for cutting millstones, and by me applied 16 years ago to turn, i.e., *cut* (not merely abrade) steel hardened as hard as fire and water could make it. I wrote to "Ours" on 4th January, 1869, and my letter was inserted; but I have not kept my old numbers, as they go to the Royal Free Hospital to amuse the patients. I fearlessly assert that carbonado is not bort. One is a crystal, and the other is not.

Does Dr. Edmunds aver that in diamond dust from any source he ever finds a crystal, i.e., a piece of definite shape with facets? If so, it determines that a diamond is made up of small crystals, a point which I am interested to know, and as to which I have read vapoury statements, but no absolute assertion of the fact.

I see Dr. Edmunds speaks of dust of diamond, bort, and carbonado, being used for "truing-up hard steel," i.e., lapping it, which never leaves it true.

I want to see the diamond gem or bort, as I have defined it, or carbonado, used to *turn* the hard steel (not lapped), and take off shavings—i.e., pieces which, under a strong glass, can be seen to be shavings.

Dr. Robinson, of Dublin, used his daughter's diamond to cut or turn, not abrade, the hard steel pivot of his telescope. This he described in "Ours" in 1868, I think: at least I find it referred to in my letter of Jan., 1869, as having been stated by Dr. Robinson "a short time since." I recollect that Dr. Robinson mentioned that the diamond was re-set in his daughter's ring after using it as he described. No diamond is useful to a glazier unless it has its original outer skin, which is harder than the inner stone. Writing diamonds are splinters of gem diamond or impure diamond, alias bort, but not splinters of carbonado. In 1869 I described the tool to hold the pieces of carbonado, which were fastened in by solder. I used it to true up (by cutting) a Welsh grindstone. Dr. E. seems to doubt that a diamond has been used for cutting, not lapping, hard steel. See Dr. Robinson and his daughter's diamond, 1868.

I venture to assert that no mechanic would ever use a lap (which abrades) if he can get a tool to cut; and, further, I assert that no lap work is absolutely true.

The letter I have referred to, as of 1869, was over the signature "B. P. A." **Z. Y. X.**

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[23932.]—IN letter 23012, p. 13, Dr. James Edmunds mentions the black diamond for turning hardened steel. I have myself used it for turning and drilling this last fourteen years, and have made some hundreds of diamond turning tools and drills for different purposes, such as turning porphyry and granite, chilled cast iron, hard steel dies and cutters, Mushet's steel, &c., and am at present setting a saw 28ft. long, with bort $\frac{1}{10}$in. diameter for cutting granite slabs. Should be glad to give any information the Doctor or Mr. Wenham may ask respecting the black diamond for turning purposes, or show them proof of what can be done with it by proper angles and setting. **S. E. S.**

## LAMINATED ARMATURES.

[23933.]—ALTHOUGH we appreciate in every detail the goodly information of your worthy contributor. Mr. Chaster, *re* "Motor Construction," yet we think that he is a little hard on Mr. Jones's form of armature in calling it a "clumsy imitation of the Siemens armature." If Mr. Chaster means Jones's laminated H armature, we cannot agree with his remark at all, as it is our experience and candid opinion that this form of armature is a decided improvement upon the old solid type. In the first place, it does not heat; secondly, it is much easier to anneal and make up; and, thirdly, the circulation of Foucault's currents is in a greater measure prevented, and as to whatever slight rotary motion exists of any individual part, it is an easy matter to prevent by simply screwing the end plates tightly; and, again, we find it an easy matter to round off with the file any sharp corners which may be likely to destroy insulation.

As to not sufficient room for wire, we cannot see how this can be, as we have just wound one, which is now lighting 14 fives and giving every satisfaction, and found ample space for several layers of insulation, and we use another daily in driving our lathe, one-man power, which has given us no trouble.

We rather doubt whether Mr. Chaster has given sufficient attention to the making up of this particular armature.

With the worthy Editor's kind permission we will take this opportunity to thank your esteemed contributor, Mr. S. Bottone, for his prompt reply to our query a week ago.

South Tottenham. **H. Harcourt.**

## COMPARISONS OF TIDES.

[23934.]—THE results of a close comparison between theory and obervation in the matter of the tides during the past month, indicate the connection which always exists between the sea-level and the heights of the barometer when combined with the *direction* and *steepness* of the gradients, to which attention is directed in the daily weather reports issued by the Meteorological Office. The heights of the tides are based on the records of the self-registering tide-gauge on George's Pier, Liverpool, and may be relied upon for correctness, allowing for the difference of datum-line between that adopted by the Admiralty and the old dock sill. The first fortnight of the month was remarkable for a succession of *cyclonic* gales, and these gales, aided by an unusually low barometer, kept the level of the sea continually between 1ft. and 2ft. *above* its normal height. When this extraordinary elevation was allowed for, it was not difficult to predict the current height of tide from day to day; but navigation was much impeded, and ships scarcely liked to venture into port. The "diurnal inequality," however, still maintained its general superiority over atmospheric conditions, though, in certain instances, the sudden arrival of a depression from the Atlantic tended to interfere with it. This was particularly the case on the 8th and on the 11th inst. From the 13th to the 21st, the pressure was more distributed, and the predictions became more approximately correct. Very little *anticyclonic* action has prevailed, and the temperature has risen generally; but from the 21st to the end of the month the conditions have been very unsettled. Our attention was directed to *three* distinct depressions. The *first* arrived at the mouth of St. George's Channel on the 16th, causing not very strong southerly

Comparison of Tides at Liverpool (Fleetwood) for the Month of February, 1885.

| Date. | Calculation. | | Observation. | | Error. | Barometer | Wind. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | ft. | in. | ft. | in. | | | | |
| Feb. 1 | — | | — | | — | — | — | — — |
| | 29 | 2 | 31 | 0 | +22 | 28·8 | S.W. | *Gale, cyclonic.* |
| 2 | 28 | 2 | 29 | 10 | +20 | 28·9 | S.W. | Continuing. |
| | 28 | 9 | 31 | 1 | +28 | 29·0 | S.W. | Continuing. |
| 3 | 27 | 7 | 29 | 7 | +24 | 29·0 | S.S.W. | Continuing, *gradients very steep.* |
| | 28 | 0 | 29 | 1 | +13 | 29·1 | S.S.W. | Abating, but strong. |
| 4 | 26 | 7 | 27 | 5 | +10 | 29·2 | S.S.W. | Abating, but strong. |
| | 26 | 4 | 27 | 3 | +11 | 29·1 | S.S.W. | Abating, but strong. |
| 5 | 24 | 10 | 26 | 3 | +17 | 29·1 | S.W. to N.W. | Strong, bar. low. |
| | 24 | 8 | 25 | 10 | +14 | 29·2 | S.W. to N.W. | Still very strong. |
| 6 | 23 | 3 | 23 | 10 | + 7 | 29·5 | S.W. | Fresh to strong. |
| | 23 | 0 | 24 | 3 | +15 | 29·4 | S.W. | Gale increasing. |
| 7 | 21 | 6 | 22 | 6 | +12 | 29·3 | S. to S.W. | Very strong. |
| | 21 | 1 | 22 | 8 | +18 | 29·4 | S.W. | *Cyclonic.* |
| 8 | 20 | 4 | 21 | 7 | +15 | 29·5 | S.W. | *Gradients still very steep.* |
| | 20 | 0 | 21 | 4 | +16 | 29·4 | S.W. | Gale continuing. |
| 9 | 20 | 0 | 20 | 6 | + 6 | 29·3 | W. to N.N.W. | Strong. |
| | 19 | 10 | 19 | 6 | − 4 | 29·4 | N. | Very strong. |
| 10 | 20 | 7 | 20 | 9 | + 2 | 29·6 | W. | Fresh to strong. |
| | 20 | 4 | 20 | 11 | + 7 | 29·7 | S.W. | Strong. |
| 11 | 21 | 8 | 22 | 10 | +14 | 29·8 | W.S.W. | Strong to gale; *cyclonic.* |
| | 21 | 6 | 22 | 3 | + 9 | 29·9 | N.W. | Very strong; *steep gradients.* |
| 12 | 23 | 0 | 23 | 9 | + 9 | 30·0 | S.S.W. | Strong. |
| | 22 | 10 | 23 | 6 | + 8 | 30·0 | S.S.W. | Strong. |
| 13 | 24 | 6 | 24 | 9 | + 3 | 29·9 | S.S.W. | Fresh to strong. |
| | 24 | 0 | not observed | | | — | — | — — |
| 14 | 25 | 8 | 25 | 10 | + 2 | 29·7 | N.W. | Slight. |
| | 25 | 1 | 25 | 5 | + 4 | 29·7 | N.N.W. | Slight. |
| 15 | 26 | 9 | 27 | 2 | + 5 | 29·6 | W.S.W. | Wind backing. |
| | 25 | 9 | 26 | 5 | + 8 | 29·5 | S.W. | Fresh to strong. |
| 16 | 27 | 6 | 27 | 7 | + 1 | 29·4 | N.N.W. | Slight. |
| | — | | — | | — | — | — | — — |
| 17 | 26 | 6 | 27 | 2 | + 8 | 29·2 | N.W. | Strong. |
| | 27 | 10 | 27 | 10 | + 0 | 29·4 | N.E. | Strong. |
| 18 | 26 | 7 | 26 | 9 | + 2 | 29·5 | N.E. to S.W. | Variable. |
| | 27 | 7 | 28 | 5 | +10 | 29·5 | S.W. | Strong. |
| 19 | 26 | 2 | 26 | 5 | + 3 | 29·8 | S.S.E. | Slight. |
| | 27 | 3 | 27 | 3 | + 0 | 29·8 | S.S.E. | Slight. |
| 20 | 25 | 6 | 25 | 8 | + 2 | 29·8 | N.E. | Light and variable. |
| | 26 | 1 | 26 | 1 | 0 | 29·9 | N.E. | Light and variable. |
| 21 | 24 | 3 | 24 | 2 | − 1 | 29·9 | N.E. | *Anticyclonic.* |
| | 24 | 11 | 24 | 3 | − 8 | 29·9 | N.E. | *Anticyclonic.* |
| 22 | 23 | 2 | 24 | 6 | + 8 | 29·8 | S.W. | Strong to a gale. |
| | 23 | 4 | 24 | 0 | + 8 | 29·8 | S.W. | Fresh depression—*cyclonic.* |
| 23 | 21 | 9 | 22 | 3 | + 6 | 29·7 | S.W. | Gradients steep. |
| | 21 | 11 | 23 | 6 | + 7 | 29·7 | S. to S.W. | Bar. falling. |
| 24 | 21 | 4 | 22 | 3 | +11 | 29·6 | S.W. | Strong to gale. |
| | 21 | 9 | 22 | 9 | +12 | 29·6 | S.W. | Gale continuing. |
| 25 | 22 | 5 | 23 | 0 | + 7 | 29·7 | W.S.W. | Abating. |
| | 23 | 0 | 23 | 2 | + 2 | 29·8 | — | Wind variable — light to moderate. |
| 26 | 23 | 10 | 24 | 8 | +10 | 29·7 | S.W. | Deep depression. |
| | 24 | 7 | 25 | 9 | +14 | 29·7 | S.W. | Gale continuing. |
| 27 | 25 | 10 | 26 | 6 | + 8 | 29·8 | S.W. | Wind abating. |
| | 26 | 5 | 27 | 0 | + 7 | 29·8 | S.S.W. | Rather strong. |
| 28 | 27 | 6 | 26 | 9 | − 9 | 29·7 | N. | Strong, decided change of pressure. |
| | 27 | 6 | 27 | 3 | − 3 | 29·9 | N. | Fresh. |

winds in one place, but north-easterly winds in the Irish Sea. The *second* depression advanced from the Bay of Biscay on the 19th, causing southerly winds at the French stations, but north-easterly winds over the Irish Sea. The *third* was a deep and very large depression, causing heavy gales to the west of Ireland; but as the prevailing direction in these latitudes was *westerly*, the extended coast-line prevented the elevation of the sea-level to the *east* of it. This depression began to make its influence felt on the morning of the 22nd. It will be seen from these remarks to what large variations the tides are subjected, and yet in the midst of all this irregularity, they submit to the dominion of *law*; and when the range of tide is large, as is the case at Liverpool, the study of this law becomes not only possible, but most interesting and instructive.

**James Pearson, M.A., F.R.AS.**

*Fleetwood, March.*

## A NEW ZEALAND TELEPHONE.

[23935.]—The transmitter described by Mr. Howlett is the "Hunnings," which has been in use in England since 1878. The patent was bought by the London and Globe Telephone Company, who patented it abroad, and at the present time are using it for household and other purposes in France, Belgium, &c. It was also the instrument being used by Harrison, Cox-Walker, and Co., when they were attacked by the United Telephone Co., whose Edison patent they showed to be bad. The Hunnings transmitter is acknowledged to be the best instrument for use on all underground or other cables. The patent for it was bought by the United Telephone Co. with the English business of the L. and G. T. and M. Co. last year for £25,000 in cash, and ⅛ths of all shares or money received from new telephone companies, i.e., such as the new South of England Company.

It is probable the L. and G. T. and M. Co. have already patented it in Australia and New Zealand, and *now* hold all rights in it there, as elsewhere, except in the U. K.

**N. E. D.**

## ANHYDROUS ANALYSIS.—V.

### D. Separation of Metals of Class 3, Division I., from those of Class 4, *et seq.*

[23936.]—We will suppose the assay now to consist of a weighed alloy of bismuth (Class 3) with silver and gold (Class 4). A "floor" or "bottom" of a piece of charcoal, with convex underside, to fit the bottom of the oval cavity of the aluminium furnace; or of "charcoal paste" made according to Plattner's method of similar shape, is placed in the aluminium furnace, and the assay treated upon it with "a gentle O.P." (1, Fig. 88), when the "brown-yellow and lemon-yellow sublimate shading off to white" (p. 105) of metal (*i*) will be copiously deposited on the vertical Al plate, and upper surface of the furnace. This should be frequently brushed off and collected for weighing, if necessary. If there is the slightest sign or "streak" of a *rose-coloured sublimate*, the heat must be lessened by withdrawing the point of the pyrocone from the assay as above described; because this is a proof that silver (or metal *j*) has commenced to sublime (Table V. p. 107). If it is found impossible to avoid this loss of metal (*j*) without leaving behind some of the metal (*i*) in the alloy, the heat is increased by inserting O.P. and the rose, or, in a thick deposit, carmine, coloured sublimate is to be carefully scraped off, made into a paste with soda, and fused on charcoal with the remaining gold and silver alloy in H.P. (Fig. 87, p. 74). This is now weighed, the loss of weight being taken as equal to the proportion of metal (*i*).

### E. Separation of Metals of Class 4, Division I., from all those above it on the Table; from each other, and from Metals of Division II.

The above-mentioned alloy (platinum being left out of consideration for the present), having been freed from the volatile substances of Class 1 and from the metals of Classes 2 and 3, as above described, and assumed to be in the shape of a metallic "button" or ball, is placed on the clean and very slightly inclined (towards the operator) surface of the aluminium tray in position over the cavity of the furnace upon a small crystal of boric acid, which, when it fuses, will cause the ball to adhere mechanically to the tray, and not roll away.

The alloy ball in this position is now treated with P.P. (2, Fig. 88), directed precisely on the centre of one hemisphere or side of the alloy, so as to keep it in a constant condition of red-heat, but it is not on any account to be allowed even to begin to fuse. If it does, the assay is spoiled, and must be commenced *de novo*. It is hoped that when this valuable reaction in alloys becomes better known than it is at present, apparatus will be so constructed that the lamp and assay can be *fixed* in the proper position on a sliding scale, and the blast made constant by a hydrostatic or other machine, so that the operator may simply have to place his apparatus and assay at the proper distance from each other (which of course varies according to the object required) with the pyrocone directed at the proper angle upon the latter, and watch results.

In an alloy of equal proportions of metals (*j*) and (*k*), after the above operation has been carefully carried out, the exact hemisphere of a ball which has been kept next the source of heat (i.e., the point of P.P.) will be found a pure silver-white colour, whilst the back hemisphere, which has been kept away from the source of heat (although it has, of course, remained red-hot from the force of metallic conduction), will have become an equally pure gold-yellow colour; in fact, by this simple but efficient mode of "parting," the Au + Ag alloy has evidently been *disalloyed*, and we have now a hemisphere of pure gold on one side, and a hemisphere of pure silver on the other; apparently because the metal possessing the lowest fusing point will imperceptibly melt, and its semi-fluid molecules gradually flow towards the source of heat; remaining eventually on that side. But it is also evident that gold molecules must be *repelled*; so that the phenomenon would appear to be partly pyro-electrical.

I could scarcely believe the evidence of my eyes when, in 1871, with my mouth-blower (see "Pyrology," page 299), I discovered this fact, the certainty of which I proved by treating many different alloys in the same manner with a similar result; as e.g., an ordinary commercial pin, the fused alloy-ball of which, thus treated, exhibited a "backing" of pure copper. I even found, or supposed I could see through a powerful lens, that a paste of the mineral *cyanite* (which consists generally, or, roughly speaking, of one-third silica and two-thirds alumina, or, according to "Dana Syst. Min.," p. 375, $Al_2O_3SiO_2$), when thus treated on Al plate, showed minute glittering points or facets of silica next the soure of heat or pyroxidation, whilst the back seemed to consist of comparatively pure white, rounded alumina. This circumstance, however, remains to be proved as a fact, but there can be no possible reason to doubt the ocular evidence, as to the separation by this means, of differently coloured metals in an alloy, and I intend to exhibit specimens of these, thus separated, in the International Inventions Exhibition. A silver-gold ball was shown at the "Scientific Loan Collection" of 1876.

The operator has now got as his assay certainly not an *alloy* of metals (*j*) and (*k*), nor even a mixture of them, but what may be termed a metallic electrical connection—a great step towards separation, but still not complete separation itself. The exact mechanical separation of such a "connection," moreover, even supposing the pure metallic distribution to have been precisely hemispherical; or, in other words, that the alloy consisted in the first place of equal proportions, would evidently still be an exceedingly difficult problem to solve, as both metals are very hard to cut. I therefore propose to work out results thus: The assay consisting of the parted metals (*j*) + (*k*) is taken up and fixed in the pliers (Fig. 42, p. 42), so that either hemisphere, or part it is intended to determine (say silver in this case), is projecting clearly from the points of the pliers, downwards. This downward part is then firmly pressed into a properly made mould of loam, which is shaped with a knife so that it exactly covers the silver hemisphere and no more, and allowed to dry. When perfectly dry, silver nitrate (or pure silver in any shape) is fused with a mouth or hand-blower in the cavity, until the operator has a silver hemisphere (or cast) exactly corresponding to that part of his assay. This cast, when weighed ought to give a close approximation to the quantity of metal (*j*) of his assay. To determine the quantity of metal (*k*), it will, of course, be only necessary to deduct this weight from that of the whole assay.

In like manner, metals (*j*) and (*k*) can be separated from such other metals as (*w*) or (*t*), with which they may be found alloyed, and thus estimated as to quantity.

In concluding this brief account of the analysis of metals, &c., belonging to Division I., it should be mentioned that no account has been taken of the matrix or "gangue," as it is technically called, often obtained from mines, &c., with ores—the combined metals having been treated above as though they were simple alloys:—first, because metals of the first three classes are generally remarkably free from such matrix; secondly, because the ordinary process of reducing ores containing such matrix to simple alloys, and separating the gangue as "slag" by means of some reducing flux is well known, and need not be reproduced here. For assays in the small way, Plattner's reducing flux is perhaps the best. It is thus made: "Mix very thoroughly ten parts by weight of freshly ignited and finely-powdered sodium carbonate, thirteen of potassium carbonate, similarly prepared, five of powdered freshly-made borax glass (fused borax), and five of well-dried starch powder, and keep the flux in a glass-stoppered bottle, since it will be useless if damp." (Prof. Cornwall's translation of Plattner's "Probirkunst," &c., 1879). Of course, such reductions can be made in the aluminium furnace by using H.P. (Fig. 87, page 74.) All sublimates can be at once reduced to metal with this flux except that of (*a*.)

A detailed description of my proposed new method of *estimating* mercury in ores, &c., by means of the *amalgam formed on gold-leaf per acensum* will be afterwards given, with a figure of the simple glass apparatus necessary.

It must be remembered that the above is a mere outline, and by no means a detailed practical description, of new processes of separating metals by fire, and estimating them separately by weight, or loss of weight of the residue. Should I receive due encouragement and help at the hands of those who *ought* to help me, the analysis of each metal will on some future occasion be separately given from actual results, headed by an alphabetical list of the minerals in which it is most usually found. Meantime, there can be no doubt of the principles or *facts* upon which the processes rest, which have been proved long ago; and it can also be proved by the blowpipe and aluminium plate that there is a serious loss of silver and gold in the ordinary method of cupellation. **W. A. Ross.**

P.S.—The figure (Fig. 2, ENGLISH MECHANIC, No. 1,040, page 563) is intended to represent a furnace "charged" with boric acid, containing spherical calcium borates. The shading of the cavity is too dark to show this properly, in consequence of my having sent the sketch in pencil, instead of ink. —W. A. R.

### A PLEA FOR GOOD MANNERS.

[23937.]—I, FOR one, beg to thank Mr. Ledger for so courteously calling attention to the unpleasant reading to be found from time to time amongst the correspondence of the ENGLISH MECHANIC. While continually admiring the patience and unselfishness of many writers, I have frequently deplored the absence of good taste and kindly feeling in some letters upon the noblest subjects of physical science. **R. W. Oldham.**

Wellow, Romsey, March 9.

### BRASS AND GLASS.

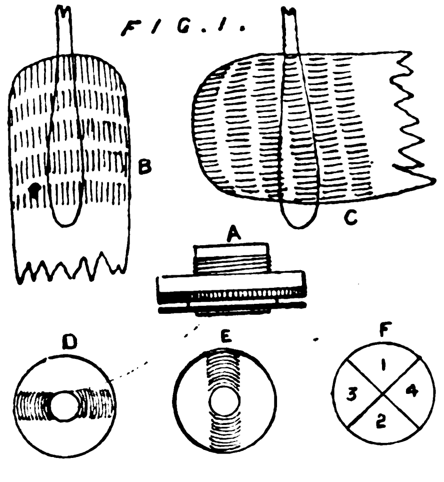
[23938.]—MAY I call the attention of the brass and glass section of your readers to a new revolving nose-piece I have designed for the purpose of testing the various sectors of an object-glass, which I exhibited at the Q.M.C. on the 27th inst.?

For long I have been of the opinion that all the sectors of an object-glass are not equally good in defining objects. Fig. 1 F, sectors 1 and 2, might not be as good as sectors 3 and 4. I have formed this conclusion from the study of the exclamation marks on the Podura, when viewed in different azimuths.

There was, however, always this difficulty—viz., that when the scale was rotated, the illuminating conditions were altered. B shows the relative positions of the scale and the flame, when viewed in the usual way, the achromatic condenser being accurately centred, and the edge of the flame carefully focussed on the object. D shows the position of the diffraction spectra seen at the back of the objective, the eyepiece being removed; in this case 3 and 4 F would be the working sectors of the object-glass. Now, if the scale be rotated through an angle of 90°, the exclamation marks will lie across the edge of the flame, as at C. The diffraction spectra will be turned round as at E, and a different pair of sectors, 1 and 2 F, brought into play. Assuming, for a moment, that the sectors 1 2 3 4 are all equally good, it is to be expected that the exclamation marks, as at C, would appear different to those at B, on account of the position of the exclamation marks with regard to the edge of the flame. Therefore, in the dissimilarity in the pictures, when a Podura scale is being rotated, something must be allowed for the alteration of the illuminating conditions with regard to the position of the exclamation marks, and something for the difference in the quality of the sectors. The importance of separating these variables will be obvious to every one. For this purpose I have designed a revolving nose-piece A, which will enable the object-glass to be turned round, and so bring its various sectors into play. By this means it can be easily demonstrated how much of the difference in the pictures is due to the objective, and how much to the illumination. When I practically tried this nose-piece, I was very much astonished at the enormous difference I found in the defining powers of the alternate sectors of an object-glass.

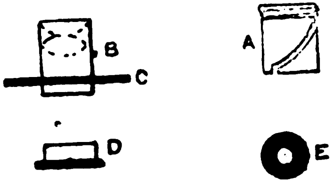
To illustrate the difference in the chromatic aberration, let me mention only an example. A very fair water imm. $\frac{1}{8}$, 1·17 N.A., showed the exclamation marks red in one position, but turned them green when the object glass was rotated through an angle of about 90°. The practical outcome of all this is important.

FIG. 1.



1. An object-glass which performed well enough when exhibited on the optician's microscope, might tell a very different tale when tried on the purchaser's instrument, because the objective might not screw up to the same point.
2. It may account for the difference of opinion held by experts as to the quality of any particular objective, for they might have been testing different sectors.
3. It would be worth while, in the case of expensive object-glasses, to have the society's screw portion of them capable of rotation, and provided with jam screws, so that the purchaser might place the better pair of sectors in a line across his own microscope, then fix it with the jam screws. He would only have to remember to place any exceptionally difficult object in a line with the front and back of his stand.
4. I think this appliance will prove useful in very delicate work, such as that carried on by the Rev. W. H. Dallinger.

FIG. 2.



The design has been most beautifully carried out for me by Messrs. Powell and Lealand, and I would like to draw attention to the flange $1\frac{1}{2}$in. in diameter, which secures perfect steadiness when the object-glass is rotated. Fig. A is drawn to the scale of $\frac{1}{2}$.

I now wish to describe a cheap form of condenser I have designed to meet the wants of students and others who use microscopes on the "Hartnach," "Student," or "College" models. It consists of a tube A, Fig. II., with a spiral slot cut in it, this is screwed into the hole in the microscope stage. A tube B C, carrying the lenses (a meniscus and a biconvex) slides into the other tube; a pin B fits into the spiral slot. A flange, with a milled edge, is fixed near the end of the tube B C, and at the end of the tube B C fits a cap D, like the lid of a pillbox, with a large hole in it. This holds a diaphragm E; I think that three sizes of diaphragms would be sufficient. At the Q.M.C. I showed a Leitz £3 12s. microscope, on which Mr. Baker had fitted one of these condensers; I exhibited some micro-organisms both with and without the condenser. The superiority of the picture when the condenser was used was admitted by all who saw the comparison. Fig. 2 is drawn to scale $\frac{1}{2}$. **Edward M. Nelson.**

February 28th, 1885.

P.S.—The flange, which is $1\frac{1}{2}$in. in diameter, is for the purpose of focussing the condenser by rotation, the pin B running up and down the spiral. The small vertical piece of the slot should be noticed, as it prevents one accidentally twisting out the condenser. The aperture is ·5 N.A.—E. M. N.

### LOCOMOTIVE DRIVING AXLES.

[23939.]—IN pursuance of a recommendation contained in Major Marindin's report on the Penistone Accident, a return has been published showing the number of driving axles in use and the proportion thereof broken or taken out during the year 1883, the details of which are given in the following summary:—

| Description. | Number in use. | | Broken in running. | | Taken out in shops. | |
|---|---|---|---|---|---|---|
| | iron | steel | iron | steel | iron | steel |
| | | | per cent | per cent | per cent | per cent |
| Crank axles *without* hooped webs | 2,867 | 4,733 | 3·1 | 0·9 | 6·0 | 3·8 |
| Crank axles *with* hooped webs .. | 4,121 | 1,222 | 0·85 | 0·9 | 7·7 | 0·7 |
| Straight axles, outside cylinders | 438 | 1,467 | 5·0 | 0 5 | 2·7 | 0·8 |
| Total driving-wheel axles.... | 7,426 | 7,422 | 2·0 | 0·8 | 6·8 | 2·7 |
| Total...... | 14,848 | | 2·8 | | 9·5 | |

The advocates of outside-cylinder engines frequently claim that they avoid the danger of a crank axle; but from the above figures it appears that 5·5 per cent. of straight driving axles broke when running. It is satisfactory to notice that a large proportion of defective axles were discovered and taken out in the shops, and doubtless a more careful and frequent examination will reduce the number "broken in running"; but still, growing flaws will exist, which no care nor investigation can detect. **Clement E. Stretton.**

Leicester, March 9.

### NEW BRAKES.

[23940.]—I OBSERVE in your issue of the 6th inst. that "Driver" (letter 23907) says I have made a mistake in saying that the new Midland brake is the same as that in use upon the Lancashire and Yorkshire Railway. I beg, however, to say that I have made no mistake in what I stated, as the latter company have for some considerable time past been fitting up and working with every satisfaction, a brake of exactly the same arrangement as that which is now being fitted to the Midland Company's vehicles. It is quite true, as stated by "Driver," that the Lancashire and Yorkshire Company have some vehicles fitted with the brake having a sleeve round the piston rod; but from inquiries I have made I find the type they now fit up is the same as the Midland are going in for, and I believe it to be the system which is preferred over any other. **G. Mitchell.**

[23941.]—IN your issue of the 6th inst., a correspondent on "New Brakes" says: "There are a lot of changes going on now," and then proceeds to enumerate several, but omits the most inexplicable of all. Everyone knows that, both in theory and practice, the Westinghouse automatic brake is the best. Then why are the G. and S.W. Railway, who have hitherto been staunch supporters of the Westinghouse brake, now engaged in trying a form of vacuum, with a view to fitting their stock anew? Perhaps Mr. Stretton will explain and oblige.

**W. B. Thompson.**

### THE NEW MIDLAND ENGINES.

[23942.]—YOUR correspondent, "More Expansion" (p. 540, letter 23853), ought to have the thanks of the railway company for giving his ideas on how to work the big engines which have been such "failures" for want of steam.

The plan of working expansively was fairly tested last Friday, Saturday, Sunday, and Monday; it is a strange thing, but those very engines that before had to take a pilot with twelve coaches now are running with sixteen, and have lots of steam; and a bit more practice and a sixteenth of an inch more lead which is now to be tried on "More Expansion's" suggestion will enable these fine engines to take the twenty coaches they were built for. The engines are right enough so long as you keep them well linked up; but the moment you put them in too forward gear to "push" them, they use more steam than they make, and they are soon short of steam. This correspondence shows more clearly than words the practical and scientific value of the information given in the ENGLISH MECHANIC.

It will perhaps interest your locomotive readers to know that during the past week not a second of time has been lost by any of the 19in. engines—they have even picked up some, and are burning much less coal than they did before the expansive working had a fair trial.

**Locomotive.**

### NEW MIDLAND ENGINES.

[23943.]—WITH your kind permission I should like to ask "More Expansion" a question or two. In his letter (23853, p. 540) he says as soon as a train is well away from a station notch up the gear, and work expansively; if steam-pressure falls in boiler still work more expansively, and attend well to fire. Now, Sir, suppose a man is going to work an express train for a distance of 100 miles, due to leave A at, say, 10 o'clock, pass B at 11 o'clock, and arrive at C at 12. He knows his engine is not very good for steam, so he puts a good fire on and gets it well burnt through, and puts as much water in the boiler as it will carry, and when the time is up to start, the engine just begins to blow-off. As soon as he gets well away he pulls up his lever in the second notch out of gear, and opens the regulator about three-parts of the way. When he gets 10 or 12 miles on the road he finds he is not keeping time, and the engine is not making enough steam, so he pulls up the lever another notch and gives her the whole of the regulator, and by the time he passes B he has dropped, perhaps, four or five minutes. Now what is he to do? Remember his engine was well up to the mark when he started, as regards steam, fire, and water, and now he has another 50 miles to go, with steam 20lb. to 30lb. lower in the boiler, and perhaps about an inch of water in his gauge-glass; he cannot give her any more regulator, nor pull her up any higher, so what must he do but keep going on as well as he can, and by the time he arrives at C he will perhaps be 10 or 12 minutes late, and perhaps got 60lb. of steam, and the water only just in sight at the bottom of his gauge-glass.

Now, Sir, "More Expansion" says it is the attempt to push an engine which causes all the trouble. He says you must not push them; but what is a man to do? He must have the time out of them either one way or the other; but if you cannot get the steam into a locomotive you cannot get the time out.

Now, Sir, I am not a driver, but if I live I shall be some day; and I should very much like to know how to go on if I was fixed in the way I have described. Hoping "More Expansion" will give his advice through these columns, I think it would benefit a good many more than one.

Lincoln. **A Fireman.**

### L. AND S.W. EXPRESS ENGINES.

[23944.]—I SEND dimensions of the new London and South-Western express engines, as requested by some correspondents:—Cylinders 18in. by 24in. (outside); dia. bogie wheels, 3ft. 4in.; dia. coupled wheels, 6ft. 7in.; wheel base, bogie, 7ft.; bogie centre to driving centre, 9ft. 11½in.; coupled wheels, 8ft. 6in.; boiler, length, 10ft. 2½in., dia., 4ft. 4in.; firebox shell, length, 6ft., breadth, 3ft. 10½in.; firebox, length, 5ft. 2⅝in., breadth, 3ft. 3¼in., depth, 5ft. 9¾in. 218 tubes 1¾in. dia., length, 10ft. $\frac{5}{16}$in. Heating surface—Tubes, 1051·13 sq. ft.; firebox, 110·18 sq. ft.; total, 1161·31 sq. ft. Boiler pressure 160lb. Weight about 46½ tons. Tender, six wheels 3ft. 9¾in. dia., holds 2,350 gallons and 3½ tons of coal. Weight, empty, 16 tons. These engines are Nos. 460–469 (Neilson and Co., 1884), 147, 470–478 (Stephenson and Co., 1884). **Meteor.**

### LATHE MATTERS.

[23945.]—F. H. WENHAM (23882), I would venture to point out, is wrong in stating that screw-threads cannot be cut by wheels.

The contact between a cutting-wheel and a thread is not a surface, but a line; a straight line in Dr. E.'s case. Mr. Wenham seems to mistake it for a surface. By cutting one side at a time, square, or even undercut, threads can with suitably-sized cutters be truly worked upon, theoretically and practically, by inclining the axes to one another of the screw and wheel. If there is an error, it is in the grinding speeds at apex and bottom of threads; with very light grinding it should be of no moment.

I prefer a bit myself as simpler and avoiding shake in bearings, though, perhaps, less clean and much less rapid in its action. I have found it useful, though perhaps the practice is old, to bend bits or finishing tools cold out of the cut, so that when stress comes on them (up to the limit of their stretching), they remain rigid under it.

**Vulcan.**

### LATHE MATTERS.

[23946.]—MY contributions to the ENGLISH MECHANIC during the past fifteen years have been on subjects I have practised and which I can vouch for. I am reluctant to speak of matters relating to myself, but as I am held up as a paper theoriser by one of this class, who writes beyond his knowledge, I am constrained to say that I do not appear as a mere amateur. Several years of my minority were passed as a pupil in the drawing office of a firm of marine engineers and shipbuilders, and as long ago as 1845 I was in business on my own account as a maker of marine engines and machinery. For improvements in these engines I obtained a prize medal at the International Exhibition of 1862, awarded to me by jurors, themselves marine engineers; and until quite recently I have been more or less connected with machine shops. I have made lathe mandrels innumerable, from the heaviest to the smallest. I repeat my assertion that some of the best makers of foot lathes do true up their hardened mandrels by means of diamond cutting tools. I shall not attempt to obtain a gratuitous advertisement in these pages for any maker, or make him the subject of coarse contradictions and verbose controversies, or submit his mandrels so finished for any self-constituted juror to "report upon," for the competency for such an office is usually to be judged by others, and not by the individual himself; but if any reader of this requires a lathe as accurately finished as a lathe can be, and will give his direction in the address column, I will show him two lathes with traversing mandrels which have been trued up with diamond turning tools. The manufacturers are in an extensive way of business, and make this kind of lathe a specialty, at very moderate prices. I have also used diamond turning tools both for turning up hard mandrels and for cutting back the shoulders of lathes that have been misused from having long worked with a slack back centre.

To flat contradiction No. 2, I reply that it is not a "real fact" that pieces of diamond of the proper shape are "extremely difficult" to set so as to be held safely. On the contrary, it is a remarkably easy operation to do this so securely that the splinter will rather smash up than leave the setting. This operation, by which I have set numbers, occupies but a few minutes. I have on a former occasion explained the method, and if correspondents desire it will do so again. Diamond tools cut the very hardest steel "sweetly," requiring but a light pressure: and I am about to apply them for giving a finished surface to parts of mechanism in wood, as their ever-enduring keen edge would save the trouble of the constant sharpening and readjusting which steel requires. Again, this questionable authority at once condemns the use of the roller for bedding down diamond particles in laps and slicers, an instrument which it is apparent that he has never used or seen. As the owner of a lapidary lathe, with all the requisites, that I have long used for shaping and slicing different kinds of materials for optical and philosophical purposes, I am in a position to state that a narrow hard steel roller does bed in the diamond more effectively and economically than the agate rubber, and I prefer to use it, as a very heavy pressure can be given to bury the large particles. This is not my own idea, but was recommended to me, and I at once got the tool made.

And now let me give a friendly hint to Mr. Hines, if he has any regard for his reputation, to act with caution in being prompted in any argument for cutting screw-noses and taps by circular cutters, and finishing them up by similar grinding laps. Take, for example, a deep V or square-threaded screw of coarse pitch, for a sufficiently palpable experiment; have a circular saw or cutter the width of the thread space which is to gauge the same from top to bottom. To use the saw with its plane at right angles to the axis of the screw would be utter folly, but with all care in adjusting the circular cutter to the screw angle an inaccurate form of screw will be the result. Neither by theory nor practice can a perfectly symmetrical screw-thread be obtained this way. Let anyone take a circular disc of metal turned just to the gauge of a square screw-thread of coarse pitch and drive it into the bottom; the kind of twist that it has taken at the place will then be seen. This is the effect in practice; but there are several who write for the ENGLISH MECHANIC who can readily demonstrate this mathematically. I have just had a case in point. Having had occasion for a pair of wheels on the silent or skew gear principle, in which the driving and driven spindles cross over each other at right angles, although I had got a circular wheel-cutter just to suit the form of cog that I require—these wheels, in fact, being multi-threaded screws of coarse pitch—this cutter could not in consequence be used, nor could a fly-cutter, so I made a kind of grooving drill of the contour between the threads, which cut the spaces accurately, but into which the circular cutter would not fit.

I am aware that circular discs, charged with emery or diamond dust, are used for cutting screws; but on what? Such as bottle-necks and stoppers. A short time ago I cut a screw on a porcelain cylinder for a gas-burning experiment, using a diamond-charged disc; but the form of such screws as these is of no consequence, so long as they hold the work securely together.

The "prussiate" case-hardening, as applied to soft iron, is almost a useless process; it acts in blotches, and raises the surface, and, at the best, the hard skin can be taken off with a vigorous rub with an old file; but for homogeneous mild steel, treated in the way that I have described, after being dusted continuously at a blood-red heat and quenched, it has an unimpaired surface, without scale, looking as if the steel had been merely oil-stained.

About two years ago I purchased a strong 6in. foot lathe, because it had a very convenient form of overhead gear, and included a number of cutter and milling frames, circular cutters, and other useful traps; but the mandrel was one of the detestable iron sort, with steel welded ends, and, as the screw-nose was a mongrel thread, I determined to make a new one, as the chucks would bear cutting out to the Whitworth standard. This mandrel was treated and hardened just as I have described, the cone fitted throughout in the collar, just as it was finished to do while soft, and so accurately that I have not found it necessary to grind it in; its own work soon made the bearing right, and as for hardness, no file will touch it, and it cannot be indented, as the softer steel below has been indurated by the heat. I will give Mr. Hines an opportunity of exercising his candour. When he is next in this city I shall be glad to produce the mandrel, and defy him to indent it on the hardened part with a centre punch and hammer. As to swaging in the fire, I take care never to allow this, or have an overdone side. I am too old a smith to make such a stupid mistake—with a blood-red heat, too! If Mr. Hines says that he is unable to make a mandrel so as not to warp or cast, we may take his word for it; but if he states that it cannot be done by others, then he must expect contradiction. I see no reason why, with proper metal and suitable treatment, mandrels should not be as true after hardening as before; but, in these cases, the nautical and astronomical terms so learnedly and humorously applied to the eccentricities of a drunken mandrel would be wasted. I take it that finishing up with diamond tools is a modern and not an old practice; the delicate fine lines left on the steel are soon taken out by the screw grinding clams, and there is no such perfect way of finishing up cylindrical rods as this.

I have no interest in looking at the model mandrel named at the soirée; the drawing, which has appeared again and again, is sufficient, and which is to be seen once more at page 562 of this journal for Feb. 27, for the design is objectionable. In the first place, the most important part of the screw is sacrificed for the sake of the cylinder at the base of it. This is of no use if a screw is to be got true; for acting as this does as a series of reverse cones to bring the chucks against the mandrel face, it forms a good centring agent in itself. If the cylinder is true and the screw is not, we have always one part struggling to destroy the truth of the other. Again, the face of the mandrel is needlessly large, which would cause it to cast in hardening. The nearer that we can approach uniformity in size and material, in steel work to be hardened, the less likely it is to warp, and this error will be worse in the model mandrel by the extra diameter given by the useless rounding of the periphery of the face. A lathe mandrel should be cut out of the rolled bar, without any forging whatever; if steel is hammered or swaged, and condensed more in one place than another, such parts are sure to warp or swell up in the hardening, however well annealed beforehand. Perfect homogeneity is what we require.

**F. H. Wenham.**

### AMPHIPLEURA PELLUCIDA AND DIFFRACTION (No. I.)—TO MR. P. A. PHILLIPS.

[23947.]—THE question now raised is a very complex and difficult one; it involves diffraction and the laws of the *minimum visibile*.

On the general question it is here impossible to enter. I must, therefore, confine my remarks to facts. It is interesting to note the stages of opinion through which the subject has passed. Fraunhofer was the first to state, in his admirable paper on Light, his strong belief that on the wave theory some of his finest rulings on glass would be quite beyond the power of the microscope to resolve. Sir John Herschel (Art. "Light") declared he thought Fraunhofer's statement unwarranted by his formulæ, and that a much smaller thing would be visible. Helmholtz next stated that in the case of brilliant discs about half a wave-length appeared the probable limit; but there might be circumstances which would reduce this limit still further.

The whole thing hinges upon the original hypothesis of brilliant discs. These swell out under microscopical examination. An infinite number of experiments on this question may be sustained. Here is one of the simplest:—

1. Place a "beetle's eye slide" on "the stage," form an image behind it of a small lamp-flame by means of a ¼in. objective. As you withdraw this image further from the slide you will see the flame image gradually diminish, till with the best powers you have you will find that this image soon reaches *a small limit beyond which it will not pass.* You will now see innumerable brilliant dots of light surrounded by faint diffraction rings. The focus of the facets I measured at 1-1000th of an inch.

2. Place at four yards distance in a darkened room before a brilliant shaded flame a piece of brass punctured with holes arranged closer and closer. Miniature these holes brilliantly illuminated by means of a fine ⅛th objective attached beneath the stage. Bring the image of these holes under the focal plane of the microscope. You will see that the closest (and perhaps the next pair) entirely *coalesced*. The finest pair have vanished. Two things may here subvent the phenomena—first, the diffraction swelling of the bright discs; secondly, the lateral residuary aberration produced both by the observing and miniature forming lenses. (All these things have been most carefully measured.)

3. If your eye can bear the effulgence of a miniature of the brightest *sun* brought upon the stage, you may repeat the following experiment:—

An Amici prism, focus 3in., is placed in bright sunshine, so as to form an aërial image of the sun, about four yards from your microscope, placed horizontally. You will require a mechanical substage to carry your ⅛th objective, so as to bring the miniature of the sun exactly in view of the observing microscope armed with a ⅛th. If you have a good spider line micrometer, you will find a magnificent measurable solar disc (and if your glasses are good enough) surrounded with an intensely black ring. Size of disc, 1-16000th; thickness of black ring, 1-50000th. But by trigonometry the sun's disc is now four times larger than it ought to be. (I am away here from all my data.) Here, again, the spurious disc is greatly enlarged. This enlargement is compounded of residuary aberration, if any, and diffraction.

The phenomena presented by aberration and diffraction have now been pursued about twenty-three years, with ever-increasing interest. But while one class present themselves with an effulgent brilliance which no words can describe, another distinct class can be observed when *brilliance is dissipated.* An overpowering diffraction outblazes minute details in the miniature, which at once start into view by withdrawal of the sunbeams. And the possibility of a *minimum visibile* being examined and measured becomes at once apparent.

I recollect, when a medical student, the pains required even by old Topping to exhibit the squares of the Hippocampus. And after a great amount of conjuring with the concave mirror, at last the cross striæ of the lattice appearance of the Angulatum were visible. To what causes were these difficulties ascribed? That would be an interesting text. I was once on the point of buying a 1-16th Ross. This glass, however, persisted in exhibiting the markings on P. formosum as elongated squares (parallelograms). Was this diffraction, or bad spherical correction, or incorrect centring of the system of lenses, or all combined?

To bring this answer to a close, I must point out that brilliant points or lines are the grand sources of diffraction, and mild equable illumination its general abatement.

I have lately seen letters, spontaneously written, in praise of certain American glasses, in which it is boldly declared the markings on Amp. pellucida have been displayed without a condenser, and with *very little obliquity of light from a concave mirror.* If this be so it must be ascribed to great perfection in the spherical and chromatic corrections and mechanical work of the objective. As years rolled by, I have constantly observed improvement in objective quality, followed by less elaborate illumination. The pin-hole stop gives a direct cone of light of very small aperture, say 15°, and this is a most severe test of quality. I found it serviceable with my 1-50th of Powell and Lealand, and I have used largely condensers formed of a battery of objective glasses ranging from 10° to 140° for the last twenty-five years, and often with immersion fluids both above and below the slide, so as to produce as far as possible equivalent mediums (now called homogeneous) and allow the rays to penetrate with the least possible deviation. On another occasion I propose to speak of the reduction of diffraction and the minimum angle visible more in detail. For instance, Messrs. P. and L. once showed me with their 1-80th the veritable dark dots of Amp. pellucida. The dots were very much smaller than the interspaces. What angle would these dots subtend?

Note.—My Amici prism has a 3in. focus. Taking the sun at 30 min., diam. of 1st disc = 3 sin. $30' = 3 \times \frac{1}{114}$. Then this disc is miniatured down by ⅛th objective placed at 4yds., or 144in., to a minute size, 144 × 8 smaller—i.e., 1,152 smaller than $\frac{3}{114} = \frac{3}{114} \div 1152 = \frac{1}{43776}$, or nearly 1-44000th. I see the sun is now 32min. in diam.; this makes 1-41000th, instead of 1-44000th.

By the system of miniatures I have seen dark objects on a darkish background of a size immensely less than 1-100000th thick. A most useful formula for ascertaining size of miniature at a given distance ($d$) of an object with a lens of focus ($f$) is given by me in *Phil. Tr.*, Vol. II. 1870. If $m$ be the proportion of miniature to object, for a long distance $d$, from object to image nearly—

$$m = \frac{d}{f}.$$

In the case of ⅛th and half a mile distance, the rung of a ladder 1in. thick was beautifully seen—

$$m = \frac{\frac{1}{2}\text{ mile}}{\frac{1}{8}} = 31680 \times 8 = 253440 \text{ times.}$$

The rung of the ladder in the microscope was about the 250000th of an inch. With magnifying power of 1,000 diameters—all immersion lenses, set to "uncovered," with either water or glycerine between their noses, and sometimes a piece of cover glass ·004 thick. But without miniaturing at all, I have on several occasions exhibited, under peculiar conditions of illumination, jet-black dark bodies very much less than two millionths of an inch in size.

If you can dismiss diffraction, it is difficult to assign what really is the limit of visibility with absolutely perfect instrumentation. There is reason to believe from the markings on insects that minutiæ are visible to their eyes far more minute than anything our best microscopes accomplish. Now, what is the angle at which a bullet mark at 500 yards is seen? The mark is about an inch spot. The angle $= \frac{1}{500 \times 36} = \frac{1}{18000} = 19$ seconds of arc. (I have seen a rifleman mark down without a glass his own hits at this distance.)

Now, what would be the angle of vision subtended by the 1-100000th of an inch seen at 10in.? The angle (say $\theta$) $= \frac{1}{100000} \div 10 = \frac{1}{1000000} = \theta$. Now, a second is $\frac{1}{206000}$th, say, $\frac{1}{200000}$th. Hence this angle $\theta$ = one-fifth of a second. Now, if we could magnify this a thousand times—

$$1000 \times \theta = \tfrac{1}{5} \times 1000 \text{ secs.} = 200 \text{ seconds.}$$

So, after all, the size of a line $\frac{1}{100000}$ thick then presents a visual angle of 200 seconds; and yet 2 seconds has been authoritatively pronounced as the limiting angle of human vision! And the one-millionth of an inch would still present an angle of 20 secs. ten times larger than the assigned limits.

*With proper precautions*, the limit of angular vision, or linear diameter, in my experience, lies beyond the one millionth of an inch with the best glasses and finest manipulation.

With a clear power of 2,000, one millionth would subtend an angle of 40 seconds (at 10 inches).

**G. W. Royston-Pigott.**

Hastings, March 2.

## PHOSPHORIC ACID IN MANURES.

[23948.]—I FANCY I saw recently an inquiry as to the best method of ascertaining the amount of phosphoric acid in fertilisers, and as the subject is of much importance to agriculturists all the world over, the following from the *Chemical News* may be of use to some of your readers:—

"1. The sample should be well intermixed and properly prepared, so that separate portions shall actually represent the substance under examination, without loss or gain of moisture.

"2. Water-soluble Phosphoric Acid.—Bring 2grm. on a filter; add a little water; let it run out before adding more water, and repeat this treatment cautiously until no phosphate is likely to precipitate in the filter. (The washings may show turbidity after passing the filter.) When the substance is nearly washed in this manner, it is transferred to a mortar and rubbed with a rubber-tipped pestle to a homogeneous paste (but not further pulverised), then returned to the filter, and washed with water until the washings no longer react acid with delicate test-paper. Mix the washings. Take an aliquot (usually corresponding to one-third or one-half of a gram of the substance), and determine phosphoric acid as under Total Phosphoric Acid.

"3. Citrate-insoluble Phosphoric Acid.—Wash the residue of the treatment with water into 150cc. flask with 100cc. of strictly neutral ammonium citrate solution of 1·09 density; shred and add the filter paper; cork the flask securely; place in a water bath with constant temperature of 65° C., and digest for thirty minutes with frequent shaking. Filter the warm solution quickly, and wash with water of ordinary temperature.

"Transfer the filter and its contents to a porcelain capsule. Ignite until the organic matter is destroyed; treat with 10 to 15cc. of fuming hydrochloric acid; digest over a low flame, until the phosphate is dissolved; dilute to 200cc.; mix; pass through a dry filter; take an aliquot, and determine phosphoric acid as under total.

"4. Total Phosphoric Acid.—Weigh 2grm. into a capsule, add and mix intimately with 4 to 7cc. of a nearly saturated solution of magnesium hydrate, dry; ignite gently; if necessary, moisten the residue with nitric acid and ignite again to destroy all organic matter; add to the residue 15 to 20cc. of fuming hydrochloric acid; digest at a gentle heat until all phosphates are dissolved; dilute to 200cc.; mix; pass through a dry filter; take 50cc. of filtrate; neutralise with ammonia; add about 15grms. dry ammonium nitrate, and to the hot solution, for every decigram of $P_2O_5$ that is present, 50cc. of molybdic solution. (Test the filtrate by renewed digestion and addition of more molybdic solution.)

"Dissolve the precipitate on the filter with ammonia and hot water, and wash into a beaker to a bulk of not more than 100cc. Nearly neutralise with hydrochloric acid; cool, and add magnesia mixture from a burette, slowly (one drop per second), and stirring vigorously. After 15 minutes add 30cc. of ammonia solution of density 0·96. Let stand several hours. (Two hours are usually enough.) Filter; wash with dilute ammonia; ignite intensely for 10 minutes, and weigh.

"5. Citrate-soluble Phosphoric Acid.—The sum of the water-soluble and citrate-insoluble subtracted from the total gives the citrate-soluble.

### Preparation of Reagents.

"1. To Prepare Ammonium Citrate Solution.—Mix 370grm. of commercial citric acid with 1,500cc. of water; nearly neutralise with crushed commercial carbonate of ammonia, 410grm.; heat to expel the carbonic acid; cool; add ammonia until until exactly neutral (testing for excess both of acid and alkali by aid of delicate red and blue litmus papers), and bring to volume of 2 litres. Dilute further until the density is 1·09 as tested by the balance or *accurate* specific-gravity spindle.

"2. To Prepare Solution of Magnesium Nitrate.—Dissolve 320grm. of 'calcined magnesia' in nitric acid, avoiding excess of the latter; then add a little "calcined magnesia" in excess and boil; filter from the excess of magnesia, ferric oxide, &c., and bring to volume of 2 litres.

"3. To Prepare Molybdic Solution.—Dissolve 100grm. of molybdic acid in 400grm., or 417cc. of ammonia of sp. gr. 0·96, and pour the solution thus obtained into 1,500grm. or 1,250cc. of nitric acid of sp. gr. 1·20. Keep the mixture in a warm place for several days or until a portion heated to 40° C. deposits no yellow precipitate of ammonium phospho-molybdate. Decant the solution from any sediment, and preserve in glass-stopped vessels.

"4. To Prepare Ammonium Nitrate Solution.—Dissolve 200grms. of commercial ammonium nitrate in water, and bring to a volume of 2 litres.

"5. To Prepare Magnesia Mixture.—Dissolve 22grm. of recently ignited 'calcined magnesia' in dilute hydrochloric acid, avoiding excess of the latter. Add a little 'calcined magnesia' in excess, and boil a few minutes to precipitate iron, alumina, and phosphoric acid; filter, add 280grm. of ammonium chloride, 700cc. of ammonia of sp. gr. 0·96, and water enough to make the volume of 2 litres. Instead of the solution of 22grm. of 'calcined magnesia,' 110grm. of crystallised magnesium chloride ($MgCl_2 6H_2O$) may be used.

"6. Dilute Ammonia for Washing.—One volume ammonia of sp. gr. 0·96 mixed with 3 volumes of water, or, usually, 1 volume of concentrated ammonia with 6 volumes of water."

**F. I. C.**

## A FEW WORDS ON THE NEW TIME.

[23949.]—Whether or not the "new time" will ever become part and parcel of our everyday life is a matter of considerable uncertainty at present, and one which should be carefully considered before finally adopted. It is certainly a more scientific method of dividing the day than the present system of two periods of twelve hours each, and for that reason if for no other should be adopted if possible. It might with advantage be adopted by railway companies and the Telegraph and Postal Services. Railway and other time-tables would be much simpler and less liable to confuse one if the abbreviations a.m. and p.m. were rendered unnecessary. It would greatly facilitate its general adoption if the clocks in Government and other public buildings—e.g., railway stations, were made to indicate the new time; and if the time tables were altered as above suggested, the masses would very soon, from absolute necessity, be made familiar with the new style, and its general adoption would be almost certain. The feeling of novelty one would experience in, say, asking a friend to dine with them at eighteen o'clock, instead of saying 6 p.m., would, of course, soon wear off, and though it would have a more pedantic sound, it would take barely longer to give expression to than the present nomenclature. For purely scientific purposes, such, for instance, as the registering of physical and meteorological phenomena, the proposed change is admirably adapted; though it is exceedingly doubtful, as pointed out by Prof. Newcomb in the January number of the *Monthly Notices* of the R.A.S., whether the advantages to be gained by astronomers are of sufficient importance to cause them to adopt it. The referring all observations to the Greenwich meridian might possibly be an advantage, though changing the commencement of the astronomical day from noon to midnight would probably not be so. Considering that the change is only adopted at Greenwich by way of experiment for twelve months, and may not finally be made use of at that institution for recording astronomical phenomena; and in all probability will not be universally adopted by astronomers, it is certainly premature to make use of it for that purpose as some of your astronomical correspondents have done, until some authoritative decision has been arrived at. In the mean time, all those correspondents who prefer the new time for recording their astronomical observations, should distinctly state that they have made that use of it, to prevent confusion being made between the day reckoned from noon and the day reckoned from midnight. **B. J. Hopkins.**

# REPLIES TO QUERIES.

⁂ *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[55226.]—**Screw-Cutting.**—"Young Turner" could cut a pitch of four threads to the inch in his lathe by using a 20 and 40, or a 60 and 120. If he has a back speed, a 20, 60, 30, 80, or 30, 70, 35, 120, or 50, 60, 75, 20,—any of these would cut a ¼in. pitch screw in a lathe with a ½in. pitch leading screw.—DUMBARTON.

*[55226.]*—**Screw Cutting.**—If you mean the wheels I gave in my index to "Glover" are not large enough to gear in your lathe, you can double the first set, which will be 40 mandrel, and 80 on leading screw, with the largest intermediate wheel you can get in. For the second set, change the 35 for a 50, and the 70 for a 100. If these are of no use, please write again, and I will do my best to help you.—VALETTA.

[55323.]—**Musical Scale.**—On page 564 Mr. S. E. Hunt objects to my division of the diatonic scale, because he believes that it gives different values to the two semitone intervals. How he arrives at this conclusion is not very clear. If he will turn to the monochord scale shown on page 478, he will there find that the values of all the semitones are identical; but for perfect accuracy in calculating the ratios it is, of course, necessary that the decimal fractions be completed, and this Mr. Hunt may easily do by carrying out the process there described according to which the scale is constructed. Here I beg to apologise for and correct an error I have made in copying out the decimal figures of the fraction expressing the semitone interval:—Instead of $\frac{100}{105{\cdot}333}$ it ought to be $\frac{100}{105{\cdot}3497}$ &c. The simplest vulgar fraction equivalent to this is $\frac{243}{256}$. Perhaps the following statement of the diatonic scale may give a more definite idea of it than can be got from the unavoidably imperfect decimal figures given for the monochord:—

| C | D | E | F | G | A | B | C |
|---|---|---|---|---|---|---|---|
| 81 | 72 | 64 | $60\frac{3}{4}$ | 54 | 48 | $42\frac{2}{3}$ | $40\frac{1}{2}$ |

$\frac{8}{9}$ $\frac{8}{9}$ $\frac{243}{256}$ $\frac{8}{9}$ $\frac{8}{9}$ $\frac{8}{9}$ $\frac{243}{256}$

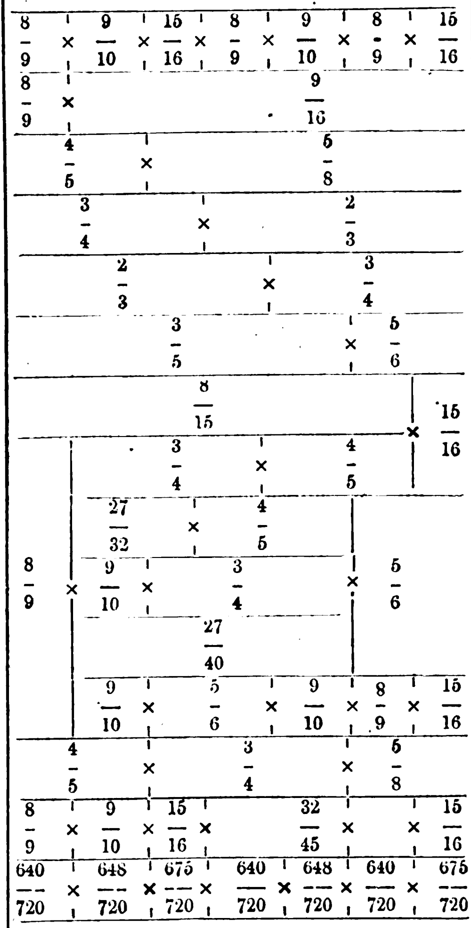
—WALTER HARDIE, Joppa.

[55323.]—**Musical Scale.**—In reply to Walter Hardie, in No. 1038, "E.M.," as an introduction, I would say in 1855 or 1856, I had "Hawkins' History of Music" lent me by a rev. gentleman. It was a reprint, I think, by Novello; in the preface is a catch which was copied from a "History by Dr. Burney," who was a contemporary; the catch was a satire on "Hawkins' History" by the words "Mystery and History: Burney's History and burn his history." Hawkins was a thorough mathematician as well as a musician; and Dr. Burney was not both; therefore, like many, if theory is spoken of, those who practise only, often ridicule, forgetting that others also can, and do, practise. Mathematical proportions of the monochord is the question now; and as my name has been called into it, I feel I must try to prove it. I will try another form to make what I think is correct. I will take only the major scale in the key of C, or I might trespass on time and space, and others might handle the question better. The fractions $\frac{8}{9}$, $\frac{3}{4}$, $\frac{2}{3}$, and $\frac{1}{2}$, are acknowledged; but $\frac{9}{10}$ and $\frac{15}{16}$ are not kindly received. I will leave out heights of bridges, frets, or shortening of strings by pressure, &c., and stick to the mathematical part of it.

MONOCHORD PROPORTIONS.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | $\frac{8}{9}$ | $\frac{4}{5}$ | $\frac{3}{4}$ | $\frac{2}{3}$ | $\frac{3}{5}$ | $\frac{8}{15}$ | $\frac{1}{2}$ |
| C | D | E | F | G | A | B | C |

INTERVALS.



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Monochord | 1 | | | | | | |
| Seconds | $\frac{8}{9}$ | $\frac{9}{10}$ | $\frac{15}{16}$ | | | | |
| Thirds | $\frac{4}{5}$ | $\frac{5}{6}$ | | to DF | $\frac{27}{32}$ | | |
| Fourths | $\frac{3}{4}$ | | | F to B | $\frac{32}{45}$ | AD | $\frac{20}{27}$ |
| Fifths | $\frac{2}{3}$ | | | DA | $\frac{27}{40}$ | BF | $\frac{135}{172}$ |
| Sixths | $\frac{3}{5}$ | $\frac{5}{8}$ | | FD | $\frac{16}{27}$ | | |
| Sevenths | $\frac{8}{15}$ | $\frac{9}{16}$ | | ED | $\frac{5}{9}$ | | |
| Octave | $\frac{1}{2}$ | | | | | | |

By taking the fractions as above, the whole of the monochord as 1 or any length of string, tuned to C, $\frac{8}{9}$ of this gives D—$\frac{9}{10}$ of D, or $\frac{8}{9} \times \frac{9}{10} = \frac{72}{90} = \frac{4}{5}$, or E $\times \frac{4}{5} \times \frac{15}{16} = \frac{60}{80} = \frac{3}{4}$, or F $\frac{3}{4} \times \frac{8}{9} = \frac{24}{36} = \frac{2}{3}$ or G—$\frac{2}{3} \times \frac{9}{10} = \frac{18}{30} = \frac{3}{5}$ or A—$\frac{3}{5} \times \frac{8}{9} = \frac{24}{45} = \frac{8}{15}$ or B—$\frac{8}{15} \times \frac{15}{16} = \frac{120}{240} \times \frac{1}{2}$ or C, the octave above the whole monochord note. The reason that these proportions are not generally received seems to be that all fifths have been taken alike—C to G, F to C, E to B. G to $\frac{4}{9}$ D, and A to $\frac{2}{5}$ E are perfect fifths, because in each, by taking the monochord fractions for the lowest note, and multiplying by the interval fractions, it will give the monochord fractions of a perfect fifth in each case; or, by taking the interval fractions and multiplying, we get the $\frac{2}{3}$ or fifth fraction; but from D to A it is not so, for this fifth is only $\frac{27}{40}$, therefore a smaller fifth. There is also another, the diminished fifth from B to F. The table above will show thirds, fourths, sixths, and sevenths of more than one fraction. I might go on, as I have done years ago, and show the difference of the additional flats and sharps which might be called into use to modulate into other keys; but the equal temperament has come into use, and more practical with all its shortcomings. I love to find the whys and wherefores of any question; but let us reason: we cannot square the circle, however near we get to it. I knew one man who worked that up to 200 decimals, and then he said he felt he might still go on. Messrs. Grey, "F. T.," and N. E. Child have already given enough to my mind; but there have been times when some slight difference has cleared a fog from my mind. I hope in this I have helped to do so to you. This theory I have put in practice, tested it, and found it agree—it coming to concords or discords by melody or "thorough bass," as the theory pointed out. This I tested by the family of instruments that might be called overblown pipes, such as the trombone, trumpet, French horn, Kent bugle, cornet, and other valve instruments; therefore, I feel I may write.—W. H. ELPHICK, New Cross, S. E.

[55384.]—**American Organ.**—In reply to "H. M. I. R." about shorter scale reeds (p. 15), I would point out to him that the manufacturers of reeds will make them of any scale desired, provided the order is sufficiently large: they will also make them to any pattern. The reeds used in the majority of organettes are of a smaller scale than those he mentions, and perhaps they may be on sale in this country; but certainly he can procure such special reeds as those used for the Euphone stop of one maker, and the Æoline and Vox humana of another. This fact induces me to make one more effort to clear up the extraordinary illusion about 8ft. reeds in 16ft. tubes. Tubeboards, I need scarcely remind your readers, are made by machinery, and it is necessary to fix upon dimensions and keep to them. The dimensions in use for ordinary registers of 8ft. and 4ft. have been adopted after experiment, and good results having been obtained, nothing more was desired; but it does not follow that no other dimensions could be used with the same reeds. As a matter of fact within the cognisance of anyone who has had much experience with reed organs, reeds which are said to be adapted only to certain tubes are found in tubes of all sorts of sizes: that is one of the means adopted to obtain variety of tone in large organs. It is very rare to find large reeds put into small tubes, because there is then a difficulty in fitting the "mute"; but reeds are often completely buried in tubes, the makers of the instruments being happily ignorant of the importance of studying that mysterious "windway."—FLIEGEN.

[55384.]—**American Organ.**—I have no wish to enter into any useless controversy with Mr. Floyd (p. 564); but I should like to correct his misconception with regard to "theoretical notions" to which he alludes. It is no mere "theoretical notion" to state that 8ft. reeds (as well as 16ft. and 4ft. reeds) should be placed in the cavities or tubes intended for them, for under these conditions the reeds give out the best results, if in other respects everything is all right. There is not the slightest necessity at any time of placing 8ft. reeds in cavities unsuited (without some alteration) for them. I think it but fair and just to remark that the explanation on p. 522 is clear enough on this point to any reasonable person. If any of "ours" see fit to place 8ft. reeds in tubes suitable for 16ft. reeds, I have nothing particular to say against it, except that there is no advantage whatever in adopting such a plan. Neither is it absolutely necessary in one single instance to resort to such a proceeding, and it is quite evident to all who understand the use of reeds that such a proceeding or undertaking as the one in question is in one or two respects objectionable. It would occupy too much space in "Ours" to fully explain what these objections are. I have pointed out one objection, and that must suffice. One thing is quite certain, and a fact that cannot be denied, and that is that no American-organ builder of repute was ever guilty of advising an amateur to place 8ft. reeds in tubes intended for 16ft. reeds. If, in any instance, there was the slightest necessity of resorting to such a proceeding, I would say nothing; but there is no necessity of doing so. In American organs, as well as other musical instruments, there is a proper place for every portion of the action, including the reeds. To those who possess a really good American organ I would say, Don't interfere with the instrument, but let well alone, for it is impossible for any amateur to improve a really well-made American organ. If any of "Ours" possess an inferior instrument, I should not blame them in the least for trying to improve it in any way, providing they are really capable of making the improvement. I always regard it as a pleasure to assist such persons, in spite of the credit which have been conferred on me by one correspondent who never do, or never has, given any valuable assistance to any of "ours"; but who is ever ready to find fault with those who do.—G. Fryer.

[55393]—**Lathe.**—To C. Calvert.—The plan you suggest of driving grindstone from lathe shaft is very reasonable, and is one easily applied as regards small stones. I hope to have a further say on this later on.—Invicta.

[55487.]—**Hot-Air and Vapour Baths.**—Yes, a gas-burner, a charcoal brazier, or anything else, provided the head is outside, or there is free ventilation, supposing it is a bath-chamber. You mean a portable bath, I presume. Always have the head outside that, for the hot air often acts injuriously when breathed, as many have found by going to the ordinary Turkish baths.—Massage.

[55571.]—**Turbines.**—I am sorry to say I cannot answer the query of "E. F." I take it that the authorities had a reason for saying "provided the draft tube is placed perpendicularly," or were not aware of any attempts to work in the manner described by the querist. As, however, some of the correspondents are skilled in using water-power, I have no doubt he will get a satisfactory reply shortly.—Essar.

[55679.]—**Lever Watch (U.Q.)**—To adjust a watch to the same rate when first placed in a horizontal, and then in a vertical position, is a difficult operation. The rates in a vertical and horizontal position are made identical, or nearly so, by equalising the resistance that interferes with the motion of the balance in the two cases, and by taking advantage of the displacement of the centre of gravity of the balance spring, satisfactory results will be obtained in most cases by employing the following methods, either separately or two or more together, according to the results of experiments or the rates, the experience, and the judgment of the workman. 1. Flatten slightly the ends of balance pivots, so as to increase their radii of friction when the watch is lying flat; the friction will be greater. 2. Let the thickness of jewel hole be more than is absolutely necessary. 3. Reduce the balance pivot, of course changing the holes, as the resistance due to friction when the watch is vertical, increases rapidly with any increase in the dia. of pivots. 4. Let the bal. spring be accurately centred, or it must usually be so placed that the lateral pull tends to lift the balance when the watch is hanging vertical. 5. Replace the bal. spring by one that is longer or shorter of the same strength. 6. Set the escapement, so that the strongest impulse corresponds with the greatest resistance of the balance. 7. Replace the balance. A balance that is too heavy renders timing in position impossible. 8. Lastly, when these methods are inapplicable or insufficient, there only remains the common practice of setting the balance "out of poise." If there is a gain in the vertical position of the watch, slightly reduce the lower side of balance. The oscillations will increase in extent, and the watch will lose in the above position. The converse must be done in the opposite case. When the vibration exceeds a whole turn, the changes will be the reverse to those above. This fact must not be forgotten in regard to duplex and lever escapements, which may at first swing more than a turn, and subsequently less, according to the state of the oil.—Annie.

[55783.]—**Sag of Telegraph Wires.**—According to Culley, it has been ascertained that on a standard line of 20 poles to the mile, the difference in dip is 3in. between 54° and 25° F. The expansion of the iron wire is about 4·1in. per mile for every ten degrees of temperature. The subject is rather too complicated to explain at length here; but Culley gives formula and a table for calculating sag, strain, temperature, and span.—P. T. S.

[55786.]—**Legal.**—This question is much too complicated, as it depends on whether property is freehold or leasehold, how long the rights to the path have been in existence. At any rate, tenants have nothing to do with it: it is the owners of the property who must be consulted. The tenant has a voice in the matter if he holds on a lease; but from the statement that B. is afraid of losing his tenant, I presume the cottages are let only on the usual terms.—Limb o' th' Law.

[55793.]—**Boiler.**—Querist does not give grate area. For multitubular boilers, the following is the formula—

$$H.P. = 1{\cdot}8\sqrt{S \times G},$$

where G equal area of grate in feet, and S equal the heating surface in yards. About 4½ square feet of heating surface is reckoned as a horse-power in multitubulars; but the best rule is to see how much water the boiler evaporates: 30lb., or half a cubic foot, should develop an I.H.P. with a moderately good engine.—Essar.

[55791.]—**Horizontal Engine.**—This is rather a peculiar query. Surely the length of the eccentric rod does not vary with the position of the slide-valve? What is it you wish to know?—Essar.

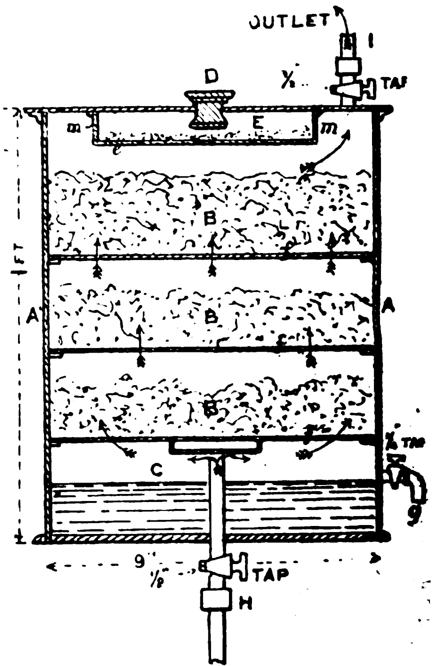
[55827.]—**Gravity and Dead Escapements.**—As Sir E. Beckett denies that I have quoted his book correctly, perhaps I may be allowed to give the words as they stand. At page 127 we read: "They (gravity escapements) are made by Mr. Brock, and I dare say by other makers, for half the price of the old-fashioned best dead-beat escapement regulators." The above, without doubt, conveys a wrong impression; for the comparative costliness of gravity regulators is a well known fact, and is referred to by Mr. Britten as such in the extract I gave last week, and also by "F.R.A.S." in his letter of the same date; and it is necessitated by the fact that clockmakers, both professional and amateur, have long since found out that gravity regulators must, in order to bring them up to the level of the dead beat, combine the very finest workmanship with a highly-numbered train. Sir E. Beckett, in his book, seems to me to lead one to suppose rather the opposite. On page 125, while admitting that the train should be a thoroughly good one, he says, "a highly-numbered train ought not to be requisite for these clocks," and also that the numbers "need not be anything like what are used for first-rate dead escapements." If Sir E. Beckett still holds this opinion, he does so, I believe, in opposition to that of all practical clockmakers. As Sir E. Beckett meets with a flat denial my statement that he does not seem sufficiently to recognise in his book those points mentioned by Mr. Britten, perhaps he will be so kind as to refer us to the page where such a recognition may be found. The sense in which I used the word "suitability" was, I think, sufficiently obvious, as having reference to cost and other considerations mentioned by Mr. Britten; and from this point of view it cannot, I think, be said that the G. escapement, as applied to regulators, is an "all-round" improvement on the dead-beat. Whatever difference of opinion there may be on this point, the fact remains that there is practically no demand for gravity regulators, and the dead-beat, as an escapement for regulators, holds its own, and is likely to continue to do so.—A Country Parson.

[55870.]—**Optics with the Lantern.**—I can find plenty of blow-through jets which will push up close enough to condensers to get a parallel beam. But I may say that if the condensers are at all short in focus, which is in itself desirable, blow-throughs are very dangerous to the glass, and parallel beam work with such jets is apt to be expensive. "S." will get much better results every way with a mixed jet, and with far less of this danger. Since his last letter I have made a special trial with the prism on "S.'s" account, with the comparatively feeble light of my Silber argand; but the only result is that I stand nonplussed at his difficulty. There is not so very much difference in brightness wherever a prism is placed, so long as a fair proportion of the cone of rays gets through it. The eye seems unable to distinguish beyond a certain extent. On the other hand, I find just beyond the crossing-point (not exactly *at*, but near, on one side or the other, and preferably on the screen side) is decidedly the best place, whatever light is used. "S." must somehow place his prism wrongly to the rays. Perhaps he is not careful to find the position of "least deviation," which is always the proper one, and is found by turning prism on its axis till the spectrum comes nearest to the direct image of the slit. No screen round the prism is ever needed when it is properly placed and used. I tried 5in., 7in., and 14in. focussing lenses—all the same result. A cylindrical lens is no use for any ordinary experiments, in all which the eye perceives no gain in brilliancy—a thing I do not quite understand. But to brighten faint spectra I use a cylindrical lens of about 5in. focus in the slide-stage of the optical front, and substitute an adjustable slit for the focussing power in the jacket, so that it can be brought to the focus of the cylindrical lens. By a "longer jet" I simply meant one longer from tray-pin to lime-pin: hence, a longer one, in any position of the tray, will place the lime nearer the condensers.—Lewis Wright.

[55870.]—**Optics with the Lantern.**—I have experienced the same difficulty as "S.," and have got out of the difficulty by putting aside my lime burner and gallery and constructing one on a very simple plan. If "S." would be willing and able to construct one, I will send drawings and instructions with pleasure. I can get my lime (cylinder) within an inch of condenser.—Excelsior.

[55870.]—**Optics with the Lantern.**—I get a parallel beam when the principal tube-jet is ½in. from condenser, and occasionally get a back lens fractured by the heat. It is impracticable and unnecessary to get nearer than this. The tubes of my jet were too short for this adjustment to be made until the condenser was brought back by means of metal collar. I strongly recommend "S." to get Lewis Wright's book on "Light," which I have found of great value. It has enabled me in a short time to emerge from the status of a blunderer to that of a somewhat expert demonstrator. I take the opportunity of mentioning a recent experience. In the slide stages of biunial I had a blue and a yellow solution for blending into white light. On removing these solutions the colours remained on the screen, and by experiment I found that the objectives had become transparent to these two colours, and opaque to the rest. Is this a usual experience?—W. H. Shrubsole.

[55876.]—**Improving Light in Coal-gas.**—In reply to "Woolwich Gas," I now send pen-and-ink sketch of a very good carburetter, which will give splendid results if followed in all details, each being requisite for the proper working of apparatus. This is made for using "benzol" or "benzoline," as this is preferable to all others for many reasons, a few of which I will give. Pure benzol is composed nearly all of benzene, and is the body lost to gas in carbonisation, being carried away in the residual tar, and it has been most successfully reproduced in the redistillation of the body. The wonderful influence of benzol when reunited to coal-gas in the carburetter may be evidenced by seeing the constituents of this body. It is as follows:—Benzene, $C_6H_6$; toluene, $C_7H_8$; xylene, $C_8H_{10}$; isoxylene, $C_8H_{10}$; pseudo-cumene, $C_9H_{12}$; mesitylene, $C_9H_{12}$; tetra-methyl benzene, $C_{10}H_{14}$. This is the rational formula of benzol, and these are the gases (if I may say so) that are lost in gas manufacture to a great degree. Mansfield found this out, and attempted to reproduce from the coal-tar spirit benzol for carburetting purposes; but chemistry was not sufficiently advanced at the period. I may say here you must be careful that all joints are well made, and that the lid, taps, screw-plug, &c., are all well soldered on, and the whole a sealed chamber, which need never be undone if all interior parts are properly joined and fixed, the benzol being very volatile and inflammable. No danger attaches to its use, however, if proper precautions are taken to keep a light from the spirit, and the taps turned off when not using, and a leather washer should be put under the thumb-screw, D. Explanation of sketch—A A is body of carburetter in section. This can either be round or square; but round is preferable, as less joints are required. It may be in measurement for from 10 to 20 lights—say, 9in. dia. and 12in. deep. The size you name is simply useless, and would give no result worth your trouble. It should be made of good stout tin, carefully jointed. B B, chambers partly filled with cotton wool. Don't use "sponge," as the cotton wool presents a far better surface to the rising gases, and if properly scattered will also act as a "governor" for the gas, keeping your lights from roaring or flickering when extra pressure is put on unknown to you at the works. C, chamber for benzol overplus of what the wool does not absorb; any overflow from this being taken off



at *g* tap, so that none may enter pipe H, over which I place a bit of tin to prevent any spirit running direct from chamber above it. D is the thumb-screw through which benzol is poured into carburetter, while E is a chamber made of fine wire gauze, marked $e^1$, on which a bit of wool is placed to scatter the spirit on chamber below. Gauze is soldered to lid at *m m*; *f f f* are partitions of perforated zinc, through which is found an easy gasway. These are fastened to the sides of vessel here and there, or may have supports tinned on sides for them to rest upon. By putting at least three trays of wool, there is a larger surface for the gas to take up spirit, and this will in turn be seen by the vastly improved light given. Always open tap *g* when you are putting spirit in at D, so that all overplus is returned to stock, and stock should be kept in a stoppered bottle. You will oblige me if, after you have tried this plan, you will send results to "ours," so that others suffering from poor gaslight (and these are numerous) may have the benefit of your observations.—Arvonia.

[55881.] — **Bar Armature.** — To Mr. S. Bottone.—I thank you very much for your kind inquiries; the mistake is mine. I should have mentioned that I wish to make an armature of copper bars, and use it instead of the Gramme ring. I wish to increase its efficiency. Could I get the required number of revs. from a ¼ h.p. gas-engine?—Amateur.

[55887.]—**Altering Clock.**—The reply to this query on page 16 is incorrect, for the arrngement, as illustrated and described, would not work. The design shown on page 567 is substantially correct, but is objectionable, on account of the pinion C riding upon the escape-wheel arbor, for this creates pressure, and consequently friction, between the pinion and the arbor, and destroys that perfect uniformity of driving force on the escape-wheel, which it is the great object of this remontoire arrangement to attain. If the escape-wheel arbor be mounted as shown on page 16, or in any similar way embodying the same principle, then the only friction to which it is subject will be that of its own pivots in their bearings, and that caused by the pressure of the fly ends upon the arbor. To diminish the former make the pivots as small in diameter as consistent with strength, and harden and polish them well, and to diminish the latter remove the piece D shown on page 567, and attach to each end of the fly projecting therefrom about ¾in., a steel wire about $\frac{1}{16}$in. square, or a round wire flattened at the end will do equally well. The *fly must be* sufficiently long to allow the wires to reach very nearly to the centre (not the circumference) of the escape-wheel arbor. Now on opposite sides of the said arbor and distant from each other along the arbor about ¾in. or so, cut with the edge of a flat file two nicks about ⅛in. or so wide, and deep enough to come to the centre of the arbor. It is clear that if the wires on fly are set in different planes the same distance apart as are the two nicks, they will alternately escape through them at every half-revolution of the arbor. The wires should be carefully shaped so as to minimise the friction and insure a prompt escape at the 30th second, and the arbor should be of small diameter, say, not more than ⅛in. where the nicks are, in order to reduce the radius with which the friction acts, and it and the wires should be hardened and polished in the acting parts. Of course, the further the wires are from their centre of motion—i.e., the fly arbor, the less will be their pressure upon the escape-wheel arbor. The diameter of the wheel G determines the maximum radius of the fly and wires. If the details of the existing clock are such that the above instructions cannot be exactly carried out, it will probably be easy to design another arrangement based upon the same principles. Some simple arrangement should be made by which the pressure of the spring can be adjusted so as to give the right amount of driving-force to the escape-wheel. I should strongly advise "Clockey" to fit this remontoire action to his clock, and if the escapement be well made and the pendulum a good one, accurately and firmly suspended, he will obtain such a highly satisfactory and accurate performance of the clock as will fully repay him for any trouble and expense incurred in making the alteration.—Wm. Granger.

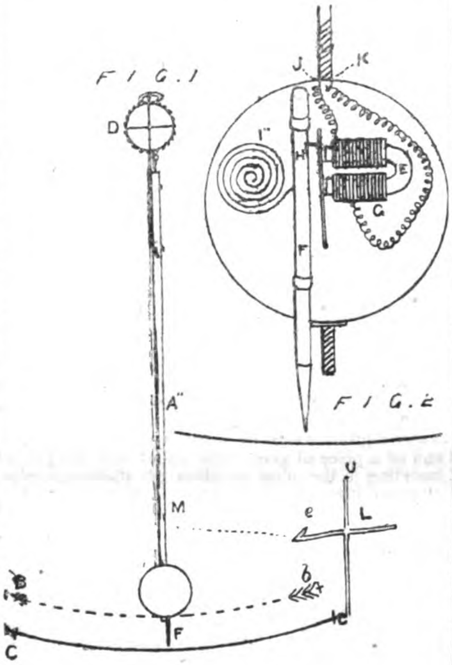
[55930.]—**Watch Winding.**—I do not quite understand from the description given, so should be glad if "Annie" would send the promised sketch.—M.M.I.Sc.S.

[55935.]—**Electro-Chemical.**—In reply to Mr. W. Grey *re* "several million volts," &c., I obtained the current from an induction coil giving 26in. sparks at the rate of 32,000 per minute, and absorbed about 30 h.p. for exciting the primary. This, I must add, was a *tour de force*, and could be kept up only for a short time. It was a discovery of my own, and a paper was read on the subject before the Royal Society in 1880 giving a detailed account of the results of this enormous and truly terrible current, in connection with my electric valve. I am writing an exhaustive account of these experiments and their results, which will shortly be in the press, and I must be pardoned for withholding any particulars which would anticipate such a work.—P. Ward.

[55935.]—**Electro-Chemical.** — Erratum.—34in. in this reply, page 16, should be 3 or 4.—Wm. John Grey, F.C.S., Gateshead-on-Tyne.

[55947.] — **Pressure of Water in Pipes.**—I think the following method of calculating the pressure of water in pipes at various depths will suit "One in a Fix": $\frac{\text{Head of water in feet} \times 62\frac{1}{2}}{144}$ = pressure in pounds per square inch. In answer to the second question let P = pressure in feet, *d* diameter of pipe, *l* length of pipe, and *v* velocity at point of issue in feet per minute; then $v = 2837{\cdot}5 \sqrt{\frac{P d}{l}}$, and $525\, v \times {\cdot}7854\, d^2$ = gallons of water per minute. The latter rule is given as for boreholes, but for practical purposes it may answer for "One in a Fix."—G. Worlands.

[55957.]—**Stop Watch.**—Does "Pendulum" want a portable instrument, or what? If not a portable one, I think the accompanying sketch will serve to show my idea. It is also the cheapest; I think it could be put in working order for a few shillings. A, Fig. 1, is the pendulum of an ordinary clock with long case. B *b* show the oscillation of same. Under the imaginary arc, B B, construct a piece of zinc or wood, C C, at equal distance from the pendulum. Now look at Fig. 2, which shows the pendulum on an enlarged scale; E is an electro-magnet, which liberates the metallic pencil, F, at the groove, H, immediately a current is put on; I is a strong spring to give the pencil a quick fall on its liberation; G shows coils on magnets. I and K are the two line wires, which should be insulated with silk, and carried up the pendulum to the arm; thence one to battery viâ bell push and one directly. It would also answer if the bell push was on the side of the clock (or where convenient). Its action will now plainly be seen. It is, as before said, an ordinary clock, and the seconds can be read by the dial. Now for the fractions. It is generally that the pendulum makes one oscillation per second; then the arc C C represents a second. The moment the spring push is pushed in the circuit is complete, and consequently the metallic pencil, F, drops, aided by the spring, I, and marks a piece of paper placed on the arc, C C, and stops the clock; then you divide off on paper with vernier or measure, and can arrive at the most accurate measurements of time. To know which way the pendulum has come, I should advise that it be started—say, from left to right for odd beats, and vice versâ for even beats. Example.—Clock stopped at five seconds, and pendulum marks precisely in centre of arc, C C. You know that the pendulum has come from right hand, for 5 is an odd number, and it has registered its last odd number, and is on the way to the even side. A good way is to put a piece of carbon paper over the ordinary paper, when the pencil leaves a clear, distinct mark. To start the pendulum off, a catch is provided at side of clock, see L *e* M. N is casing of clock. I hope this is what you want. If not, say more fully, and for what purpose.—Englethwaite.



[55972.]—**Glass Working.**—The kind of lamp used when gas is not obtainable is a long flat wick one, the length of the wick put parallel with blast from nozzle and fed with tallow. A metal shield is put over flame to protect it from draughts. Stick to your gas, it is far preferable to the old wick and fat. Any flame will turn lead glass black if the glass be put in the "reducing" part of it. "New Subscriber" had better use "soft Bohemian" glass until he gets expert enough to use the oxidising flame only.—P. Ward.

[55975.]—**Magnetism, 1881.**—Let A be the required angle, and let $T_1$ and $T_2$ be the moments of torsion round the centre required to deflect the 3in. and 5in. magnets respectively through 10°; let H represent the horizontal component of the earth's attraction, and *m* the amount of magnetism in each of the poles. Now since the magnet has two poles, the earth will act on both, and—

$$T_1 = 2\,m\,H\,\tfrac{3}{2}\ \text{sin.}\ 10^\circ$$
$$T_2 = 2\,m\,H\,\tfrac{5}{2}\ \text{sin.}\ 10$$

And since the angles of torsion are proportional to the moments—

$$\frac{180^\circ}{A} = \frac{T_1}{T_2} = \frac{3}{5}$$
$$\therefore 3\,A = 5 \times 180^\circ$$
$$\therefore A = 300^\circ$$

—$H_2S$.

[55978.]—**Tallow in Boilers.**—It is a most dangerous and ruinous practice to put any kind of oil or tallow in steam boilers, as in time it causes small pits like small-pox marks to be eaten into the plates. That is the reason why exhaust steam should never be turned direct into the feed water to heat it, as it always is laden more or less with particles of the lubricant.—P. Ward.

[55980.]—**Electric Bells.**—The galvanometer, or, more properly, galvanoscope, will not show where the fault lies, but only indicate whether a current is passing through it or not. There is no book published that would give you the information you want, as everything depends upon the circumstances of the case. If you will state the particulars of one breakdown you require put right, you shall have assistance to enable you to proceed, and that will give you much better information than could be derived by explaining away a supposition.—C. D R.

[55982.]—**The Zinc-Iron Cell.**—This cell only gives a powerful current at first starting, rapidly falling to nothing. If writers of books would test for themselves, and not accept unproved assertions, these errors would not find their way into print.—C. D. R.

[55983.]—**E. M. F.**—One way to get at E. M. F. of alternating current machine is to construct an instrument like Siemens's dynamometer, only wound with fine wire, as a voltmeter, and put it in "shunt." Of course, the constant of the instrument must be determined first.—P. Ward.

[55986.]—**Battery for Sewing - Machine Motor.**—Look up the indices; solutions for batteries have been given weekly almost. Do help yourself.—C. D. R.

[55987.]—**Zinc.**—Melt the zinc with the least possible heat; when melted put in a bit of sal-ammoniac and stir about till all the smoke has passed off, when all dross and impurities will have come to the surface; skim off carefully, and pour into cakes, which, when thoroughly cold, roll out into sheets; if it will not interfere with battery use, the addition of some grain tin would be an improvement.—Dens.

[55997.]—**Paint.**—It is the sun that does it, and it is very trying to withstand, and it is a well-known fact that the sun has more power on dark paint than it has on light paint; but if "Tram" will begin sooner, so that it can get well dry before the hot sun comes, and not put quite so much linseed oil in his paint, say, enough to make it about as thick as paste, and put sugar-of-lead driers, then thin with turps, and use nothing but the best, he will then get over it, as I have done many a time.—Calix.

[55997.]—**Paint.**—If the previous coats of paint are not taken off, but merely covered over with fresh, it will be certain to blister in the sun.—C. D. R.

[56001.] — **Ventilation of Colliery.** — It is almost impossible to answer this question so as to satisfy your correspondent without further information, as so much depends on other circumstances, besides depth and size of shafts. Waddle, Guibal, and Schiele are all good fans, whilst a more recent one, called the "Capel," is producing excellent results. If a "Mining Engineer" will advertise his address, I shall be most happy to assist him.—G. Worlands.

[56001.]—**Ventilation of Colliery.**—"Mining Engineer" will find the "Acme" patent system of ventilation the most compact, best, and cheapest, requiring but a fourth the power taken to drive a fan.—J. C. Baker, C.E., Liverpool.

[56008.]—**Bichromate Cell.**—Lead will answer perfectly for the containing cells of this battery. The chromic solution turns it yellow (forming chrome yellow I suppose); but does not further effect it. I have a plate by me which has been immersed for nearly six months. Lead will not, however, do for the negative surface, as in the Daniell's cell; but it is sometimes used as a support for a sheet of platinised platinum, which is very efficient.—G. JACKSON.

[56008.]—**Bichromate Cell.**—Yes, you can use lead for cells. See the description of the Edco battery, p. 379, No. 980, and subsequent numbers. —C. D. R.

[56010.]—**Milling Hose, &c.**—As it will depend upon the kind of goods to be treated, also the quantity requiring to be operated upon in a given time, say, a week, as also the amount of motive power at command, before any practical reply could be given to "G. B. P.'s" questions; so if "G. P. B." would put an address in the proper column of "Ours," I will send jotting.—X. Y.

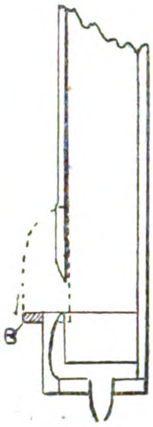
[56014.] — **Internal Gear Wheels.** — To "J. H."—Pitch of large wheel is $4\frac{7}{8}$in., with 48 teeth. Pitch of small wheel is $4\frac{1}{4}$in., with 44 teeth. Length of large wheel is $\frac{1}{4}$in. bare. The smaller wheel is the one I want to get out more exactly. I have got the wheels to work together, but they don't go quite smoothly. Should be obliged to "J. H." if he can give me rule for spacing and shape of teeth.—HYPO.

[56025.]—**Trueing Grindstone.**—All honour to "Marcus." There has latterly been a great tendency in "Ours" to get at trade secrets and the mode of getting round a patent. This is only evidence of the Socialistic tendency of the times. I may assist "Marcus's" statement by reminding your readers that the prohibition clause in the patent is against making, using, vending, or exercising the invention without the license of the patentee.—Z. Y. X.

[56025.] —**Trueing Grindstone.** — Being a patentee, I naturally agree with the remarks of "Marcus," and I am sure the general public share his views; but my experience has altered my views in this particular case; it is this:—These grindstone dressers were shown at the Health Exhibition, and I have been familiar with their use for years; but the attendant explained that they were preferable to the diamond for trueing emery-wheels. I therefore took their price list, giving price of cutters as 1s. 3d. each, resolving, when in Westminster, to get a cutter to try upon an old cutter-spindle. On calling at the office some time after, I was informed that they only sold the cutters to persons having their machines (the machine is a rough single slide-rest, with a cast cutter-spindle to swivel on the top, instead of fixing it under the tool-holder in the ordinary way). I said, in that case, I shall have to make one. I was told, with much high-handed bad feeling, that if I did they would prosecute me for fraud, and demanded my address, which I did not give. Such treatment I have not before received from business people. Next day I tried an ordinary pipe-cutter upon the spindle in the slide-rest; it cut up an emery-wheel very nicely. Later, having business at the Patent Office, I searched up the matter, and I found that the action of cutters revolving by contact had been known and used for 20 or 30 years for similar purposes, and that Brunton's patent, No. 702—1875, stated:—"I bring the stone to be operated upon into contact with rapidly revolving cutters"—the subject matter and drawings show the action to be that of communicating this rapid motion to the circular cutters "by means of toothed or friction wheels" (this action will be familiar to those who use the cutter-spindle); and he claims "imparting to cutting-discs a positive rotary motion on their own axis, independent of the rotation which they derive from the contact with the stone"; showing there was no attempt to claim the old method of cutters revolving by contact. Now, with grindstones and emery-wheels we do not drive the cutter, it turns by contact only. I again called and explained that they seemed to have no patent at all; they then said that they did not particularly claim the old method, but they now specially claimed the making of the cutter itself of a stamped cone of thin sheet steel, which keeps its edge to the last, recently patented. Evidently they try to what is vulgarly called *rush* those who go to buy what they advertise to sell in order that they may sell something else. It is the grocer who sells sugar only to those who buy tea. Without questioning the validity of a patent, I would not on principle make a thing patented by another unless he refused to sell it to me. I do not think the question of the validity of a patent is good subject for discussion in these pages, unless in public interest to expose such proceedings as these. "Marcus" is not aware of this system of business, as, I think, he and everyone else will uphold—FAIR DEALING IN MONOPOLY.

[56028.]—**Induction Coil.**—Under "Answers to Correspondents" you will find a list of back numbers, and amongst them Coils, induction, Nos. 832, 815. Send stamps to the Editor, with a request to forward by return, and proceed to make your coil from the instructions therein contained. It will save you a deal of trouble.—C. D. R.

[56029.]—**Organ – Voicing Pedal Open Diapason Pipes.**—The cause is probably the want of a "beard," which is a piece of wood (any thickness) placed directly under the mouth, outside, to prevent the too-great updraught interfering with the proper intonation of the pipe. The annexed sketch will explain. The required breadth of the beard for any of the pipes may be best ascertained by experiment, but I should say a couple of inches (at most) would suit your largest. "Ears" might be added with advantage, and would support the beard. The dotted line in the figure will show what I mean; they may be of light stuff and screwed to either side of the pipe.—HAM.



[56033.]—**Shocking Coil.**—You can regulate the strength by employing a water regulator, or putting the coil into a brass tube and withdrawing it gradually to intensify the current. A simple water regulator can be made by plugging up the end of a piece of glass tube about 9in. long, and inserting in the plug a piece of platinum wire, allowing it to protrude into the tube 1-16th of an inch, and leave sufficient outside to solder a copper wire. The other end must now be plugged in like manner, and into this a brass wire must be inserted tipped with platinum. The brass must be of sufficient length to allow it to slide down the tube and touch the platinum at the other end. If the tube be filled with water and stood upon end or supported in a rack, your regulator is complete. To use it, connect a wire from one of the binding screws of the coil to the platinum end, and from the sliding brass rod fasten the wire on which one of the handles is connected. Withdraw the rod from the tube to its utmost limit, and you have now the means of regulating the current by sliding the rod down the tube. You can, if you wish, mount the regulator with brass caps and wooden frame with binding screws.—C. D. R.

[56033.]—**Shocking Coil.** —Presuming your electro-magnet consists of a bundle of thin iron wires, or a solid piece of soft iron placed in the tube of your coil, you can regulate the shock, to a great extent, by cutting a brass tube the length of the core, which can slide freely in the central tube enclosing the iron bundle. You can regulate the shock by this brass tube, sliding it out and in as you want an increase or a decrease of shock. If the shock is too strong with the brass tube covering the entire length of the core, I should advise the use of a small bichromate cell, or fewer layers of secondary.—BOBADIL.

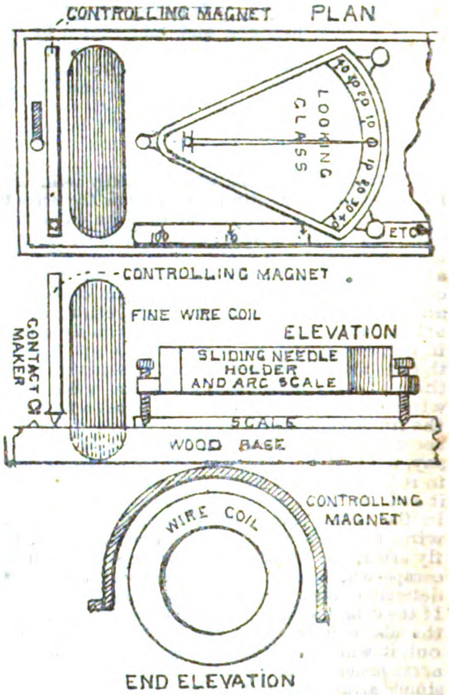
[56035.]—**Books on Veterinary Medicine.** —In my opinion the following are the best:—Williams' "Principles and Practice of Veterinary Medicine"; ditto, "Surgery"; Greswell's "Manual of Equine Medicine"; Robertson's "Equine Medicine." Pathology is best learnt from works on human pathology, such as "Green" or "Pepper."—GEO. A. WALTON.

[56037.] —**Induction Coil.** — Your wooden bobbin may be too thick in the tube; but whether or not, you must make a fresh cone. Why did you not make it of cotton wool at once? Take out the lemonade-bottle wire, and insert a core made of soft iron wires, No. 16 B.W.G. If you cannot procure it, use a piece of round iron rod of the size required. You do not want a condenser for giving shocks; nor anything like so much secondary. I presume you have fitted a contact breaker?—C. D. R.

[56037.]—**Induction Coil.** — Your secondary wire is too thick. Better to have used a size between Nos. 35 and 40, silk-covered. Every layer must be thoroughly insulated. If not, the coil fails. You do not require condenser for shocking purposes; but if for experiment proceed thus: —Prepare 50 or more sheets of tinfoil, each sheet 5in. long and 5in. wide, two thin boards of hard wood of a smaller size, and 60 sheets of thin paper steeped in paraffin wax, each 7 by 5. Upon one of the boards place five of the sheets of paper, and then one of the tinfoil sheets, placing the latter so that 1in. of its breadth projects over the side of the paper. Lay another paper on this, in the same position as the first, and upon this you place the second sheet of the tinfoil, but with the projecting part on the opposite side to that of the former one. Cover this with an insulating sheet, and lay down a third tinfoil sheet, with its projecting part on the same side as the first tinfoil. Arrange the other tinfoil sheets in similar order, remembering that ends of each alternate tinfoil sheet project at one side, and the ends of the intervening ones at the opposite side. Then lay on five more papers and the second board. Tie up the whole with a stout string, pressing together the projecting tinfoils at one side, and also those at the other side. You connect these two tinfoil projections, one to the spring and the other to the screw of the contact-breaker. The dimensions given may not suit your coil, as the size of condensers varies; but the best way to discover the size is to arrange as described, and connect temporarily to the coil, increasing battery power gradually to the strongest you are likely to use, and add sheet after sheet of tinfoil as long as beneficial effects are produced.—BOBADIL.

[56041.]—**Gun-Metal.**—As gun-metal is composed of copper and tin, copper and zinc, or those three metals with the addition of iron, it is not easy to understand in what proportions they can be mixed to withstand the action of a 3 per cent. solution of sulphuric acid. Does the queriest know of such an alloy?—NUN. DOR.

[56042.]—**Voltmeter.**—I reluctantly send sketch of Thompson's graded voltmeter in answer to "Volt's" second request for me to do so. I say reluctantly, because it is an imperfect sketch from memory, it being now over a year (through a lamentable personal accident) since I saw the instrument; but I think that the principle and general construction will be evident to him, especially if he looks up my description of it in a back number. —P. WARD.



[56043.] — **Engraving with Acid.** — I think "Acier" will find the following the most satisfactory process. First coat the surface to be etched upon with a thin film of yellow soap. Scratch out the lines of the pattern with a needle point; if the lines are to be broad, the point should be ground down a little. Then apply the following mixture: copper sulphate, 4 drachms; alum, 4 drachms; common salt, 4 drachms, with enough liquid acetic acid to dissolve the whole. If the article is large, as, for instance, a saw-blade, it will be sufficient to flood with the above solution, and leave for some time. If, however, the article is small, it is more convenient to plunge in mixture, and take out when required. The length of time for the steel to remain in the solution varies, of course, with the depth of lines required; but from five minutes to half an hour will generally suffice. If you have flooded the steel, it is best to remove the solution by means of blotting-paper before wiping off the soap.—Mikros.

[56045.]—**Lantern Lamps.**—I think "Exhibitor" will find what he requires in the numbers of your journal for January 16th and 23rd, 1885, under the head (55648) "Pamphengos Magic Lantern." He will also find some useful information in your journal for April 4th, 1884, page 100, by "Limelight," "On Mineral Oil Lamps for the Optical Lantern."—Syntax.

[56045.]—**Lantern Lamps.**—If "Exhibitor" really wishes for an appreciable increase of light, why not go in for limelight, which can be added at less cost than the 4-wick refulgent lamp if he can bring a small amount of ingenuity and patience to bear upon it? Should be glad to assist "Exhibitor" in this, also other correspondents who for an unexplained reason seem to be afraid of limelight being too expensive, when, in reality, it is not so.—Excelsior.

[56046.]—**Turning Spindle.**—If "Apprentice" will test his centres, he will no doubt find that they are not true. True up the centres, and turn them both to the same angle, and see that everything is clean when you reverse the spindle.—Valetta.

[56046.]—**Turning Spindle.**—The running centre cannot be true. If this is the case, turn it true with your graver. Were the centres punched in the spindle lopsided, causing it to run with a side bearing?—C. D. R.

[56046.]—**Turning Spindle.**—"Apprentice" will find that the point of his live centre describes a circle. True up the centre, but do not harden it. This will be sufficient if centre is at fault, but if mandrel nose is bent, mark centre and nose, and always insert former in same position. If mandrel nose is soft, it may be re-bored.—Geo. A. Walton.

[56051.]—**Gramme Dynamo Machine.**—If your query is worded correctly, the dynamo should have an E.M.F. of 120 volts, and a current of 300 ampères, and it will absorb between 60h.p. and 70h.p. If you have never made a dynamo before, a 600-light machine is no light matter. Send full particulars as to diameter of ring, length, breadth, and width of magnet-core, and also the width of the pole pieces. Through not sending full particulars, a querist ("Anglo-Dane") is making a dynamo, which, in my opinion, when it is finished, will stand a good chance of being thrown on the scrap heap. Perhaps, by 600-light, you mean 600 candle-power? *If* so, the matter is greatly simplified.—*W. H. Eaves*, Coventry.

[56052.]—**Kerosene Lamp.**—If kerosene oil is good, it will not burn without a wick unless heated considerably. Let "Brickwall" fill a cup with kerosene and plunge a lighted match into it so as to immerse the lighted part, the match will be put out. But when a lamp is thrown down the lighted wick often comes in contact with the spilt oil, and then the carpet or tablecloth becomes an enormous wick. The best extinguisher would be damp sand, but, of course, this is not always handy. Water is not to be despised, however, and is usually to be had at a moment's notice. A rug or large cloth is a good extinguisher if thrown over all the flame, and this, combined with water, ought always to be efficient if applied promptly.—Geo. A. Walton.

[56053.]—**Singing Noises in the Head.**—It is difficult to answer medical queries without examining the case, and I would earnestly advise "Arvonia" to consult his medical man. If he obtains no relief, he can consult a specialist. In questions involving medical aid the rich man has no advantage over the poor, for the latter may have the best opinion on his case at institutions for that purpose. It may be that "Arvonia's" trouble is caused by wax in the ears (a common cause); but this he cannot remove himself, and I would warn him not to be disappointed if he relies upon advice, which I expect he will get through these columns, recommending onions for breakfast, carrots for dinner, and parsley for tea, or some other such nonsense.—Geo. A. Walton.

[56059.]—**Geneva Watch.**—The cause of stopping is easily detected by the fact of it going while being "still," and "Ll. B. A." should first examine the hair spring, which most likely is in contact when in certain positions; secondly, see if it is in beat—i.e., the cylinder must be at right angles to the tooth of 'scape when in the shell of cylinder, when not in action; thirdly, examine cock jewel hole and top stone: if a fracture in either, the watch will stop when held face downwards, and so with foot hole, vice versâ. See there is not too much "end shake" in cock, or too much in foot holes, which will cause the cylinder to shift up and down as the watch is moved, and strike 'scape teeth improperly. Is your motion work free? also hands?—F. Hunt, Widnes, Lancashire.

[56061.]—**Vapour Density.**—The observed volume of vapour must be corrected for the expansion of the tube containing it. Taking the cubical expansion of glass as ·0000262, then at a temperature of 215° the observed volume must be multiplied by—

$$1 + ({\cdot}0000262 \times 215) = 1{\cdot}00563.$$

This gives the real volume to be 51·056cm.$^3$ The 80mm. difference of height of mercury inside and outside the tube must next be corrected to zero, for which we have—

$$\text{True height} = 80 - (80 \times 215 \times {\cdot}0001815) = 76{\cdot}88\text{mm}.$$

The actual pressure on the vapour is, therefore—

$$755{\cdot}5 - 76{\cdot}88 + 16{\cdot}9 = 695{\cdot}52\text{mm}.$$

It is now necessary to ascertain what would be the volume of the vapour under standard conditions, and we evidently have—

$$v = \frac{273 \times 695{\cdot}52 \times 51{\cdot}0566}{488 \times 760} = 26{\cdot}139\text{cm.}^3$$

A litre will weigh

$$\frac{{\cdot}1163 \times 1000}{26{\cdot}139} = 4{\cdot}4493\text{grm.}$$

Dividing this by the weight of a litre of hydrogen—i.e., ·0896grm., we obtain the vapour density = 49·657.—Wm. John Grey, F.C.S., Gateshead-on-Tyne.

[56062.]—**Chemical Problems.**—·567grm. of $CO_2$ contains $\frac{{\cdot}567 \times 3}{11}$grm. of carbon. Hence, the percentage of C in the substance is—

$$= \frac{{\cdot}567 \times 3 \times 100}{{\cdot}4245 \times 11} = 36{\cdot}428$$

·3025grm. of $H_2O$ contains $\frac{{\cdot}3025}{9}$grm. of hydrogen. Hence the percentage of H in the substance is—

$$\frac{{\cdot}3025 \times 100}{{\cdot}4245 \times 9} = 7{\cdot}917.$$

Calculating the reduced silver to argentic chloride, we get ·4074grm. as the total weight thereof; and as 287grm. AgCl contain 71grm. Cl, we have for the quantity of chlorine

$$= \frac{{\cdot}4074 \times 71}{287}\text{grm.}$$

and the amount per cent. is—

$$\frac{{\cdot}4074 \times 71 \times 100}{{\cdot}181 \times 287} = 55{\cdot}682$$

Thus, the found conposition is—

| | |
|---|---|
| Chlorine | 55·682 |
| Carbon | 36·428 |
| Hydrogen | 7·917 |
| | 100·027 |

Dividing each of these by the atomic weight of its element, we get the numbers 1·57, 3·03, 7·91; and taking the lowest as unity, we obtain the coefficients—

$$Cl_1\, H_{5{\cdot}01}\, C_{1{\cdot}93}$$

Now, an organic combustion usually gives the carbon too low and the hydrogen too high, so we may take $C_2H_5Cl$ as the formula required. Calculating the percentage composition of this body we obtain—

| | |
|---|---|
| Chlorine | 55·03 |
| Carbon | 37·20 |
| Hydrogen | 7·75 |
| | 99·98 |

There is rather too much error in the carbon for a good combustion. The determination of the vapour density is as follows: Corrected difference of level of mercury—

$$= 140{\cdot}5 - (140{\cdot}5 \times 50 \times {\cdot}0001815) = 139{\cdot}225\text{mm.}$$

Corrected volume of vapour—

$$46{\cdot}2 \times [10 + (0000262 \times 50)] = 46{\cdot}26\text{cc.}$$

The difference of level of the oil is not given, so we cannot allow for it, and must take the effective pressure on the vapour to be—

$$739 - 139{\cdot}225 = 599{\cdot}775\text{mm.}$$

Correcting to standard conditions we obtain—

$$v = \frac{46{\cdot}26 \times 599{\cdot}775 \times 273}{760 \times 323} = 30{\cdot}856\text{cm.}^3$$

Hence a litre weights—

$$\frac{{\cdot}0803 \times 1000}{30{\cdot}856} = 2{\cdot}6024\text{grm.}$$

and dividing this by ·0896 we get the vapour density = 29·044. The theoretical vapour density of ethyl chloride is 32·25. The temperature of the air is not needed.—Wm. John Grey, F.C.S., Gateshead-on-Tyne.

[56064.]—**Troublesome Battery.**—You have very probably a leakage somewhere, causing the battery to be constantly at work. You say that it does principally bell-work? Do you use it for any purpose for which a constant current is required? If so, this will account for the state you complain of, as your description points to the fact that the cells have been worked to exhaustion. You must test the system and discover, if possible, whether any leakage occurs. It may be that one of the pushes is in slight contact. If so, this will account for your trouble. Test the battery, see that the connections are perfectly clean and dry, clean out the cells, thoroughly wash with hot water, put in fresh solution of sal-ammoniac, only half-saturated, made by dissolving the salt in water until it will take up no more, and diluting with the same quantity. Clean your zincs, and, if worn, put new ones in. The zincs should be as pure as possible, as if they contain, as they often do, impurities, a local action is set up within them, and they consume away.—C. D. R.

[56065.]—**Tricycle Spokes.**—I should not, if I were you, bother with the enamel; scour the spokes with emery-paper, getting off as much rust as possible; serve hubs the same; and then give it two coats of Japan varnish, which you may thin with some spirits of wine. If you can put the machine in a warm place to dry, you will get a nice glossy black, at a cost of about 3d.—W. H. Eaves, Coventry.

[56066.]—**Gas Purifier.**—If "J. B. C." will look for my reply to "Woolwich Gas" on this subject, which will, with the Editor's permission, appear either in this or following number, he will see something which will be adapted to his case, although not just as he has requested, as the Albo-Carbon burner is a patent, and also is so constituted as to always require heat to develop its energies and give the result to increase of light. If "J. B. C." follows the instructions given, closely, he will obtain excellent results. The apparatus should be put just beyond where the gas issues from meter.—Arvonia.

[56070.]—**G. E. Engines.**—I believe the 8-wheeled double-end tank engines already at work are numbered 650—659. They have been built by the G. E. Railway Company, at their works at Stratford, where more of the same type are in construction. Following Mr. Webb's practice, Mr. Worsdell has fitted them with radial axle-boxes at both ends.—B.

[56071.]—**L. and N. W. Railway Engines.**—I am not aware of any 6ft. engines having been made by Ramsbottom; but the following are the required dimensions of his 6ft. 7½in. 4-wheeled coupled engines:—Firebox, 4ft. 3in. long, 3ft. 6in. wide; area, 15 sq. ft.; 192 brass tubes 1⅛ diam.; heating-surface, 1,013 sq. ft.; and that of firebox is 89 sq. ft.; total heating-surface, 1,102 sq. ft., or 73½ times the grate area. With trains averaging ten carriages the consumption of coal is 26·3lb. per mile. All boiler plates are $\frac{13}{32}$ thick.

Distribution of Weight.

| | Tons. | Cwt. |
|---|---|---|
| Leading Wheels | 9 | 9 |
| Driving ,, | 11 | 0 |
| Trailing ,, | 8 | 16 |
| Total | 29 | 4 |

—Regulator.

[56076.]—**Rope Pulleys.**—It is just possible to get a motion at right angles with rope pulleys, but I would not say much for the rope after it had had a little wear.—Valetta.

[56077.]—**Specific Heat.**—A mass of 1lb. falling 1,390ft. evolves a unit of heat (theoretically) on striking the ground. The latent heat of water is 80 units; hence, the ice must fall 1390 × 80 = 111,200ft. = 21 miles to melt it. In order to evaporate it, there would be needed 80 + 100 + 540 = 720 units, so it would have to fall 720 × 1,390 = 1,000,800ft. = 189 miles. I answered this question (which is from Thorpe's book) about a year ago.—Wm. John Grey, F.C.S., Gateshead-on-Tyne.

The Prudential Assurance Company have just issued their thirty-sixth annual report, which shows that during the last twelve months the funds have increased by a sum of £862,000. Of this £158,840 is due to the Ordinary Branch, and £703,766 to the Industrial portion of the business. These additions raise the assets of the Company to the sum of £4,711,464. In the new business of the Ordinary Branch we find 11,823 policies, assuring a sum of £1,359,361, which produce an annual premium income of £58,580. The premiums of the year amount to £238,868, which is an increase over the year 1883 of no less a sum than £58,580. The number of policies now in force in this branch is 51,835. In the Industrial Branch during the year the premiums received have reached the sum of £2,644,516, an increase on the previous year of £140,208. The number of policies in the Industrial Branch show a total of 2,302,890. The expenditure shows a rate of reduction equal to 2 per cent. on the premium income.

The 18 in. gauge railway from Suakin to Berber, 4½ miles of which are already on the spot, will not be proceeded with.

# UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list and send what information they can for the benefit of their fellow contributors.*

Since our last, "Annie" has replied to 55679.

55502. Paralysis, p. 395.
55503. Siemens' Dynamo. 395.
55507. Overhead Wires—Strain on Terminal Insulators, 395.
55512. Japan or What? 396.
55522. Hexagonal Parts of Globe Valve, 396.
55533. Sugar, 396.
55534. Concave Lenses, 396.
55535. Boiler Chimneys, 396.

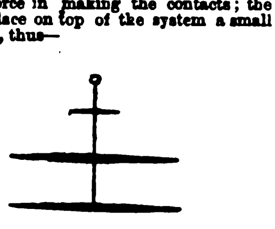
55768. Regrinding Cutlery, p. 483.
55780. Cardiff Railways, 484.
55782. Steel Castings, 484.
55788. Bookbinding, 484.
55795. G.N. Locomotives, 484.
55798. Stove, 484.
55799. Bending Angle Iron, 484.
55800. L. and N.W. Engines, 484.
55808. Bischopp's Gas-Engine, 484.
55809. Dynamo Construction, 484.
55811. Cement Analysis, 484.

# QUERIES.

[56079.]—**Lathe**—I have a 3in. centre lathe, with good slide-rest. If I set rest right, for turning truly parallel between the centres, and then come to bore, or turn anything from mandrel alone, I find the hole, or work, is not parallel, notwithstanding that the lathe centres coincide when slid along the bed. I suppose it is because the mandrel is not truly parallel with bed of lathe. Will you kindly tell me the best way to adjust it, so as to turn truly parallel, whether between centres or from mandrel alone, without shifting quadrant of slide-rest? I may mention the rest is a bought one, the lathe home made, with parallel necks to mandrel, running in halved brasses. Would it be more reliable if I made brasses whole, and made a new steel mandrel, with cones to run in brasses, and could I bore brasses out after fitting in head, with present rest, not having another lathe to run to?—PRO BONO PUBLICO.

[56080.]—**Helical Teeth.**—To "J. H."—I should be very much obliged, and no doubt others, if "J. H." would give full particulars (with sketches, as I understand those better than technical terms) for striking out and making large wheels, say 5in. pitch, 12in. wide, and 60 teeth, by core box. I am conversant with ordinary gear, but don't understand when you part the teeth in core-box. With ordinary you part in centre of teeth—do you do the same with helical, which would mean ends to be at an angle,—in your reply to "Novice," No. 55745, when a pattern is made to joint through centre, and each half screwed out of mould; am I right? Also a helical tooth is simply a tooth with all the ordinary conditions of plain gear observed, but laid at an angle? Is there any difference in the space of teeth allowed—more, or the same? An early answer would be greatly appreciated.—ATHOS.

[56081.]—**Electrical.**—I am constructing an apparatus, in which, amongst other essential features the sounding of an electric bell, or any other form of alarm, by the deflection of the astatic needles of a common galvanometer, is a vital one. The needles are 1¼in. in length, and suspended. I have failed at present, owing to a want of force in making the contacts; the plan tried being to place on top of the system a small shaft of platinum wire, thus—



The sharp points of which were intended to prick two small globules of mercury, held in cups at the ends of the battery, and bell wires which were brought over the top of the instrument to meet them. There is an objection, however, to this plan, even if successful; as, in working, the mercury would be liable to be jerked out.—BAFFLED.

[56082.]—**Telephone Transmitter.**—Will Mr. Lancaster, or some other subscriber to the "E. M.," give a diagram, with dimensions, of a good telephone transmitter to fit in a box 4in. square, with induction coil? I think the Blake transmitter is the best. I use three No. 3 Leclanché cells at one end of line for telephone circuit; the distance between each instrument, say, ½ mile.—T.

[56083.]—**Telescope.**—Would Mr. Lancaster, or some other optical correspondent, inform me as to the arrangement of lenses (focal lengths, distances apart, and diaphragms) for terrestrial eyepieces of powers suitable for 1in. and 1½in., achro. o.g.'s? I am thinking of having two powers for the larger o.g.—one moderate, and one high; the latter for clear days. I should also like to know the best focal lengths for the two o.g.'s. I cannot refer to back numbers, as I am at a considerable distance from mine. An answer to the above will greatly oblige.—J. P.

[56084.]—**Canvas Canoe Building.**—Will some readers of "Ours" help me on the above subject? I want to build a small one, chiefly for sailing, to take yachting with me, and light enough to sling in davits inside another boat. The loan of working drawings would be very acceptable. Is there any book published on the subject?—CECIL D. TRAVERS-WIRE, Croom's Hill, S.E.

[56085.]—**Scroll Chuck.**—My scroll chuck has become difficult to work through becoming clogged by using inferior oil. Shall be thankful if any reader will kindly instruct me how to take it apart to clean it.—B.

[56086.]—**Optical Formula.**—To MR. BRADBURY.—I have recently come into possession of a copy of "Practical Illustrations of the Achromatic Telescope," by Andrew Ross, and in looking it over, I see that one or two corrections have been made in the formula. These have been made by hand, and seem to have been made by some person, possibly Mr. Ross himself, before the book was issued to the public. Comparing it with the formula which you give upon page 445, in the centre of the middle column, I find that the part "$\frac{f'}{R'c}$ be called $c$" is corrected to $\frac{F''}{R'c}$, that is to say, the small $f'$ with one dash is changed into a capital F, with two dashes. This is important, as the small $f$, with one dash, represents the flint focal length, while capital F, with two dashes, represents the combined focus. A little further down I find that the fourth expression within the large brackets, the numerator of which is $(c' + 2 + b)\, g'$ is also altered, the sign of $b$ being minus and not plus. Also in my copy the denominator of the second expression reads:—$c\,(a'c + a' + 1)^2$, the second $c$ having a dash instead of being without one; also the denominator of the fourth expression appears C' with the dash, and not plain C. These various changes would materially affect the result of any calculations from these formulæ—indeed anyone of them would vitiate the result—and if you could throw any light upon the matter, and say which is the correct one, you would confer a benefit upon many who are interested in these investigations, and very much oblige.—ASCALON.

[56087.]—**Dynamo.**—Will Mr. Bottone please explain the cause of the following? When using my dynamo, which is shunt wound and gives an E.M.F. of about 10 volts, with a small induction coil of about ⅛in. spark, I am unable to get any appreciable length of spark from the secondary coil, although with a small bichromate cell I can easily obtain ¼in. Is it owing to the extra current in the condenser returning through the machine—how could this be prevented? Also, would he be kind enough to tell me the proper position of commutator with respect to the wire coils in Siemens armature, when the brushes are nearly horizontal, being inclined slightly in direction of rotation?—NAVAL.

[56088.]—**Knife-Cleaning Machine.**—In a family of 10 or 11, it is always a difficulty to get over the daily knife-cleaning with the ordinary board. I should be glad if any fellow reader can put me in the way of making a revolving machine, without of course infringing any patents. I want, if possible, to make one to take six knives at a time, and shall be glad of sketches, giving interior and exterior, in sections, &c.; no matter how rough a sketch, so that our kind Editor can reproduce it in our columns.—ARVONIA.

[56089.]—**Fasting and the Jews.**—Will some of your readers kindly say what a Jewish fast is? I know it is once a week from eve to eve; but does it mean during period, that absolutely no food or drink are taken; also what are Passover cakes? The Jews are said to be a healthy people, and have long life. It may be in part owing to their periodical fasts, giving the organs a rest, which, in this busy age, we seem to have no time to do, for if we work we must eat. Nevertheless my own experience teaches me that a fast, as far as I have gone, seems beneficial, both clearing the mind and the body. I should be much obliged by an answer.—S.

[56090.]—**Self-Lubricating Bearings.**—Would some engineering correspondent be good enough to inform me if lignum vitæ bushes, to wood rocking bar, and connecting rods (or traces) would be self-lubricating? Also are there such things as plumbago bushes, requiring no lubricating, and how can they be made?—R. H. T.

[56091.]—**Water Capacity of Boiler.**—To "YAMA" OR "MODDING."—Boiler should be 15ft., not 17½ft.; flue 3in. off bottom, and 3in. below gauge. Please work it fully in simple arithmetic.—T. HAWKINS.

[56092.]—**Altering a Dynamo for Plating Purposes.**—I have a D4 Cuttris dynamo machine, which I use for lighting, and I wish to know if I can alter it, so as to use it for electro-plating, or whether it would be best to buy another specially for plating?—RAT.

[56093.]—**Pitch Grease.**—Will some of our readers give me a little information how to make pitch grease, for to put on hot necks in sheet and tin mills. I have some tallow on hand, and I should like to know what is the composition, and how to boil and mix it.—SEA BORN.

[56094.]—**Iron Brake Pipes.**—Wanted details or a sketch of the iron brake pipes, with joints, now tried on the Great Eastern, North Eastern, and Brighton lines, in place of hose, between the carriages.—BRAKE.

[56095.]—**Gramme Machine.**—I have a Gramme armature of 5in. diameter, with a resistance of three ohms between two opposite pieces of the commutator. I should be obliged if some reader of "E.M." would tell me whether the resistance is such that a useful machine could be made out of it; or if the resistance is not right, what ought it to be?—J. D. L.

[56096.]—**Amalgamating Zinc.**—Will some one kindly tell me how to amalgamate zinc for a Daniell cell? I got a cell to work with a new zinc, but it has ceased since the mercury has gone off. I have some mercury that has been bottled up for about 20 years—will this do for the purpose? It has never been turned out of the bottle, nor does it stick to the glass.—W. J. GRIFFITHS.

[56097.]—**Conics.**—Three tangents are drawn to a parabola, such that the tangents of the angles which they make with the axis of the parabola, are in harmonical progression. What is the area of the triangle inclosed by them?—GEO. SMITH.

[56098.]—**Grinding V Tools.**—What is the best way to grind V tools for screw-cutting? Can I get a gauge for grinding to, and for setting them square with the work?—JUNIOR.

[56099.]—**Faulty Leclanche.**—Would some brother reader of the "E.M." kindly explain the following?—A short time ago, one of my Leclanché batteries ceased working altogether, which rather astonished me, as it had comparatively little work to do. At this I supplied it with a new zinc, washed the carbon and blocks, and recharged it with sal-ammoniac, when it rallied a little, only to return to be as bad as ever. What more astonished me is, that the other batteries, which have more work to do, require no attention at all, and work most satisfactorily. Would the fault lie with the agglomerate blocks or the carbon?—A. J. G.

[56100.]—**Oxyhydrogen Lantern.**—To "INVICTA."—What are the American composite gas bags? Information much requested.—OXYGEN.

[56101.]—**Spinning Wheel.**—Will some reader tell me how to make a spinning wheel?—SPINNER.

[56102.]—**To Mr. Lancaster or Mr. Bottone.**—I am constructing a small coil, about 2¼in. long between the ends, wound with two layers of No. 18 c.c. as primary, and 2oz. No. 36, as secondary, and insulated with brown paper, soaked in paraffin between each layer of wire. I want to know what quantity of tinfoil to use for a condenser, and how best to make the connections with the coil, also what size and kind of battery to use? This information, and any other hints, will oblige.—MODEL.

[56103.]—**Electric Accumulator.**—I want to make an accumulator to run a Cuttriss motor, latest pattern. I use the motor to work a small dental engine, and have to visit a country town once a month. I wish to avoid taking a large battery with me backwards and forwards, and as I should only require to run the motor one day a month, equal to about two or three hours continuous work, the remaining 29 days could be employed in recharging or storing the accumulator. Could this be done by a Daniell, Leclanché, or other constant battery, not requiring frequent renewal? I hope S. Bottone, "Nun Dor," "Sigma." or others will help me, or I shall be glad if they can give me the title of some inexpensive work or brochure on accumulators that will impart the required knowledge?—C. S. B.

[56104.]—**Gasoline Gas Engines.**—With the Editor's permission, will "Invicta" kindly send sketch and description of the cylinder, admission-valves, and firing arrangements of the simplest kind for a gas-engine of about ½ horse-power, and using gasoline vapour. I wish to construct one myself. The sketch only need show the cylinder (with dimensions and length of stroke) but with a particularly clear view and description of the simplest efficient valve arrangement for the admission of the gas and air to the cylinder, and the simplest firing device; the principle to be non-compression.—GASOLINE.

[56105.]—**Lever Fusee.**—Would any of our watchmaking readers kindly give me a hint that would enable me to recut the turns of a lever fusee that has been damaged by the over-running of the chain? I have experimented on an old verge fusee, but have not been very successful, and am therefore afraid to attempt the job in question.—O. C. T.

[56106.]—**Gun-Barrel Browning.**—Many thanks to "Armourer" for information on the above. Will he please say whether there is any difference in the mixture or application for laminated steel barrels? I have done my ordinary simple muzzle twist pigeon gun with success. I have tried my double central fire steel laminated barrels. After the first coat or two, the figuring begins going out of sight at the breech end, and by the fifth coat it is all out of sight all over the barrel. I have tried it three times, the same as I tried my single one, but each time, by the time I had finished, there was not the slightest figuring in them. Will he please help me out of the difficulty, or some other brother reader who has had experience?—A. Z.

[56107.]—**L. and N. W. Locos.**—Can any reader of "Ours" oblige with dimensions of the inside cylinder single-saddle tanks, with outside frames, which ran on the Manchester and Liverpool section of the L. and N. W., about 10 years since? Also of the four coupled outside cylinder saddle tanks which followed these, and have been replaced in their turn by Mr. Webb's double-enders.—B.

[56108.]—**Microscopical Staining.**—Can any one of "ours" tell me what shops sell aniline colours in powder? I have inquired at every colour shop in this neighbourhood for aniline black and aniline green, without success?—B.Sc., Plymouth.

[56109.]—**Photo. Lenses.**—I have a portrait lens, 2¼in. diameter, 5in. back focus. Can that be considered an extra-rapid lens? Also what should be the different diameters of a set of five stops to suit that focus and diameter for studio work?—GWENT.

[56110.]—**Mill Bills.**—Will some of our readers inform me how to temper cast steel mill bills? Also what to use as flux when two worn-out ones are shut together to make one new one, and oblige?—P. M.

[56111.]—**A Legal Question.**—A local board, responsible for the maintenance of the roads of its district, lays down new metal over the whole width of a road, and when one portion of that becomes worn down the board places tressels—during the hours of daylight—over this worn portion, in order that the traffic may be diverted to the other parts of the road, so as to insure the equal wearing of the metal everywhere. The road is sufficiently wide to allow ample space for traffic without encroaching on the part guarded by the tressels. Is the putting up of such tressels an obstruction of the highway, in a legal point of view; and can the board be indicted in the event of an accident occurring to a carriage caused by the presence of the tressels?—G. C. C.

[56112.]—**Chemical.**—Will somebody give me directions for testing for As in wall paper? Has any way been described before in the "E.M."? If there has, in what number?—J. K.

[56113.]—**Clock.**—To SIR E. BECKETT.—Given the area and the length of the arms of a fly in a turret clock: to find the resistance of the air? How is it done?—J. K.

[56114.]—**Electro-Plating Dynamo.**—To MR. BOTTONE.—I have fitted up a dynamo whose F.M.'s weigh 30lb., and have 5lb. of No. 14 wire on each limb—

that is, 10lb. in all on the F.M.'s. This weight of wire gives me 7 layers on each limb. The armature is the ordinary H, is 6in long and 8in. diameter, and revolves in the tunnel of F M.'s, which is also 6in. long. The armature has 1lb. 6oz. No. 16 wire wound in the slot; kindly tell me how many volts, and how many ampères my machine should have?—Faraday.

[56115.]—**Gilding Watch Movements.**—Will any reader of "Ours" kindly describe the process of finishing a watch plate before gilding? I want to know how to get up the nice matted surface. If it is done with acid, state what should be done with the pivot holes, so that they may not be eaten too wide, and also the kind of acid used in the trade. State also how they are scratch-brushed so that no scratches appear; leaving the beautiful dead surface all our watch movements have.—Horologer.

[56116.]—**Brick Clays.**—We are just opening some fresh brick pits, and should be glad if anyone would tell us how the following analyses compare with other clays:

Red Earth.

| | |
|---|---|
| Chlorine | ·034 per cent. |
| Saltpetre | ·0015 „ |

White Gault.

| | |
|---|---|
| Chlorine | ·1 per cent. |
| Saltpetre | ·008 „ |

—Brickburner.

[56117.]—**To Mr. Bottone.**—Will you kindly give diagram of winding and connecting up of Pacinotti ring, as I am at a loss to understand the diagram given by you in No. 1012 of "Ours"?—J. P. M.

[56118.]—**American Gas Bags.**—Will "Invicta" be good enough to give full instructions for making the American composite gas bags; giving particulars of the materials of which they are made, how to put them together; where the materials may be procured, and the size he has made his?—M. A. G.

[56119.]—**Magnitude of Small Stars.**—Will "F.R.A.S.," or any other astronomical reader, kindly inform me if there is any reliable formula for ascertaining the magnitude of the smallest star visible in any given aperture, and if so, to whose scale does it apply—viz, Ba., Sm., H., or A.? Please give formula.—H. A.

[56120.]—**University.**—A young man, aged nineteen, the son of a clergyman—income limited—wishes to get some exhibition or scholarship to enable him to go to Cambridge. A year ago he was some ten places below the successful candidate for an exhibition in a classical examination at Cambridge, but has improved since that time. He has a fair knowledge of elementary mathematics. —R. B. R.

[56121.]—**Canine.**—A pet dog—a Yorkshire toy terrier—is troubled with scurf and is losing its coat. Is it a good thing to wash with borax and water?—W. H. B.

[56122.]—**Small Brace.**—Will "Invicta" please oblige us with sketch of small brace for drills, from 1-32 to ¼in. for brass work, &c.—Four of Us.

[56123.]—**Wire for Dynamo.**—To Mr. Bottone.—I have a small H armature 5in. long, on to which I can wind about 1½lb. of No. 18, B.W.G. (of which I have a large quantity); how much must I wind on each field magnet to properly balance same with armature, and what power could be obtained from same?—C. W.

[56124.]—**L. B. and S. C. Engines.**—Can anyone give me principal dimensions of the London Brighton and South Coast engines known as the "Terrier" class, or state where I could get full particulars?—F. M. C.

[56125.]—**Staining Buckskin.**—I wish to stain a pair of buckskin gloves mouse colour. Could I mix anything with the pipeclay I use for cleaning them to produce the desired shade, or is there anything else that could be similarly applied? The gloves must not be made too wet, or they will shrink.—D. G.

[56126.]—**Chemical Examination, London University.**—Which are the most important articles of Gill's "Chemistry" for the purpose of passing the London Matriculation Examination in this subject? I cannot afford time to read the whole, or the greater part, of the work.—Londoniensis.

[56127.]—**Turning Small Cranks and Setting Lathe heads.**—Will any expert kindly tell me the best way to set about turning small cranks, say about ⅜in. diameter? I am in a fog as to turning pin. I find my lathe heads have side-play. I should be glad to know the way to find out if they are perfectly in line, after lining them up to fit lathe bed.—H. J. S.

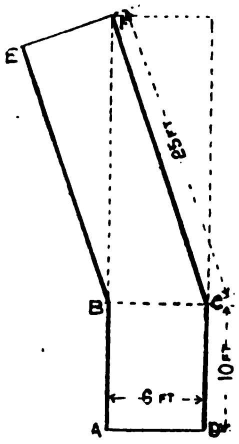
[56128.]—**Engine and Boiler.**—I should be obliged if some reader of the "E.M." would answer through this paper the following questions. I am making a loco. engine boiler 2ft. long by 9in. diameter, I want to know what will be the proper size of slide-valve cylinders for such a boiler? I have a pair 1in. by 2in. stroke—would they be of any use? I intend making it on the compound principle. Also how many tubes and what diameter should they be, the firebox is about 8in. square, inside measurement: and what pressure could I keep up with such a firebox; boiler is double riveted, and is full ¼in. thick. I should be much obliged if these questions could be answered on the 20th.—Compound.

[56129.]—**Legal.**—Will anyone of "ours" answer? A. and B. are executors to, and duly prove, a will which leaves £700 to a boy when he in some years hence comes of age. By arrangement the money is deposited in a bank, in the joint names of A., B., and C., C. being the boy's father. The boy attains age, but in the meantime B. has become insolvent and cannot be found. (1.) Can A., C., and boy without B., draw the money? (2.) Is B. actionable at law for not coming forward? (3.) If so, what punishment does he incur?—Parvus.

[56130.]—**Pau.**—Would any of your readers kindly give me some information relative to Pau as a winter residence. What is the most reasonable mode of living for a gentleman's family? Can good musical and other education be obtained? Any information regarding cost and mode of living and climate would be acceptable. Are there any pleasant summer resorts in the neighbourhood?—Alpha.

[56131.]—**Full Moon and Lunar Cycle.**—Will "F.R.A.S." or some other astronomical reader of the "E.M.", say if there will be a full moon in February, 1904; and also describe the process by which the fact is ascertained. The moon was full this year March 1; but 1904 being a leap year, if the full moon of Jan. 30 be repeated on the completion of the lunar cycle, the moon will that year be full in February. I find a difficulty in reckoning the leap years, and allowing for the fraction of a day's difference in each cycle.—Leo.

[56132.]—**Cutting Wrought-iron Pipes to any Angle.**—Will any kind reader of the "E.M." inform me how to cut large pipes, such as funnels for steamers or large ventilators? I have seen two or three ways, but never a proper fixed rule. The sketch will show what is wanted, the plates to be cut before they are bent. A B C D is square. B to E is the length I want. I have done it by measurement on paper, but it is not convenient in practice, when the pipes are of large diameter—M. B. M.



[56133.]—**Milling.**—Would any kind reader give a detailed description of a milling attachment for a 5in. centre s.c. lathe, vice for holding work and adjusting for height, &c.—Belgian.

[56134.]—**Taps and Dies.**—I have a good screw plate and indifferent taps, and I am making other ones which I want to finish well. How must I file them or groove them to obtain good inside threads? My object is to thread little brass binding screws, and other electrical small pieces. The screws must go in and out freely and not shake.—Belgian.

[56135.]—**Value of Gas Liquor.**—What percentage of ammonia does gas liquor contain? how much sulphate will it make? and what is a fair price for liquor at gasworks? The liquor to be fair average quality. —Sulphur.

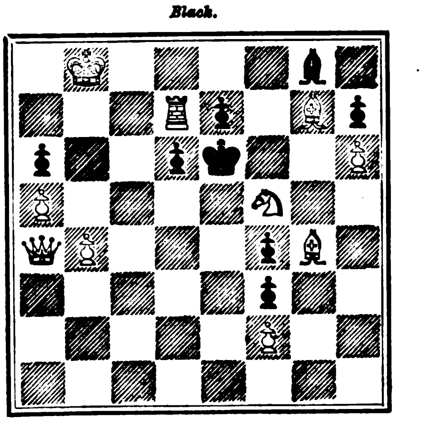
[56136.]—**Composition of Gas Lime (from dry Process).**—Of what does this consist, and in what quantities?—Sulphur.

## CHESS.

All Communications for this department must be addressed to J. Pierce, Llandwrog, Carnarvon.

### PROBLEM DCCCCXXX.—By J. P. Taylor.

*Black.*



*White.* [10+8

White to play and mate in two moves.

Solution to 928.

| *White.* | *Black.* |
|---|---|
| 1. Q-K R 8 | 1. K-Q 4 (*a*) |
| 2. Kt-Q B 3 (ch) | 2. K moves |
| 3. Q or B mates | |
| 2. Kt-K B 6, &c. | (*a*) 1. B-K 3 (*b*) or B-K sq |
| 2. Kt-K 7 (ch), &c. | (*b*) 1. Kt-K 3 (*c*) |
| 2. Kt-Q 4 (ch) &c. | (*c*) Anything else |

We are glad to inform our readers that a sufficient number of problems having been sent in for the Tourney, it will not have to be abandoned. We propose, however, to defer starting it until March 31st, in the hope that a few more may appear in the mean time. The Solution Tourney will begin simultaneously. Of course, any competitors who have already sent in their problems are at liberty to alter or withdraw them up to that date if they think fit.

### NOTICES TO CORRESPONDENTS.

Correct solutions to 928 by Raymond, J. E. Piper (fine problem), and Rev. W. Anderson (Old Romney).

Experto Crede.—There is no mate if 1 $\frac{\quad}{\text{K-Q 4}}$ 2 $\frac{\text{Kt-K B 4 (ch).}}{\text{K-K 5}}$

Tourney problems received from Ideen, Patience passes Science, Orlando, and Check.

## ANSWERS TO CORRESPONDENTS.

⁂ *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

### HINTS TO CORRESPONDENTS

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

⁂ **Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.**

### A NEW VOLUME.

The last number was the first of Vol. XLI. Readers willing to oblige us by recommending "Ours" to new subscribers should do so now, when a new volume is commencing. The index to Vol. XL. will be published next week, and cases and bound volumes will be on sale shortly after. Readers desirous of making up their sets for binding the past volume are recommended to do so at once, as the back numbers soon run out of print.

**The following are the initials, &c., of letters to hand up to Wednesday evening, March 11, and unacknowledged elsewhere:—**

Chas. Bright.—D. W. Armstrong.—A. J. Adams.—W. Donald.—C. Birchall.—British Gas Engine Co.—Prof. Patrix.—R. Mills.—R. T. Omond.—G. Riddiford.—F. A. Davis.—Allan Bros.—C. M. C.—E. J. S.—Jod.—Hopeful.—J. Kean.—J. Rance.—A. J. B.—C. H. Carter. —Yesallaw.—Plate Worker.—Burner.—Gramme.—Loco. Draughtsman.—E. A. K.—Argent.—B. Harcourt. —David.—H. A. Wassell.—J. E. Floyd.—A. W.—Subscriber.—Asterisk.—J. B. Valetta.—F. C. S.—Uncas.

Younker. (Are not the instructions given sufficient? The simplest form of bath of the kind is an old chair, a spirit lamp, and a good blanket. For full details how to make vapour and hot-air baths see Vol. XXXV. pp. 130, 157, 181, 289, 354, 378, 384, 403, 454, 597, 599. 2. What is it you mean? There are dry batteries; but chemical action must go on when the current is produced.)—N. Y. T. (Yes, an error of the types. It was Vol. XXIII., in which the "E.M." telephone was described. The No. and Vol. are both out of print, but we quoted the pith for you.)—E. Hugo. (See p. 341, No. 925. They are made of pieces of copper and zinc separated by cloth kept moist with salt or acidulated water.)—A Sufferer. (What is the cause of the enlargement? If rheumatic gout, we are afraid you will not find a remedy. See pp. 211, 215, 452, Vol. XXXIV.)—J. S——, Chelmsford. (You will find such statistics in the returns made to the Board of Trade, which are published by the Queen's printers, Messrs. Eyre and Spottiswoode, East Harding-street, E.C.)—X. Y. Z. (Procure a catalogue of books from Messrs. Macmillan, Bedford-street, W.C.)—G. E. (Surely you know that a blowpipe lamp on the same principle is used to burn off paint. Depends on what you call "expensive"; it is about as cheap as anything else, and it will heat anything of moderate size. 2. Why not go to a tool-shop and ask them to show you one?) —V. Bottom. (Of what interest would such information be, and who is to know whether it would be correct?)—W. R., Notts. (The upper part of a carriage wheel moves faster than the lower. Plot it down on a piece of paper, and you can then measure how much.) —John L . . . (For prices apply to the manufacturers. About one penny per hour per horse-power; but the gas-engine does not use so much gas when running light.)—Irresolute. (The usual method of making books sell is to advertise them. 2. The usual way is to measure, or refer to a table in which the diameters are given.)—J. H. Edwards. (It would be cheaper to give the parts out to different workers. Phosphor-bronze would be a suitable metal, but rather expensive; aluminium would be cheaper.) —Daniel Rome. (Would not Bourne's "Catechism of the Steam Engine" suit you? It is published by Longmans.)—Model. (The paint is usually mixed with stoving copal, and the articles are generally stoved. See pp. 139, 374, last volume.)—Hydrogen. (It can be done by causing it to revolve for some time in all possible positions before a powerful magnet or between the poles of a dynamo. See an article on the demagnetisation of watches in No. 762.)—Lux. (See p. 481, No. 982, and the indices generally for several methods of making oil gas. 2. Pocket batteries have been described many times. See p. 119, No. 1019, for description of a good dry battery.)—A New Reader. (See the indices, or No. 967, p. 99, for instance.)—Veritas. (There is a good deal about zincography in Vol. XXVII. The processes are much the same as in lithography; but zinc plates are used instead of stones. We do not think cylinders could be used with advantage. Better purchase the inks. The rollers are made with wood, covered with flannel, and an outer skin of fine calf.)—H. R. R. (Try David Nutt, Strand, W.C., or Williams and Norgate, Henrietta-street, Covent-garden, W.C.)—W. H. L. (There are several recipes, but the following makes a good brown hard: Gum sandarac, 3lb.; shellac (brown), 2lb.; methylated spirit, 2 gallons. Dissolve. Add a quart of turpentine varnish, shake up well, and strain. If by white polish you mean the finish, dissolve two drachms of benzoin and the same quantity of picked shallac in half a pint of "pure" methylated alcohol, and add about 2 teaspoonfuls of poppy oil.)—Chemicus. (What is it you mean? It must be made large enough for the given lens. See back numbers. 2. For burnishing photographs, see the indices. The roller press gives the best results; but you can use one of the preparations sold for the purpose.)—Gold Face. (Have you tried to precipitate it with common salt? You cannot get it darker than the pure gold will give. You must use alloy, for which see back numbers, or one of the handbooks of the art.)—A Collar Maker. (See the indices for recipes, and use a rubber or steel-faced stamp.)—Amateur. (Yes, or gun-metal.)—Woodrouffe. (Something wrong, evidently; but how that is to be found out by inserting your query we fail to see. You must carefully follow the instructions and trace out yourself; but see some recent replies.)—T. Cridland. (Consult a medical man. He must examine you. No one else can give useful advice.)—Silver. (Of course, if there were enough cells. One cell would not, if that is what you mean. For directions to make, see indices.)—B. H. F. (Why not write to the makers? The query would not be answered if inserted.)—Armature. (See Prof. S. P. Thompson's work on Dynamo Machines, or look through back volumes.)—Reader of "E. M." (Miller's "Chemistry" is in three volumes, published by Longmans. They also issue Miller's "Introduction to Inorganic Chemistry" in their Textbook Series, price 3s. 6d.)—Racquet. (It is quite satisfactory if properly laid.)—Friar Bacon. (For painting lantern slides, see No. 946, p. 226.)—Dan. (The methods of ascertaining power of engines of all kinds have been given often enough, surely. They will be found in the pocket-books. Dixon Kemp's work, published at the *Field* office, we believe, is the best work on yacht building.)—Centrifugal Pump. (Why waste your time in "arguments" of the kind? Your friend is either playing on the words "height of 100ft," or he knows nothing about it. A centrifugal pump will draw water from a depth of 25ft., and that is about all it will do efficiently. At 20ft. it will do much better work. Why not procure an elementary textbook, and argue over that?)—G. U. B. (Two methods of making dark slides in No. 979. In No. 958 he described the camera.)—Nemo. (The company issue a book describing all the parts, or you will find the information in Reynolds's "Continuous Brakes," or in back volumes—the numbers are out of print.)—Drone. (See the indices for several recipes. Is it not too late now?)—Non. (The best information on those points is to be obtained only by practice. We know of no book on the subject.)—J. G. (All information about appointments in the Civil Service can be obtained from the Civil Service Commissioners, Cannon-row, S.W.)—A. H. T. V. (We do not remember it. There is no "practical" work on the subject, but several on the principles.)—G. Pardoe. (We cannot find space for all the queries about dynamos that reach us—especially when they involve diagrams which will probably be of no use but to explain the meaning of the individual querist. Surely enough has been said lately to guide you as to the quantities of wire.)—Chas. Trotman. (Yes, a weak solution of sulphuric acid. 2. Several recipes for marking-ink in back volumes. 3. All the directions for removing ink with oxalic acid state that the resulting brown stain must be removed with a weak solution of chloride of lime. 4. Payen's "Industrial Chemistry," Longmans.)—F. S. D. (Horehound beer, pp. 462, 483, Vol. XXXVI., and other recipes in back volumes. 2. There are public analysts in London who, under the Adulterations Act, make analyses of articles of food for a small fee. You can ascertain the scale on application to them, and can have their addresses at the police-station of the district.)—T. E. L. (The letter, if stamped, could be produced in court as evidence of your acceptance of the situation.)—Sammy. (Yes, we think so; the fortnight's notice has evidently become customary.)—J. T. (No room to spare, but you will find a good epitome of recipes, household hints, games, &c., in the *Weekly Times* every week, in the column headed the "Home Circle.")

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Wanted known, Capps, Engineer, Hop Exchange, Southwark-street, S.E., is London Agent for Morgan's Boiler Compound.

Wanted, good second-hand Foot Lathe, 5in. or 5½in. centre gap-bed, screw-cutting.—Capps, Hop Exchange.

Wanted, second-hand double-action Steam **Pump**, about 4in. steam, 2½in. water.—Capps.

Wanted known, Bailey's Sight Feed Lubricators supplied and fixed by Capps, Engineer, Hop Exchange, Southwark-street, S.E.

Wanted, several gross of small Glass-stoppered and other bottles. Send wholesale list.—Harding, 196, Holloway road.

Wanted, Slide-rest for 9in. Lathe, Stocks and **Dies**, large size.—Hy. Walker, Cliff, Whitby.

Wanted "Dictionary of Mechanical Movements," also 4in. compound slide-rest, cheap.—Griffith, Llansannor, Cowbridge, Glamorgan.

Modern Tricycle, good, nickelled and enamelled, no objection to Coventry, £8.—H. Woodville, Abbey-road, St. John's Wood, London.

Deer Horns Wanted.—M. Day, Hook and Handle Manufacturer, 56, Driffield-road, Old Ford, London.

Wanted, "Miller's Chemistry," Vol. II. "Roscoe and Schorlemmer," 1 and 2, "Bloxham's Laboratory Guide," "Tyndall Sound and Heat."—H., 174, Charrington-street, N.W.

Wanted, Vertical Boiler, internal firebox, about 2ft. 6in. by 4ft. high.—R. Chaplin, 61, Spring-gardens, Doncaster.

Wanted, Lancaster's ½ plate Instantograph, or Meritoire, Chemicals, Apparatus; cash; approval.—C. J. H. Hamilton, Marle-hill, Godstone Station, Surrey.

Wanted, strong Iron Pedestal, with heavy many-grooved flywheel, treadle, &c.—H. Parson, The Firs, Guildford.

Wanted, Astatic Horizontal Detector, "Maxwell's Electricity." and books on Thermo-Chemistry.—J. S., 41, Manor-road, Brockley,

## Addresses.

Address wanted.—Makers of Firework Tools of every description.—Taylor, Milbourne-street, Blackpool.

To "Walsrek."—"Yesallaw."—G. BILLINGTON, 23, Falkner-street, Liverpool.

The English Mechanic

AND WORLD OF SCIENCE AND ART.

*FRIDAY, MARCH* 20, 1885.

## A STANDARD METHOD OF TESTING AND RATING STEAM-BOILERS.

THE economical efficiency of a steam-boiler is of as much importance to a steam-user as the indicating of the engine, and the American Society of Mechanical Engineers is doing good work by endevouring to bring about a recognition of a "standard method" of trial that will determine the steaming capacity of boilers under any given set of conditions. It is not quite so easy a matter as it may at first thought seem, to accurately test the economical efficiency of a given boiler; but so much has been done in this country, in the way of elaborate trials, that, if everything is straightforward, there is no room to doubt the correctness of the results obtained. Still, much diversity in practice prevails in this country, and, except amongst scientific engineers, we may be sure that in the United States the diversity is greater still. The object of the American Society of Mechanical Engineers was to give some system of testing a sort of authoritative stamp, and they therefore appointed a committee to frame a code of instructions, which, if carefully followed, would enable any fairly skilful engineer to obtain all the facts needed for ascertaining the economical efficiency of a steam-boiler with substantial accuracy at the least possible expenditure of time and money, and also without the use of any special apparatus. This committee consisted of W. Kent, J. C. Hoadley, R. H. Thurston, C. E. Emery, and C. T. Porter, and, experts as they are, they found some difficulty in reconciling the opposing views of recognised authorities; but as their object was not to devise a system giving results exact to the degree necessary in purely scientific work, they have carefully considered the advantages and disadvantages of various practices, and have formulated a code which may be relied upon for giving the substantial accuracy which satisfies the commercial requirements of the steam-users. At the same time they have presented their view of the recent refinements, which will be useful to engineers who wish to obtain results of the utmost possible completeness and scientific exactitude. So far as the commercial considerations are concerned, the purchaser of a steam-boiler wishes to know with precision the quantity of steam that a generator can supply continuously under prescribed conditions; what is the state of the steam, and what amount of fuel is consumed in producing it. He also wants to know what is the character of the combustion, and the actual conditions of operation for the boiler to do its best. It is clear that before a purchaser can expect to obtain the kind of boiler he requires, he must definitely state the conditions under which it is to be worked; then the engineer from previous experience can determine the size and pattern that are most likely to yield satisfactory results; but when the boiler is set and ready to proceed with its work, it is advisable to make a trial of its economical efficiency, and if all the necessary data are provided with tolerable accuracy, then we know that it should be as efficient at any future period, or some alteration has occurred which renders the generator less economical. It follows, then, that the trial of a steam-boiler should be made with every precaution to prevent errors in weighing-in coal and measuring water, in observing the state of the fire at the commencement and end of the trial, in noting the state of the steam, and in testing the temperature and composition of the escaping gases. In tests made in earlier times, the coal consumed was frequently estimated, on the well-known "near enough" principle, and as no one thought it necessary to look to the state of the steam, it is easy to show, if one believes implicitly in old reports, that our modern boilers are not so efficient as some of those made half a century ago. We know, however, that these old reports are altogether untrustworthy, for some of them actually give an evaporative efficiency higher than is theoretically possible. Nowadays we know that it is not possible to test a boiler on all points at once. Maximum steaming capacity and maximum economy of fuel consumption cannot be tested at the same time, and it is necessary, therefore, in any trial to state the object, and to keep that object in view during the whole time the trial lasts. It is advisable, too, to measure the boiler exactly, to facilitate subsequent calculations, and also to detect defects in construction or in the arrangements of the setting. The fuel to be used must be decided upon, and if its composition is not known an analysis should be made. The instruments should be inspected and standardised, for upon the accuracy of their work the whole trial depends. Scales and weights are easily tested; but the thermometer, barometer, and gauges should be standardised before and after the trial, while the apparatus used in connection with the calorimeter for determining the quality of the steam demand exceptional care, and even when of sufficient delicacy and accuracy, a mean of several observations must be taken to obtain a result within reasonable limits of error. The trial should be carried on for at least 10 hours, and during the whole time the utmost uniformity in the conditions should be preserved. For that reason the committee are unanimous in recommending that graphical methods of recording the conditions should be adopted wherever practicable. They also attach much importance to the method of starting and stopping the trial; so much, indeed, that they suggest an alternative method in case the first may not be practicable. In the "standard" method steam is to be raised to the working pressure, and the fire drawn as rapidly as possible, the ashpit cleared, and a new fire with the weighed fuel started, noting the time and the height of the water-level just before lighting the fire. At the end of the test the fire is to be drawn, the grates and ashpit cleared, and the water-level observed when it is in a quiescent state; it should be, if possible, the same as at the start; but if not, the difference must be noted and a correction made by computation, not by operating the pump. The pressure of the steam is to be kept as near as possible to the average during the trial by regulating the discharge by means of the stop-valve while the fires are being drawn. It will be seen that there are decided objections to this method, and the alternative provided by the committee will satisfy most experts. Instead of drawing the fires, they are to be allowed to burn low, and are then thoroughly cleaned, when the amount of coal on the grate is estimated as nearly as may be. When everything is straightforward, it is easy to contrive to have about as much fire on the bars at the end of the trial: at all events, no very serious error is likely to creep into the results by the adoption of the simple "alternative" method of the committee. The amount of fuel being estimated—it is usual to level the burning coal and estimate it as thickness of fuel,—the pressure of steam and height of water-level should be noted, and the time entered as the point of starting. The weighed coal is now fired, and the ashpit cleared. As the end of the test approaches, the fires should be cleaned so as to have about the same thickness as at the commencement and the same condition, the pressure and water-level should be brought to the point they were at when the start was made, and the time of the end should be noted. The boiler should be run continuously without stopping for meal times, or in consequence of any rise or fall in the pressure due to the demand made by the engine. The pressure should be kept as uniform as possible; but in case it rises above the desired point, an extra outlet should be provided, fitted with a stop-valve, so that steam can be released when necessary. When the boiler is connected with others—that is, delivers its steam into a main pipe—the committee suggest that the safety-valve on the boiler being tested should be set to blow-off at a few pounds higher than the valves on the others, so that in case of a rise in pressure above the limit, the valves on the other boilers will lift and relieve the excess of pressure without necessitating any interference with the damper or fire of the generator under test. As to that, it would be better in every way to temporarily disconnect the experimental boiler, and even waste the steam, for the trials are to be of such value that the mere loss of fuel during a ten hours' trial is as nothing to the economy which is to be effected in the daily working of the boiler. The committee recommend that the boiler should be worked for a week before being tested, in order to dry the mortar of the settings and thoroughly heat the walls and chimney; then, if steam is got up a few hours before the trial, the conditions so far will be suitable for obtaining a fair test of the evaporative efficiency of the generator. We need not, however, dwell on these simple conditions, for they are well understood, and are, at least, in this country, almost universally secured when tests of boilers are made; but the object of the committee is to establish some definite value for "the unit of evaporation," and to determine what shall be considered a "commercial horse-power," so that purchasers may know exactly what is meant when a boiler is said to be of such and such power. After a careful consideration of this matter, the committee recommend that the "unit of evaporation" be considered as one pound of water at 212° Fahr. converted into steam of the same temperature, which is equivalent to the utilisation of 965·7 British thermal units (B.T.U.) per pound of water. The relative economy of the boiler would then be expressed, as is now customary in this country, by the number of units of evaporation obtained by the combustion of one pound of fuel. That is a definite, easily-understood datum; but the unit to be chosen to express the "power" of the boiler is not so easily settled. On this point the committee say that since the boiler is simply an apparatus for the generation of steam, and since the province of the steam-engine is to develop power from that steam by the conversion of heat into mechanical energy, and since, furthermore, the engine develops power with a degree of efficiency which may vary enormously with differences in construction and operation of that machine, it cannot be properly said that we have any natural unit of power for rating steam-boilers. They think the most nearly scientific system of power-rating yet proposed is that which considers the power of a boiler to be that expended by it in driving out all the steam which it makes against the pressure of the atmosphere—simple evaporation that is,—but that system does not meet the wants of engineers. What is wanted is a standard unit of boiler-power which may be used commercially in rating boilers, and in specifications prescribing the power demanded by the purchaser and guaranteed by the vendor. It is obvious that there are almost insurmountable diffi-

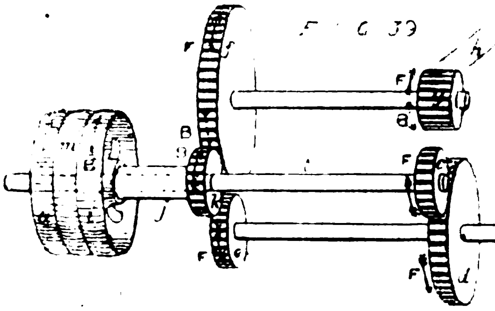
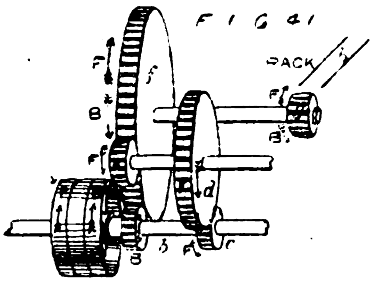


FIG 39



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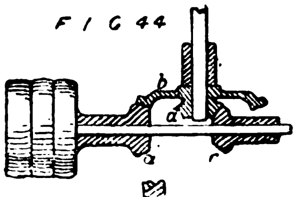

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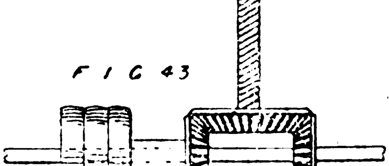

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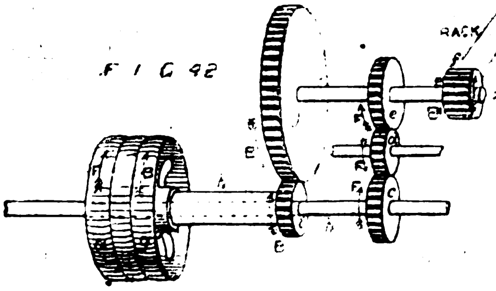

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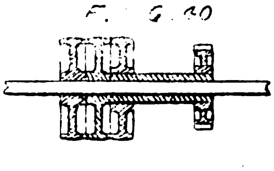

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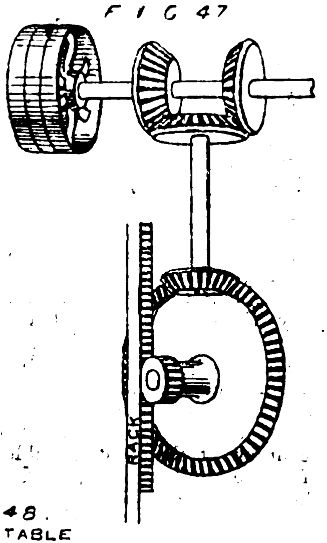

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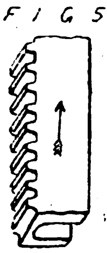

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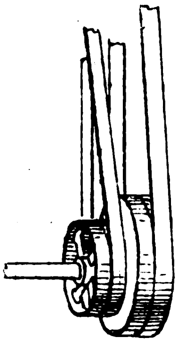


FIG 46.

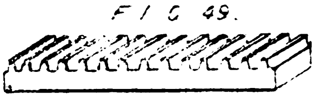


FIG 49.

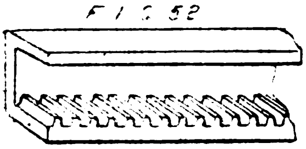


FIG 52

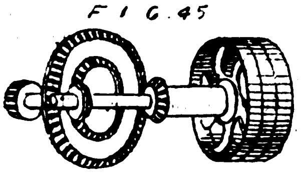


FIG 45

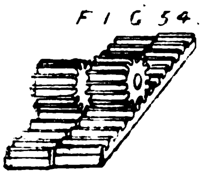


FIG 54.

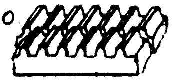


FIG 50

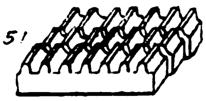


FIG 51

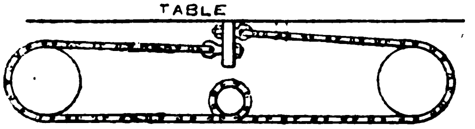


FIG 48.

culties in determining this point, and the best that can be done is to assume a set of practically attainable conditions under which it would be fair to assume that any boiler can be worked in average practice, and to take the power so obtained as the measure to be used in commercial transactions and engineering calculations. The unit which has been most generally used is the weight of steam demanded per horse-power per hour by a fairly good engine; but that weight has been gradually decreasing since the time of Watt. Good average engines of the non-condensing type use 30lb. of dry steam per horse-power per hour, while large engines with condensers use from 20 to 40 per cent. less. The committee determined to adopt 30lb. of steam as the unit, and as the conditions under which it is generated and used must be taken into account, they finally resolved that the unit of boiler power should be 30lb. of water evaporated per hour from a feed-water temperature of 100° Fahr., under a gauge-pressure of 70lb., which shall be considered equivalent to 34½ units of evaporation—that is, 34½lb. of water evaporated from feed at 212° Fahr. into steam of the same temperature. The committee consider that any boiler rated by the above unit should be capable of developing its stated power with easy firing, moderate draught, and ordinary fuel, while exhibiting good economy, and should at the same time be capable, on emergency, when maximum economy is not the object aimed at, of yielding at least one-third more than its rated power. The Committee have obviously brought a good deal of skill and thought to bear on the question, and it is for the advantage of all interested that a standard method of rating both engines and boilers should be adopted and recognised by the trade and the profession.

## THE AMATEUR WORKSHOP. — V.

### Planing Machines—Driving Gears.

In this hand machine I propose to drive the table by a pinion gearing directly into the rack, and actuated by a cross. I choose this because it is the easiest method of construction; but I shall also describe a train of gearing having fast and loose pulleys for a power-driven belt. But before doing so it will be well to enumerate some of the ordinary methods of driving planing machines.

These differ in regard to the mechanism employed, but for the most part they are designed with the purpose of bringing the table up to the cutter at a rate proportioned to the cutting capability of the tool, and taking it back with as little loss of time as possible. A heavy table is made to travel more slowly than a light one, but the feed of the tool is made greater. The forward travel of an ordinary machine takes place at a rate of about fifteen feet per minute, but the usual rate of the return stroke is from two and a half to three times that of the forward or cutting stroke. The exceptions to this practice are the screw-driven machines, with reversible tool boxes, which permit of cutting in both directions, and some few machines of the smallest class which are driven by crank or disc arrangements.

These variable rates of travel are provided for in the majority of ordinary machines by a train of gearing similar to that illustrated in Fig. 39. In such an arrangement a single driving belt always drives in one direction; hence it becomes necessary not only to vary the rates of backward and forward travel, but also to provide for the reversal of motion without changing the direction of the belt.

In the figure the wheels for forward motion are all marked F, and those for backward B, and the arrows indicate the direction of rotation, those for forward being drawn in full lines, and those for backward in dotted outline. The driving pulleys are two in number, the central one being merely an idle pulley to carry the strap when the machine is not in motion. The shaft to which the inner pulley is attached, and which drives the wheel *k*, is made hollow to allow of the shaft of the outer pulley passing through to the wheel *c*, Fig. 40. The idle or carrier pulley *m* runs loosely upon this smaller shaft. The driving therefore, is effected as follows :—

The outside pulley *a*, for the forward motion, being keyed directly on the shaft *b*, drives wheels *c*, *d*, *e*, *f*, *g*, and the rack *h*. The inner pulley *i* being keyed on the hollow shaft *j*, which runs loosely upon the shaft *b*, drives wheels *k*, *f*, and *g*, and the rack *h* for the backward or quick-return motion. The proportions of the wheels are calculated for the difference in speeds, and if wheels *e*, *k*, and *c* are all of the same size, it is obvious that the wheel *d* alone produces the difference in the rates of travel, and to treble the speed this should contain three times the number of teeth in *k*, or *e*, or *c*.

Commonly the wheels *d*, *e*, *g* are within the framing of the machine, and the others, *e*, *k*, *f*, with the pulleys, on the outside. In some instances, however, the wheels of machines of medium size are compactly arranged on the outside of the framework, the rack pinion alone being within the bed. Fig. 41 shows such an arrangement with the indicative letters and arrows placed as in the last illustration.

A different train is shown in Fig. 42. Here the forward pulley *a* drives shaft *b*, wheel *c*, the idle wheel *d*, the wheel *e*, and pinion *f*, which last gears into the rack. The backward pulley *g*, keyed on shaft *h*, drives pinion *i*, wheel *j*, and rack pinion *f*, and the difference of speeds is due to the difference in the ratios of the pairs *i* and *j*, and *e* and *e*; the idle wheel *d* of course counting for nothing in the velocity ratios.

These spur gears are used in almost all machines of large and of moderate size. But there is one type of large machine, the invention of Sir Joseph Whitworth, in which there is no spur gearing and no provision for quick return. In these the table is driven by a longitudinal screw running underneath it, and since this screw is actuated by bevel wheels of equal sizes, Fig. 43, and therefore travels at an equal rate in both directions, the tool box is made to reverse, and the cut is taken on each traverse of the table. An automatic arrangement of cords whisks the box round at the end of each cut, hence the term "Jim Crow" applied to these machines by the workmen.

Frequently however, the driving screw is retained while the tool box remains stationary, and then bevel wheels of unequal diameter are employed, as shown in Fig. 44. In these the forward or cutting stroke is given by the pinion *a* gearing into the large wheel *b*, the backward or quick return by the pinion *c* gearing into the smaller wheel *a*. The bevel gear arrangement is also applied to small machines, and is likewise a very favourite method of converting hand planers into power-driven ones. Fig. 45 shows how differential bevel gear is applied to small rack planing machines.

Again there are cases where the quick return is provided for apart from cog wheels by making a difference in the relative diameters of the driving or of the driven pulleys, the gearing for backward and forward motion (either by cog wheels or by a screw) remaining the same. An open and a crossed belt are then necessary for reversing the table (Fig. 46.)

Fig. 47 shows an arrangement of gear in a *small* power driven machine which has no quick return, and Fig. 48 illustrates the old-fashioned chain gear. The wheels in the latter (not shown) are similar to those of an ordinary machine, but the chain has yielded to the more modern rack and pinion.

In the vast majority of planing machines, the work is travelled by the last pinion in the train of gearing, engaging with a rack fastened to the underside of the table. The racks may be single or *double*, or alternate, or stepped, and their teeth may lie upwards, downwards, or sideways. A single rack is shown in Fig. 49, a double and alternate rack in Fig. 54, a doubly and trebly stepped in Figs. 50 and 51. The Fig. 49 illustrates the rack which when bolted to the underside of the table will have its teeth pointing downwards, which is the usual custom. Fig. 52 shows one whose teeth occupy the reverse position, while Fig. 53 indicates the vertical form, shown also in Fig. 47. For this last arrangement there may be some reason in the case of machines where the table slides against vertical guide faces; but I can see no advantage in its employment for ordinary machines.

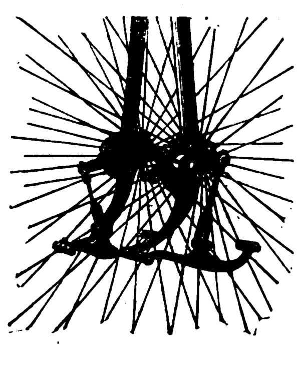
There is a decided advantage, however, in the employment of the rack in Fig. 52 where small machines are concerned. The tables of these are apt to lift, especially when made with flat bearing faces, or with double vee's. With a badly made pinion and rack the danger of lifting is increased, and with bearings worn loose, the pinion teeth may even ride over the points of the rack teeth, and either break the tool or injure the work by the upward jerking of the table. But with the inverted rack the table cannot rise at all, since the tendency is to pull it down upon its bed. In the heavy machines there is no risk of lifting occuring, and in these therefore the rack is downwards.

The use of a rack and pinion in the ordinary form having been objected to on the ground that it produces a ridged and wavy surface upon the work, various devices have been employed with the object of getting rid of this, as, for example, the screw-motion noticed above. One device consists in the employment of two racks placed side by side (sometimes united in one casting) in such a position relatively to each other, that the teeth of one come opposite to the tooth spaces of the other. (Fig. 54.)

The stepped racks (Figs. 50, 51) embody an extension of this principle. It is the slicing of the tooth width into short lengths and placing them one behind the other, the relation between the number of slices and the pitch being proportional. Thus if the breadth of the rack were divided into four parts and the pitch were 2in., each slice would be $\frac{1}{4}$ of 2in. = $\frac{1}{2}$in. behind its fellow. The idea of such a modification of the ordinary tooth form originated with Dr. Hooke in the 15th century, and singularly enough is now, in an improved shape, coming into general use in the helical form of tooth. Dr. Hooke's idea in stepping the teeth of wheels was to diminish the wearing of the tooth flanks and to insure greater uniformity of motion, for evidently the division of the breadth of the wheel teeth into numerous parts or sections insures the constant change of the parts in contact, so that the rubbing action is exchanged for momentary contact only along a succession of narrow faces.

## THE FACILE BICYCLE WITH SPEED GEAR.

To oblige some of their customers, Messrs. Ellis and Co., the makers of the now well-known Facile, who have recently removed to 47, Farringdon-road, have fitted specimens with a speed gear as shown in the illustration. The proportion adopted is as 4 to 5, so that a 40in. wheel will run as a 50in., and on the path or a good road, with a strong rider, the geared Facile will probably be found a trifle faster than the ordinary make, in spite of the additional weight and extra friction. A higher gear can be had if desired, and as not a few riders prefer the heavier and slower foot-action to the lighter and quicker motion of the ordinary Facile, the arrangement will probably meet their views; but it should be stated that the manufacturers have no intention of stocking the machine, as they consider that for the average rider and for general road work the Facile without gear is to be preferred. The illustration explains itself.



## PHOTOGRAPHIC BLOCK-PRINTING PROCESSES.

The announcement that an international competition between the operators with the new methods of automatic engraving is to be held this year (see p. 538, last vol.) lends an interest to the following patents which have been recently completed. The first relates to the invention of a veteran in the art, Mr. W. B. Woodbury, and refers to methods for producing blocks by means of photography, from which prints may be obtained in the ordinary press. Several processes of the kind are now employed with more or less (generally less) success, and the invention relates to improvements on these methods. The qualities necessary in a surface printing block produced from photographic pictures have usually been obtained by breaking up the continuous half-tone of the negative or positive into a series of lines, dots, or grains similar to the impression obtained from a lithographic stone. Mr. Woodbury first makes a series of negatives or positives from such objects as fine-ruled lines, netting, gauze, dots, or a print from a plain stone, which he uses as "resists" from which to make in the ordinary way what is known as a carbon transparency for transferring to the negative or positive, and then washing away the soluble portions. Sometimes he uses a photo-lithographic transfer, which is applied to the negative or positive, and if sufficient density is not obtained, he dusts bronze or other opaque powders over the image. In another method, in which he employs what is known as the dusting process, he coats a sheet of glass with a compound of gelatine or albumen, grape sugar, and bichromate of potash, and after exposure under a negative or positive, sifts over it suitable granular powders, or the material used for flocking paper, thus producing a grain negative or positive suitable for the purpose, or a negative or positive being coated with the solution, is treated in the same way as plain glass. Sometimes, by means of the Woodbury process, he makes a relief image from the combination of negative or positive and any of the various resists mentioned, and having obtained a suitable relief image by any of the above mentioned processes, by rolling or other convenient pressure, makes a reverse relief of the same on a sheet of fine card-board to which has been attached a sheet of transfer paper, and this image being inked over carefully with an ink roller and (after detaching the transfer paper, which may be temporarily attached to the card by means of indiarubber solution) is transferred in the ordinary way to zinc or other metal material for etching or to stone for lithographing. Another process which it would appear is applicable to almost any metal, has been recently patented by Mr. J. Brown, of Halsey-street, Chelsea. The patentee having selected a drawing, print, engraving, or photograph which it is desired to reproduce on a flat or other surface of steel, iron, copper, zinc, brass, bronze, and the more precious metals, prepares a solution of suitable gum, to which is added bichromate of ammonia or potash, in the proportions, for example, of about two parts of gum to one part of bichromate of potash or ammonia; these quantities varying in accordance with the temperature at the time of operating. In some cases it may be advantageous to add albumen, or fine soap, in the proportion of about 5 per cent. to the other ingredients. The solution is then applied to the surface of a plate or cylinder of metal, and the selected drawing or photograph is placed face downwards on the sensitised surface, and submitted to the action of light. By this means the image is imprinted on the sensitised surface of the gum sensitiser on the plate. The patentee then proceeds to develop the picture by means of a dabber or roller with a bituminous or acid-resisting varnish; after which the plate is immersed in a bath of spirits of wine or methylated spirit, which has the effect of disintegrating all those parts that have not been affected by the light, whilst hardening or coagulating those parts that have been so affected. The plate in this condition is ready for the action of the various mordants to which it is submitted, which may be either electric action, or any acids ordinarily employed, and suitable to the metal to which they are applied, the action of the mordant being allowed to operate until the requisite depth has been bitten into the plate.

In another process patented by M. L. de Roux, of Bègles, near Bordeaux, a positive taken from a negative in the usual way, is placed upon carbon paper, which has previously been dipped in a bath containing water to which four per cent. of bichromate of potash has been added. The positive and the carbon paper are then placed in a frame and exposed to the sun for an hour or two according to its strength. The carbon paper is then laid upon a copper plate in a trough, the paper being first moistened, and is caused to adhere to the copper plate by means of a roller. Boiling water is then poured upon the paper, and after an interval of time which experience alone will indicate, the paper is removed and there remains on the copper plate the mass of carbon from the paper. This is then washed off the plate with hot water, and there remains the engraving in relief upon the copper plate. The copper plate is then dried. The patentee then prepares an alloy composed as follows:—Mercury 10 parts; lead, 8 parts; tin, 12 parts; metal d'Arcet, 70 parts. This alloy, in a state of fusion, is put into a special trough, and upon the alloy is placed the copper plate, with the engraved side upon and next to the alloy. The whole is then put under a press and allowed to get cool. When the alloy is cold, the copper plate is carefully removed, and the alloy bears the fac-simile of the object to be reproduced. After removing the superfluous metal, the plate may be used as a stereotype plate, from which prints may be taken as in ordinary letterpress printing, or as in copper or steel plate printing, or as in printing from a lithographic stone.

The total commerce of the Pacific coast of the United States with Europe, Asia, Australasia, and Oceania during the fiscal year 1884 was 83,565,814 dols.

## UPSETTING STEEL AND IRON.[*]

I HAVE recently read some things in relation to the upsetting of iron and steel which are so much at variance with the generally-accepted ideas on the subject, and at the same time so flatly contradict what the everyday experience of many mechanics shows to be facts, as to prompt me to offer some testimony. First, as to the "upsetting of iron"—for under this heading may be found in a trade journal of recent date a very interesting reference to the "quality of movements of the particles of iron under pressure or percussion. * * * Red-hot iron can be pressed to fill a mould as clearly and exactly as so much wax could be. * * * Cold iron can also be moulded into form by pressure. * * * The heading of rivets, bolts, and wood-screw blanks shows some surprising results in the compression of iron; a No. 6 1in. screw requires a piece of wire slightly more than 1½in. long to form it. Yet the total length of the screw blank headed is just 1in. * * * Now, it has been proved by experiments with shorter bits of wire that less than 5-16ths. of an inch of the extra 8-16ths is required to form the screw-head. What becomes of the remaining more than 3-16ths of an inch in length of an original 1½in. that make the 1in. screw blank? There can be but one answer; the iron is driven upon itself * * * so that $1\frac{1}{16}$in. of wire are compressed into 7-8ths of an inch in length without increasing the diameter of the wire."

This flatly contradicts the assertions of scientific investigators, who have, after making many exhaustive experiments, concluded that cold working of iron and steel, such as hammering, rolling, drawing, pressing, upsetting, &c., do not increase the specific gravity. Is it likely that in the many careful experiments made by the most painstaking of men, the experiments involving the most accurate measurements possible, added to unquestionable tests of specific gravity, there has been uniformly a misconception of the real facts, and that experiments made by measuring a blank piece of wire—possibly with a box-wood rule—before heading, and again measuring the length of blank produced by heading the same wire, are to upset this proven fact, that ordinary cold working does not make iron and steel more dense?

Where does the iron go, then? It goes to round up the contour of the die, in which the blank is headed, that entire part of the block constituting the body, and to fill the die for the entire length of the body of the blank, through the upsetting process, to a fulness which in solid dies defies the efforts of any but the best of carefully-hardened and tempered steel punches, from best of steel, to push out of the dies after heading, rivets, and screw blanks, making the question of what steel to use for "punching out in solid die heading" one of the most important connected with the business.

In heading a screw-blank or rivet, the first effect produced by the longitudinal pressure applied is to upset the piece of wire for its entire length. The diminution in length will produce an exactly proportionate increase in diameter up to the point when the wire fills the die so tightly as to transfer the most of the upsetting effect of the continued pressure to that part of the wire not encircled by the die, and then comes the heading, which begins by increasing diameter, and proportionately decreasing length, the metal being in a measure held by contact with the die and heading punch from lateral expansion. As the pressure continues, it assumes first a pear shape, simply following the not necessarily written law under which all metals under pressure yield in the direction of the least resistance, and soon a shoulder is formed, which, coming in contact with the face of the die, or bottom of countersink, depending upon the shape of die, the direct or entire resistance to the pressure applied has no longer to be supplied by the body of the wire as at first. But still, as the pear-shaped bulb is gradually pressed out of that shape into the shape required in the completed blank or rivet, a time will come when a portion of the superfluous metal back of the body of the blank, or representing the centre of the head, can escape more easily in the direction of the pressure, thereby still further increasing the diameter of the body of the blank, than to escape altogether in a lateral direction under the immense pressure required toward the completion of the heading process.

"Without increasing the diameter of the wire," we quoted, it would not be possible, in any commercial sense, to do anything of the kind. Did the writer who stated as a fact that this was the rule realise the improbability of the statement which he virtually makes—*i.e.*, that over 17½ per cent. of the wire entering into the body of the blank described by him has been lost, if, as he says, the diameter remains unchanged?

I once made some carefully-conducted experiments to prove or disprove the truth of the assertion, which I had often made, that cold swaging did increase the specific gravity of steel, but which was denied by those who, having learned by actual experiment that other cold working did not, felt sure that the effect of cold swaging would be the same as that of other methods. My experiments were made with pieces of steel rod, each 2ft. in length, by reducing them by cold swaging until they were nearly 8ft. long, and, having first carefully measured the original length and diameter, the increased length and decreased diameter, was to show by measurement whether the specific gravity had been increased by swaging. I have not the figures at hand, but they showed on my side; still, when I presented them to my opponents, they met me with the statements that "there was too little difference to talk about, and, if my measurements had been absolutely correct, I had established nothing further than to appear to show the exception, which proved the rule. Cold working did not increase density; this was a well-known principle." Well, it was not much. The fraction of an inch which showed the difference in length of pieces from what they should have been had the specific gravity remained unchanged was represented by a figure in the third or fourth place in decimals—not much like the 0·1875 = 3-16in., which the writer from whom we have quoted would have us believe was lost from 1½in. in length, when it is considered that in my experiments there were pieces sixty-four times as long in which lost metal might hide, and still not more than the one hundredth part as much had hidden in the 8ft. as is claimed for 1½in. Some facts are hard to swallow unless dressed up to appear reasonable. "Upsetting iron," as applied to heading, can be easily upset by anybody who will take the time to compare diameters and specific gravity of wire before heading with those of headed blanks.

"Upsetting steel" is spoken of by some persons, whose information on the subject of steel working is very extensive, as one of the most pernicious of practices, and, by the way the subject is treated, one might suppose that they fully believed that steel was made up of fibres, which must be always worked in the one direction. Steel is of a crystalline nature—not fibrous—and such of it as will be ruined by upsetting within reasonable limits, the operation being performed intelligently, is not good, sound steel.

Pursuing the subject of heading, I can testify that in the days when our grandfathers worked steel I made heading dies of 2in. diameter by upsetting 1¼in. octagon steel, which stood to do as much work as any that I could make from steel of other shape and size. Of hundreds which were made in this way, I do not remember that seams or cracks resulted from upsetting in a single instance. If the steel was sound, and the work in upsetting was so distributed as to affect all parts of the mass alike, why should they?

As to upsetting cold chisels, strips of sheet steel, iron, or pieces of steel of any shape which are so slender as to double up like straws from the power of the blow, there are not enough blacksmiths wasting time and injuring steel in that way to call for any protest. Steel is hammered with a view to improve it many times, in these later days, in a manner so much like that in vogue with the "old chaps" that it is a wonder that so many of them have ceased from labour without ever having been told that they had "monkeyed" steel. Well, if the devil has only got those smiths who hammered cold steel, there are not many smiths in his ranks yet. Heating steel as hot as it will bear and working it while hot, with injunctions not to try to draw cold steel, never to upset, may be construed to mean: hot as is best for steel, no hotter; not cold, but continue hammering till the grain of the steel is well closed up and finer for hammering at a low heat than it could possibly be made if the hammering was all done while the steel was hotter. It dont't seem that everybody does write in the papers against heating steel too hot, and nobody can come to the conclusion that half the trouble is caused by too little heat, if his experience and opportunities for observation have been the same as mine.

What a difference it makes where a chap, old or young, stands to look at a thing. But I am off the track; upsetting steel is the question. The screw-blanks which were headed in the upset dies were threaded with rotary cutters. These cutters may be described as a section of a worm gear, the shape of tooth being that of the space between threads on a wood screw, and the cutter having a rotary motion in keeping with the rotary motion of the screw and with its own longitudinal motion, as it traversed the length of the screw which it cut. The best of steel, according to our best judgment, was used for these cutters; but running through many of the best brands, from "Jessup's" to "Hobson's Choice Extra Best," these cutters did not stand as it seemed they ought to do. I was anxious to try a high grade of a certain brand, of which I could get none of the right size till it could be imported (this was in the days of the old chaps—grandfathers). I had some ½in. or ⅝in. round; the cutters were to finish round, over ¾in. diameter; I could not wait, so I made some cutters by upsetting the steel which I had. These cutters stood to do five times the work of the cutters I had been using; and, willing to "let well enough alone," I continued using the same size of steel and upsetting.

I once had for my job the lathe work on the hook for the Wheeler and Wilson sewing machine. As it came to me it was nothing more or less than a round-headed steel bolt, made in just the same way that a blacksmith would make any solid head-bolt, by drawing a body to pass through the heading tool and upsetting the head. After this lapse of time—thirty years—I can hardly be expected to remember the character of each particular hook, but I don't remember that one of them was unsound as a result of upsetting. If steel gets too much work in one part, and not enough in another, in any direction, hot or cold, it is likely to get broken up. Upsetting need not take all the blame. How much difference in fracture does anyone suppose will be found between breaking a bar of steel crosswise and breaking a piece of the same length of the width of the bar the other way of the grain? Cut two pieces of steel, each 2in. long, from a 2in. square bar, and draw one of them down to 1in. square, or 8in. long in the direction of the length; draw the other piece to the same size and length by upsetting at every other blow, or drawing crosswise. Who believes that the tool made from this last piece will be inferior to the one made the right way of the grain? Some bars of steel, and steel for some uses, can be improved by the work which they can get on the smith's anvil. Some bars of steel, and steel for some uses, will be injured by the same treatment. When it is necessary or desirable to use the centre of a bar of steel, and it is found to be in a coarse condition by reason of having been brought to shape and size by blows disproportioned to its cross-section, there is, perhaps, no better way of improving the grain at and near the centre of the bar than to upset, and alternate the upsetting with work from the outside of the bar.

Upsetting is not a cheap, easy, or desirable thing to do, and is not likely to be resorted to often except when necessity compels, but I see no use in making a bugbear of it when, if properly done, there is no harm in it, and in some cases actual good is done by it. It does not at least break up the centre of the bar, as blows at right angles with its axis often do; and after seeing, as I have, thousands of good cutters made by upsetting, for uses requiring the utmost soundness and best condition of steel, I don't like to see the process tabooed without saying a word in its favour.

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[*] By S. W. Goodyear, in the *American Machinist*.

## EXPLOSIONS IN PARAFFIN-OIL LAMPS.

AT the Royal Institution on Friday evening last, under the presidency of Sir F. Bramwell, a lecture was given to a very large assemblage by Sir F. Abel, C.B., F.R.S., on "Accidental Explosions Produced by Non-explosive Liquids." Sir F. Abel, referring to a discourse delivered ten years ago on the subject of accidental explosions, stated that his attention had of late been specially directed to one class of such accidents, those connected with the transport, storage, and use of volatile inflammable liquids employed as solvents and as illuminating agents. Particulars having been given of a large number of explosions resulting from the application of flame to vessels which had contained volatile coal-tar or petroleum products or spirituous liquids, the lecturer referred to cases in which the vapour of volatile hydrocarbons had travelled considerable distances from the vessels containing the liquids, and becoming ignited had conveyed flame to such liquids. Instances were also adduced of explosions resulting from the accidental escape of benzoline and similar products into sewers and wells. The violently explosive nature of a mixture of hydrocarbon vapour and air was illustrated by reference to several cases wherein ships conveying petroleum spirit or benzoline had been destroyed, with loss of life, by the ignition of such a mixture which had accumulated in the hold of the vessel, and he pointed out that a fire in a cargo of petroleum oil might be extinguished by battening down the hatches, and so excluding the air. The danger resulting from the carriage of volatile inflammable liquids with gunpowder and other explosive substances having been alluded to, the subject of explosions traced to the existence on board ships of even a small quantity of some preparation containing petroleum spirit or benzoline was dealt with in detail, and it was shown that the explosion which primarily caused the loss of the *Doterel* was due to the escape and volatilisation of a paint "driers" issued to all Her Majesty's ships under the name of "Siccative." The burning of the *Goliath* Poor Law training ship off Grays, Essex, in 1875 was next referred to as an illustration of the conditions under which mineral oils, not easily volatilised, might become dangerous. The development of the employment of liquid hydrocarbons as illuminating agents then received attention, the growth of the shale oil industry, founded in 1850; of the petroleum trade of the United States, dating from the sinking of the Drake Well in 1859; and of the comparatively recent petroleum trade of Southern Russia being traced. The concurrent evolution of the many excellent mineral oil lamps of the present day from the primitive appliances available in the early days of the trade was illustrated by the representative collection of lamps. The lecturer proceeded to discuss the question of accidents occuring in the use of mineral oil lamps, and gave particulars of many such accidents. A careful investigation of the circumstances attending numerous accidents, together with a critical examination of the construction of various lamps, and the results of many experiments, had, up to present time, led the lecturer and Mr. Redwood to arrive at several definite conclusions with respect to the immediate causes of lamp accidents, and to certain circumstances which tended to favour the production of such explosions. If a partially filled lamp were carried or rapidly moved, a mixture of oil vapour and air might be caused to escape from the lamp in close vicinity to the flame, and by becoming ignited might determine the explosion of the mixture existing in the reservoir. A sudden cooling of the lamp by its exposure to a draught or by its being blown upon, as, for instance, in adopting the common practice of blowing down the chimney to extinguish the flame, might give rise to an inrush of air, and the flame might be at the same time drawn or forced into the reservoir. If the quantity of oil in the reservoir were but small, and the air-space large, an explosion would obviously exert greater violence than if these conditions were reversed. If the wick were lowered very much, or if for some other reason the flame were burning very low, the lamp would be liable to become much heated, and the tendency to the production of an explosion would be increased. The character of the wick very materially affected not only the burning quality of lamp, but also its safety. A loosely-plaited wick of long staple cotton would draw up the oil to the flame regularly and freely, while, if the wick were very tightly plaited and made of short staple cotton, it would be of inferior capillary power, the oil would be less copiously drawn up, and undue charring of the wick—with considerable heating of the lamp—might ensue. If the wick were damp when taken into use, or if the oil contained moisture, the capillary action of the wick would be impaired. Many lamps of the newest fashion, too, were so designed as to facilitate the production of explosion, openings or channels being provided through which the flame might pass into the oil reservoir. The adoption of simple suggestions would materially reduce, if not remove, the risk of accident which attends the use of petroleum and paraffin oil, and these were stated at length. It was, he said, desirable that the reservoir of the lamp should be of metal. It should have no opening or feeding-place in the reservoir, nor should there be any opening or channel communication to the reservoir at or near the burner. The wick used should be of soft texture and loosely plaited, it should fill the entire space of the wick holder, but should not be so broad as to be compressed within the latter, and it should always be thoroughly dried before the fire when required for use. The fresh wick should be but little longer than is required to reach to the bottom of the reservoir, and should never be immersed to a less depth than about one-third the total depth of the reservoir. The reservoir of the lamp should always be almost filled before use. If it was desired to lower the flame of the lamp for a time, this should be carefully done, so as not to lower it beneath the metal work more than was absolutely necessary. When the lamp was to be extinguished, and was not provided with an extinguishing apparatus, the flame should not be lowered until there was only a flicker; the mouth should then be brought to a level with the top of the chimney, and a short puff of breath should be projected across the opening. The lamp should remain on a firm support when it is being extinguished. In conclusion, the lecturer expressed the hope that pending the more thorough treatment of the subject by himself and Mr. Redwood, when the investigations referred to were completed, the points dealt with in his discourse which related to accidents with petroleum lamps might, on the one hand, tend to dispel groundless alarm as to the dangerous nature of petroleum and paraffin oil as illuminants, and might, on the other hand, serve to convey some useful information respecting the causes which lead to accidents with lamps, and the readiness with which they might be avoided. Sir F. Abel illustrated the lecture by causing several explosions with gas arising from liquids not in themselves explosive.

## NEW HARTFORD DRILL CHUCK.*

THESE chucks are adapted for holding drills, taps, reamers, wood-boring tools, long stock for cutting or working up, and a variety of other purposes. Fig. 1 is a perspective view, Fig. 2 a longitudinal section, Fig. 3 a transverse section, and Fig. 4 represents in perspective one of the jaws. A is the body of the chuck, and B B′ the jaws. The general construction will be readily understood from an inspection of the engravings. The interlocking teeth, with the V-shaped notches, permit the grasping of any drill, tool, or wire, however small, and at the same time centre it accurately and hold it firmly, without inclination to spring or bend, or otherwise injure it. The square form makes it convenient to apply a wrench to remove it from the lathe or other machine upon which it may be used, and also affords a longer bearing for the actuating screw. The manner in which the jaws are guided, and the actuating screw arranged, tends to preserve truthfulness of the jaws. A. F. Cushman, Hartford, Conn., is the manufacturer.

Fig. 1

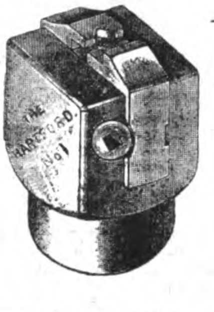


Fig. 2

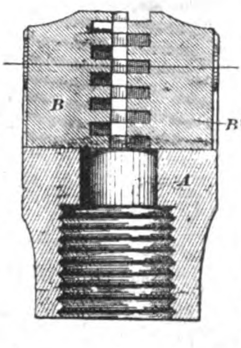


Fig. 3

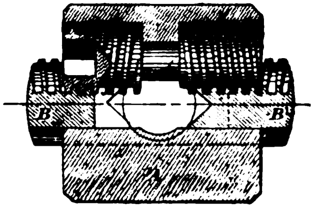
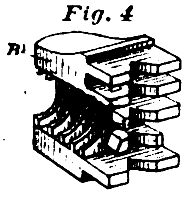


Fig. 4



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* From the *American Machinist*.

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## A NEW STORAGE BATTERY.

AMONG the most recent types, is a small zinc storage battery devised by M. Reynier, intended to replace the primary cells hitherto used for telegraphy, telephony, railway signals, call bells, etc. It bears an exterior resemblance to the ordinary Leclanché cell; and this resemblance extends to the cylindrical amalgamated zinc and porous cell, but ends there. The positive electrode, placed in the porous pot, is a sheet of peroxydised lead, folded in three directions longitudinally, pierced by numerous transverse slits, and rolled into a spiral; it is reinforced at its upper part by a diametrically placed cap or clamp of copper, surmounted by a screw-post for the connecting wire. The useful surface of the electrode is about 62 square inches; the holes with which it is pierced putting the interior portions in communication with the exterior. The liquid is a solution of bisulphite of potash. This salt in crystals is placed in the central space left by the lead electrode.

To put the battery in operation, it is only necessary to pour water into both compartments. The acid salt dissolves gradually in the porous cell; it diffuses slowly and without great excess in the exterior compartment, where it dissolves the zinc when the circuit is closed. This couple operates like Reynier's ordinary zinc storage batteries, with this difference, that in this case the sulphuric acid is borrowed from the bisulphate of potash. The salt yields an equivalent of acid, the chemical reactions involve then, two equivalents of bisulphate. The substitution of the bisulphate of potash for the free sulphuric acid, and the use of a porous pot, have for their objects the almost entire suppression of local action on the zinc. This small zinc "accumulator" has an E.M.F. of 2·2 volts in use, with one ampère, and a resistance of 0·4 ohm. Its electromotive force, its delivery, and its total work are greater than the Leclanché cell, while its resistance is much smaller—a useful quality in all of its applications, but especially valuable in all of its applications, but especially valuable when used on the carbon transmitters of telephone systems, for it renders the variations in the resistance of the transmitter more sensible, and in consequence augments the strength and clearness of the sounds transmitted. In practice, one of these accumulators will fully replace two Leclanché cells of the same size; the retail price of both being about the same per cell, the substitution of the new system for the old will result in a saving of 50 per cent. on the cost of installation. The regeneration of the accumulators may be effected in two ways:—First, by replacing the electrodes and exhausted liquid; second, by passing through the cell, during 40 to 50 hours, a current of about ·5 ampère, furnished by a dynamo machine. The expense of this work is, at the most, about $\frac{1}{10}$th of 1 h.p. This method being much more economical than the first, would be exclusively employed where the accumulator was used on a large scale for telegraphy and telephony. The small zinc accumulator possesses a great elasticity of performance; it may either expend its charge in a few hours, or extend its work over a period of six months. Under ordinary circumstances, the regeneration should be practised at intervals of three months. As the electrodes will bear 100 chargings, the life of the accumulator will exceed 25 years.

## PLATINISING GLASS.

THE following method of depositing brilliant films of platinum on glass was described recently at a meeting of the London and Provincial Photographic Association, when samples were shown. The method is that devised by Prof. Böttger. In order to succeed in coating porcelain or glass with a perfectly faultless film of platinum, of the brilliancy of silver, it is indispensably requisite to make use of a perfectly dry chloride of platinum, which must be as free from acid as possible. To that end pour some oil of rosemary over the perfectly dry chloride of platinum in a small porcelain mortar, and knead it up with the pestle, renewing the oil about three times, and continue this operation until at length there is produced from the brownish-red chloride a soft plaster-like mass, the colour of which is as black as pitch, and wherein no particles of undecomposed chloride of platinum are discoverable. The oil of rosemary assumes hereby a more or less yellow colour, in consequence of its partially taking up chlorine from the chloride of platinum. When at length we have arrived at converting the whole of the chloride of platinum into the black plaster-looking mass spoken of, rub it well up with the pestle, after pouring the oil of rosemary off, with about five times its weight of oil of lavender, and continue to do so until it has become a perfectly homogeneous thin fluid. It must then be left to stand for half an hour or so, for it is not until after that interval that it can be used with advantage for platinising. For the production of the brilliant platinum film, all that is now required is to apply the mass as uniformly as may be, and in the thinnest possible coat, to the objects of porcelain, earthenware, or glass by means of a soft, delicate brush. The thinner the coat of the above described preparation, the more brilliant the film of platinum subsequently proves. When, in fine, the articles have been gone over as thinly as possible with the fluid conformably with these instructions, all that is required further is to subject them for a few minutes to a very low, scarcely-perceptible red heat, either in a muffle, or in the flame of a Bunsen's gas blow-pipe used with caution. The articles receive from this baking (supposing always that the temperature described has not been exceeded), without requiring any subsequent treatment, an incomparable beautiful lustre, as brilliant as silver. If, by any oversight, the coating of platinum upon the articles has turned out faulty, or in the case of breakages occurring during the baking, every trace of the metal may be recovered with facility, from the objects that have suffered, by means of the following very simple galvanic process, without being obliged to have recourse to the use of aqua regia. Nothing more is required than to pour common hydrochloric acid over them, and then touch them with a zinc rod. On doing this, as quick as lightning, in consequence of the hydrogen evolved both at the upper and lower surfaces of the film of platinum, which acts as the negative pole, we see the shining metallic coating peel off in the form of infinitely thin leaves from the base of porcelain or glass, and, notwithstanding the specific gravity of the metal, ascend partially and float on the surface of the acid. On separating the hydrochloric acid by the use of a filter, the whole of the platinum, which would be otherwise lost, is recovered, so that no complaint arises as to the waste of any of the metal in question. In conclusion, I have to observe that one should prepare at once only as much of the platinising fluid as is required for the day's use, inasmuch as it loses in efficiency by keeping. That which, according to my observations, forms the active principle in the fluid, which results from treating chloride of platinum with oil of lavender, as above described, is an organic platinum salt, which, in point of fact, one can obtain, after some time, in the form of small elongated octohedral crystals, of a pale yellowish colour, by washing out carefully with alcohol a tolerable quantity of the fluid. The crystals have the property of taking fire with a brilliant flame on being brought near a lighted candle, leaving a residue of compact platinum of a dazzling whiteness.

## WATER MOTORS.

THE following is the substance of a lecture delivered by Prof. W. C. Unwin, M.Inst.C.E., before the Institution of Civil Engineers. It formed one of a course of lectures on the "Theory and Practice of Hydro-Mechanics."

The lecturer remarked that water-motors were not in this country so important as heat-motors, but yet a larger amount of water-power was utilised than was commonly supposed. Either a rise in the price of coal or greater ease in the electrical transmission of mechanical energy would make water-motors more important. At Windisch 1,000 h.p. were utilised, and at Bellegarde 3,700 h.p. But it was in America that the largest installations were found. For instance, at Holyoke, a weir 30ft. high and 1,000ft. long had been built across the river, and the water, taken off above the dam in a canal 140ft. wide and 22ft. deep, supplied power to the mills. Two other canals on lower levels had also been constructed. The whole water-power available was 20,000 h.p. in ordinary dry seasons, and the power was leased to the mill-owners at the rate of £1 per effective h.p. per annum. When water was descending from a higher to a lower level, in a pipe, for instance, it would in general have acquired, at any point, velocity and pressure. Then if H was the total fall,

$$H = h + \frac{p}{G} + \frac{V^2}{2g}$$

where the terms on the right represent three forms the energy took—viz., unexpended fall, pressure head, and velocity head. Corresponding to these were three classes of water-motors.

1. Cell or bucket wheels utilised the energy of an unexpended part of the fall. They were simple, had a fairly high efficiency, but were applicable only in a limited range of fall, and were cumbrous. They had one good point—that the efficiency varied little with a varying water-supply.

2. There were water-pressure engines, which utilised water pressure, just as a steam-engine utilised steam pressure. Water-pressure engines were used in mining districts, and hydraulic cranes and hoists were machines of the same kind. Still it was not generally best to utilise water-power in this way. The reasons that a cylinder and piston acted so well with steam, and less well with water, were these:—(1) The frictional losses in fluids were proportional to their weight for equal velocities of flow. If water were 500 times heavier than steam, then the friction at given velocities would be 500 times greater. Hence the piston-speeds, which might be 400ft. or 500ft. per minute in a steam-engine, were rarely greater than 60ft. in a water-pressure engine. In the pipes the steam might flow at 100ft. per second, but water only at 6ft. to 10ft. Hence the water-pressure engine was much more cumbrous than a steam-engine. (2) From the incompressibility of water, the same volume was used in a pressure-engine, whatever the amount of work to be done. The system of hydraulic-pressure-mains introduced by Sir W. Armstrong had proved entirely successful for intermittent work, such as lifting, but not so successful for ordinary power purposes. Probably the reason was that the consumption of water in pressure-engines was extravagant. The only engine in which the consumption of water varied with the work to be done was in that invented by Mr. Hastie, and which, in an improved form, was being introduced in London by Mr. Ellington. In this, by automatic gear, the stroke of the engine was lengthened till the resistance was just overcome. (3) There were other difficulties which arose out of the weight and incompressibility of the water. The whole column of water between the engine and the supply-reservoir virtually formed part of the piston, so that a pressure-engine had a very heavy piston, and this in general tended to render the effective effort variable. In certain cases the action of the friction and inertia of the water were favourable to particular operations. Mr. Tweddell's hydraulic riveter furnished an example of a machine in which the inertia of the parts was virtually that of 300 tons acting at the riveter-ram. To control such a mass, powerful brake action was necessary, and this was supplied by the automatic action of the friction of the water in the supply-pipe. The friction, while preventing the velocity becoming excessive in the early part of the stroke, when there was little resistance, diminished when the velocity was checked in closing the rivet, and allowed the development of a high effective pressure at the end of the stroke.

3. There were motors in which the head was allowed to take the form of energy of motion, and in which the water acted in virtue of its inertia. It was first necessary to consider in what ways this energy might be wasted. There was a waste of energy if the water broke up into eddies or irregular motions. Energy might be rejected from the machine into the tail-race; and lastly, energy was lost in friction against the surfaces of the machine. In a good motor the loss due to breaking-up could be almost completely avoided, if the passages changed gradually in section, if the surfaces had continuous curvature, and if the inclination of the receiving edges of the vanes was in the direction of relative motion. The loss due to rejection of energy could also be made very small, but by reducing this beyond a certain point, the loss from skin friction was increased.

The nature of a turbine would be best understood by considering first some simpler machines. In an ordinary undershot wheel, about 25 per cent. of energy was rejected into the tail-race, and about 25 per cent. was lost in shock, besides the losses due to shaft-friction and leakage. Suppose that instead of striking normally a flat float the water struck a hollow cup. Then both the losses in shock and in energy rejected were greatly reduced. An interesting motor of this kind has been introduced in California. Water power was there obtained from canals or ditches built to supply the mines, at elevations of from 1,000ft. to 3,000ft. above the valley. The fall was too great for an ordinary turbine, and a kind of undershot wheel with cup-shaped floats was used. Thus, at the Idaho mines, seven of these wheels were used, working to 320 h.p. The water was brought in a 22in. wrought-iron main, the head being 542ft. The water was delivered on to the wheels from nozzles $\frac{15}{16}$in. to $1\frac{15}{16}$in. in diameter. These wheels were said to give 80 per cent. efficiency, and in the special circumstances, where the jets were of small diameter under very high pressure, a high efficiency was probably obtainable. Such a wheel was the simplest form of an impulse turbine.

Next, consider a machine well-known at one time as the Scotch turbine. The water, entering the centre of the wheel, was discharged from tangential jets, and drove the wheel by reaction. The water issuing from the jets had a backward velocity, and energy was therefore rejected. It was the study of a wheel of this kind which led Fourneyron to the invention of the turbine. Fourneyron saw that the only way of reducing the backward velocity of discharge, and to prevent the waste of energy, was to give the water an initial forward velocity. The Fourneyron turbine was a reaction wheel in which initial forward velocity was given by fixed curved guide-blades. In the Fourneyron turbine, the water descending into the centre of the wheel issued radially outwards. Its greatest defect was the form of the regulating sluice, which diminished seriously the efficiency for diminished water-supply. It was followed by the Jonval turbine, in which the water flowed parallel to the axis, and by the inward flow turbine first perfected by Professor James Thomson. In the ample space outside an inward flow turbine, better regulating apparatus could be arranged than with any other form.

In all turbines as first constructed, the water issued from the guide-blades with a velocity less than that due to the head, and, therefore, there was a pressure in the clearance-space between the guide-blades and the wheel, and such turbines were called pressure turbines. Mr. Girard was the first to perceive the advantage of departing from Fourneyron's practice, and to allow the water to enter the wheel with the whole energy of motion due to the head. Such turbines were called impulse turbines. In pressure turbines the water must enter the whole circumference of the wheel simultaneously, and fill the wheel passages, or the pressure in the clearance space could not be maintained. Further, there must be a definite rate of flow through the wheel to maintain the distribution of pressure and velocity for which the turbine was designed. In impulse turbines each particle of water acted for and by itself; the wheel-passages were not filled, and the water might be shut off from any part of the wheel-circumference without affecting the action of the water. Regulation was, therefore, easier in impulse than in pressure turbines.

The consideration of the action of water in a turbine was facilitated by replacing the turbine-wheel by a turbine-rod, that was by supposing the turbine to have straight instead of circular motion. From such a rod, the transition to the case of a turbine-wheel by simple projection was easy. The water, entering vertically, was deflected by fixed guide-blades, till it had a horizontal velocity, $w_i$; it then entered the wheel, the vanes of which were so placed as to receive it without shock, and was deviated back to a vertical direction, having given up all its horizontal energy of motion. Hence, applying Newton's second law, $\frac{w_i}{g}$ was the horizontal pressure driving the wheel, due to each pound per second of water. But V being the velocity of the wheel, the work done on the wheel, $\frac{w_i V}{g}$ feet-pounds per second. Now the work might also be written $\eta$ H, where H was the effective fall, and $\eta$ the efficiency. Hence

$$\frac{w_i V}{g} = \eta H.$$

was the fundamental equation in designing a turbine.

There was one point in the action of a turbine which was unfavourable. The efficiency varied with the speed. There was a speed of maximum efficiency. But with pressure-turbines the speed of maximum efficiency diminished with the closing of the sluice. Now, in general, a turbine must be run at one speed. If it was run at the speed of greatest efficiency for a full sluice, then for a partially-closed sluice the efficiency was reduced both by the action of the sluice, and by the fact that the speed was not the best for that position of the sluice. In the mode of regulating turbines, great differences of efficiency arose. The worst mode of regulation was by a throttle-valve, which acted by destroying part of the head. Next to this, perhaps, the worst was the circular sluice, used with the Fourneyron turbine. Some modern turbines gave, in experiments which appeared to be reliable, much better results. The best mode of regulation for a pressure turbine was by means of movable guide-blades, invented by Professor James Thomson. In a Girard turbine the regulation was not so difficult, and results of an experiment carried out under the direction of Professor Zeuner, on a 200 h.p. Girard turbine, gave 79·5 per cent. efficiency with full sluice, and 80·1 per cent. with half-sluice.

## SCIENTIFIC SOCIETIES.

### ROYAL ASTRONOMICAL SOCIETY.

THE Society held a meeting on Friday, the 13th inst., at their rooms at Burlington House, Ed. Dunkin, Esq., F.R.S., President, in the chair.

Mr. Lecky stated that a few months ago a remark had been made at the Society to the effect that the manufacture of crown glass for optical purposes had practically ceased. He was glad to be able to state that Mons. Charles Feil, the son of the celebrated Paris maker of crown glass, had started business again, and we are now likely to have as large and as perfect discs of crown glass as formerly.

Mr. Downing read a paper on "Star Places in the *Nautical Almanac*." He said that in the *Nautical Almanac* for 1884 a change was made in the mean Right Ascension of 182 stars, whose places were derived from the Greenwich Nine-Year Catalogue. In looking over the Right Ascensions for these clock stars, he came to the conclusion that the average discordance was under five-hundredths of a second, there were 24 stars with a discrepancy of more than five-hundredths, and the average of their discordance only amounted to ·064 of a second. These discordances appeared to arise from inaccuracies in the proper motions which had been adopted. In the 1883 *Nautical Almanac* there would be 22 years' proper motion to be applied. The proper motions he had adopted had been taken from the values computed by Prof. Main and Mr. Stone, and by comparing Airy's earlier Greenwich observations with Bessel's reductions of Bradley's places. By applying these new proper motions the average discordance had been reduced from ·064 to ·042 of a second. This demonstrated the superiority of Prof. Auwers' proper motions, and showed the desirability of their adoption in this country.

Mr. Knobel read a paper by Prof. Oppolzer on "The Proposed Change in the Astronomical Day," advocating the adoption of universal time reckoning from midnight, and pointing out that little difficulty would be experienced in changing the heads of the columns of the *Nautical Almanac*.

The Astronomer Royal said that he had received a letter from Prof. Oppolzer stating that he was going to give practical effect to his views by adopting the new reckoning of time in a list he was now preparing of 8,000 solar and 5,200 lunar eclipses between B.C. 1207 and A.D. 2061. He felt very glad that Prof. Oppolzer had expressed his opinion so strongly, because at the Washington Conference there was no scientific Austrian delegate present, and the Austrian diplomatic delegate had abstained from voting. M. Struve, the director of the Pulkova Observatory, had recently written to him, stating that he was about to adopt the new time for internal use in the Pulkova Observatory, and suggesting that the change should not be made till 1890, by which time it could be adopted for the predictions of the *Nautical Almanac*, and other other national ephemerides, which are all published three or four years in advance.

Capt. Wharton said: I wish to remind the society that the Governments of the world print these almanacs chiefly for the use of sailors, and that their use by astronomers ought only to be a secondary consideration. If any change is to be made in the time to be used in the *Nautical Almanac*, it ought not to be made without very ample notice. A very large proportion of the ships of Great Britain are navigated by men who make their calculations entirely by rule of thumb, and who would be very easily confused by a change of twelve hours. I am, myself, in favour of the change; but think that it should not be made until some years have elapsed, and ample notice has been given to the educated sailor of what is about to be done.

General Strachey said: My having been present as one of the delegates of Great Britain at the Washington Conference entitles me to say a word on the subject. I think that we are bound, now that other nationalities have accepted our meridian, not to take any further steps without consulting the civilised world. It so happened that at the time the conference was sitting the change in the presidency of the United States took place, and the American Government has not yet taken any action on the report of the conference. No doubt before long some action will be taken either by the American Government, or some other of the governments which were represented. It will then rest with our Government to move, but it would not be decent for us, having pledged ourselves to consult with the rest of the civilised world, to take independent action; but no doubt that reserve on our part need not last beyond a reasonable time.

Mr. Spitta described an observation of a transit of Jupiter's fourth satellite. As it approached the centre of the disc it became black in colour, and assumed an oval shape, the longer axis of which was parallel to the belts.

Mr. Knobel said that he had observed the transit, and noticed that when it was first seen upon the disc it appeared as a bright spot. After five minutes it became slightly darker upon the disc, and after a quarter of an hour it seemed to be quite black; but it had appeared to him as a perfectly round black spot.

Mr. Ranyard asked whether Mr. Spitta had examined his observing eyepiece for the purpose of testing whether it was astigmatic with a vertical axis.

Mr. Spitta said he had carefully examined his own eyes, and he was not astigmatic. He had referred to several accounts of observations of transits of satellites, and had found that several observers had stated that the disc of the satellite when seen up on the body of the planet appeared not to be round. In some instances they described it as irregular, and even triangular in shape.

Mr. Common said that such appearances might possibly depend upon the instrument as well as upon the observer's eye. If the instrument made use of was a reflector, a little want of adjustment might make it appear elliptical.

The Earl of Crawford said: I was in hopes I should have had a comunication from Dr. Copeland, which I could have read at this meeting, describing an observation of a transit of one of the satellites made so near to the time of opposition that Dr. Copeland was able to observe the satellite occult its own shadow on the body of the planet. It was a very curious observation, as it showed that the sun, the earth, the satellite, and the part of Jupiter's disc occulted, must have been all in one straight line at the time, and as seen from the disc of Jupiter, the earth must have appeared to be transiting the disc of the sun.

Mr. Knobel read a note from Capt. W. Noble on the *Nautical Almanac* dimensions of the Saturnian system. The note was accompanied by some drawings illustrating the fact that the ball of the planet appears larger than it would appear according to the dimensions given in the *Nautical Almanac*.

Mr. Green said that he quite coincided with Capt. Noble as to the discrepancy in the *Nautical Almanac* dimensions. According to the proportions given in the *Nautical Almanac* the ball would not touch Cassini's division in the rings.

Mr. Stone said: I do not see Mr. Hind here, but I think that the matter has already been brought to his notice, and that he intends to make some changes in the measures of Saturn and its ring which have hitherto been adopted in the *Nautical Almanac*.

The Astronomer Royal read a paper on "Spectroscopic Observations of the Motions of Stars in the Line of Sight made at Greenwich during the Year 1884." The observations were made by Mr. Maunder and Mr. Nash with similar spectroscopic means to those which had formerly been employed an unusually large number of stars had been observed, 54 of which have been reobserved five times. The displacements have also been checked by observations of the planets. The displacement in the case of Venus does not agree very well; it is considerably larger. That for Mars is not far out—they are both right in direction. The displacement for the two limbs of Jupiter agrees very well with the computed displacement. It should be remembered, however, that the observations are subject to large discordances; but there are, nevertheless, some results which seem to be satisfactorily proved. Mr. Maunder has made 25 measures of the displacement of lines in the spectrum of Sirius on thirteen nights, and these give a mean motion of approach of 22 miles per second. This corresponds to the direction of motion which has been observed of late years; but it is opposite to the direction of motion which was deduced from the earlier Greenwich results and from the observations of Dr. Huggins. We have now a progressive change of motion from 25 miles per second of recession to 22 miles or so of approach. These observations have been carefully made at different times of the year, because it is possible to suppose that there might be a very rapid orbital motion of the star in a few months round some dark body in its neighbourhood; but in no instance has such very rapid motion been detected.

The Earl of Crawford said: I should like to know, before the meeting breaks up, whether any statement is to be made at the instance of the Council with reference to the request which has been signed by more than a hundred Fellows of the Society, asking that a change may be made in the by-laws, permitting voting by proxy.

The President said: I do not think that I have anything to communicate to this meeting. Lord Crawford will find that a resolution on the subject has been passed by the Council; but I have not been instructed to make any communication to this meeting on the subject.

The Earl of Crawford: Then I suppose the Council will not be surprised if, in the ordinary course of events, they receive a requisition to call a special general meeting to take the matter into consideration. I apprehend that there is a strong feeling amongst the Fellows of the Society who are non-residents in London, that they should have a voice in the management of the Society which at the present moment is denied them.

Mr. Common: May I be allowed to interpose, in the interests of order? In the first place, Lord Crawford is utterly wrong in moving in a question which relates to the alteration of by-laws of the Society at an ordinary meeting. In the second place, I think a great deal of misunderstanding might be removed if the President were to state the conclusion which the Council have arrived at to-day—it must come out sooner or later.

The Earl of Crawford: I am not moving any motion with regard to the alteration of the by-laws. I am simply asking what answer has been made to the Fellows who signed the request?

Mr. Beck: Would you allow me to inquire whether the constitution of the Society permits matters relating to the by-laws to be discussed at the evening meetings. I conceive that it does not, and as this matter relates to the by-law, it ought not to be referred to.

Mr. Stone: As this matter has been before the Council, they ought to be able to communicate the decision which has been come to.

The Astronomer Royal: I must protest against a meeting for scientific purposes being converted into a meeting for the discussion of by-laws. There is a great distinction between the ordinary meetings and special meetings, and I think we shall spoil the character of these meetings if we allow a discussion of this kind to be sprung upon us.

Mr. Beck: I conceive that it would be altogether out of order for the Council to give to this meeting any information with regard to the result they have arrived at. (Cries of "No.") As I understand it, the alteration of the by-laws rests with the meeting of the Fellows of the Society specially convened.

The Earl of Crawford: I am blamed by the Astronomer Royal for rising up in my place to inquire what information is going to be placed before us this evening. No harm can possibly be done by making the statement I have asked for, and if the statement is not made, the Fellows who have signed the request to the Council will lose a month, for they will not be able to prepare a requisition for a special meeting until they know the action that has been taken by the Council. If their notice is put off for a month, the special meeting is put off for two months, and that means to the end of the session, when the matter will be shelved.

Mr. Knobel: I do not know how Lord Crawford gets over the by-law which says that certain matters may be brought before ordinary meetings, "provided always that the same do not relate to the by-laws." The requisition which Lord Crawford refers to distinctly stated that it was a request to alter the by-laws. Therefore the subject he brings forward does relate to the by-laws, and how Lord Crawford can conceive he is in order, I am at a loss to understand.

Lord Crawford: I have not asked any question with regard to the by-laws, or attempted to move any motion with regard to their alteration. I have asked for information with regard to the business of the Society.

The President: I am quite prepared to read the resolution which has been come to, and I think that had better bring the discussion to a close. The Council has spent a considerable time to-day over the question, and they have discussed it with great fairness, and the conclusion they have come to is as follows:

"That the signatories to the request to the Council to take steps for altering the by-laws so as to permit Fellows unable to be present at the annual meeting to vote by proxy, be informed that the Council do not propose to recommend such a change. The Council, however, are of opinion that to enable all Fellows who cannot attend the Annual General Meeting to vote for the election of officers and Council by post under suitable precautions, might fitly form the subject for discussion at a special general meeting of the Fellows."

The Earl of Crawford: Will you kindly inform me how I can put myself in order in moving an amendment to that resolution?

The President: By getting five Fellows to sign a requisition to the Council to call a special meeting for such and such a purpose. That will be laid before the Council at their next meeting, and they will give the usual notice, and it will be considered after the May meeting.

The meeting adjourned at ten o'clock.

## ROYAL MICROSCOPICAL SOCIETY.

THE sixth meeting of the session was held on the 11th inst., at King's College, Strand, W.C., the President, the Rev. Dr. Dallinger, F.R.S., in the chair.

Hardy's Collecting Bottle with Improved Stopper.—Mr. Crisp said that, while it was not usual to look a gift horse in the mouth, it was necessary to warn microscopists against the use of Mr. Curties' so-called improvement, which consisted in substituting for the original indiarubber stopper a rectangular one of glass, which was greased in order to make it water-tight. The nuisance in the field of a collecting bottle with a greased stopper was sufficiently obvious.

Mr. Hardy disclaimed any responsibility for the change that had been made.

Mr. Crisp exhibited (1) Winkel's Class Microscope with movable stage, (2) Tolles' Clinical Microscope, (3) Siebert's Portable Microscope, and (4) Swift's Microscope for Examination of Disease in Skin of Sheep, and having a very long working distance, (5) Griffiths and Bertrand's Objective Adapters, and (6) a new form of "Finder."

Mr. H. G. Madan exhibited some new kinds of glass. He found that a combination of ordinary blue glass with a peculiar bluish-green glass, known as "signal-green" glass, was much more convenient than the usual glass cell filled with solution of cuprammonium sulphate. Glass coloured with cobalt absorbs most of the rays of medium refrangibility, but transmits, besides blue rays, a portion of the red rays in the neighbourhood of Fraünhofer's line A. The "signal-green" glass (so called from its being used for railway signal lamps) is remarkably opaque to red and yellow rays, and hence if a piece of it is superposed on cobalt blue glass, the only light transmitted by both is that which lies between Fraünhofer's lines F and G, constituting a beam at any rate not less homogeneous than that transmitted by cuprammonium sulphate. In cases where the double thickness of glass may be an inconvenience, as in discs for stage diaphragms, a plate of "flashed" blue glass may be cemented, flashed side downwards, upon the signal-green glass, and then the whole of the colourless part of the blue glass can be ground away, leaving only the coloured film upon the signal green, and thus forming a plate hardly thicker than the latter alone.

Mr. Baker exhibited some object boxes in book form for placing on a shelf with books, the objects then lying flat.

Dr. C. V. Zenger's letter was read, describing a new mounting medium, consisting of tribromide of arsenic in bisulphide of carbon, and giving a refractive index of from 1·6696 to 1·7082. An improved slide for viewing the object on both sides was also described.

Mr. C. H. Hughes' description was read of a stage for use with high powers, to prevent the decentring of the condenser, especially when used with immersion contact. Vertical, horizontal, and oblique motions are given to the slide while the stage remains stationary, but can be rotated.

Mr. E. M. Nelson exhibited a drawing of *Bacillus subtilis* made with Dr. Beale's neutral-tint reflector and a 1-12in. oil-immersion objective.

The President remarked upon the unusual appearance of the object, which was represented as a series of beads without any connecting tissue, instead of a tube with possible spores within.

Mr. Nelson explained that being mounted in balsam the tube would most likely become obliterated. His main object was to show the flagellæ.

Mr. J. Mayall, jun., described the original ruling machine of the late Herr F. A. Nobert (now the property of Mr. Crisp), which was exhibited to the meeting. He said he should not enter minutely into the details of the construction, as they could hardly be understood without a close inspection of the machine, many portions of which were too delicate and complex to be handed round to the meeting. The foundation of the machine was a dividing engine calculated to produce parallel divisions far finer than could be marked by any ruling point yet discovered. The division-plate had 20 circles of "dots," and these were supplemented by extremely fine graduations on two bands of silver imbedded near the edge, which were viewed by means of two compound microscopes, each provided with eyepiece screw-micrometers of special construction. The movement of rotation was effected by a fine tangent screw acting upon a worm on the vertical edge of the division-plate. The tangent screw was controlled by a large milled head about 4in. in diameter, and a graduated drum showed the amount of motion. The method employed by Herr Nobert for obtaining the minute divisions of his test-plates (ranging from $\frac{1}{1000}$th to $\frac{1}{20000}$th of a Paris line) was to convert the radius of the division-plate into a lever to move the glass plate on which the rulings were made at right angles to the motion of the ruling point. For this purpose, he attached to the centre of the rotating division-plate a bent arm on which slided a bar of silver, having at one end a finely-polished steel point which could be adjusted by a scale and vernier so as to project more or less beyond the centre of the division-plate or axis of rotation. The radius of the division-plate thus became the long arm of the lever, whilst the radius of the projection of the polished steel point beyond the axis of rotation formed the short arm, the centre of the division-plate being the fulcrum. The motion of the short arm of the lever was communicated by contact with an agate plate to a polished steel cylinder adjusted to slide at right angles to the movement of the ruling point in V-shaped bearings of agate. The steel cylinder carried a circular metal table on which the glass plate to be ruled was fixed by wax and clamps. The motion of the lever arms was, of course, in arc, and hence the divisions would not be strictly equidistant unless compensation were made for the difference in length of the arc and its sine; but since the actual space included between the first and last lines of Herr Nobert's test-plates hardly exceeded 1-50th inch, this difference would be inappreciable. The arrangement for carrying the diamond point was, he believed, wholly designed by Herr Nobert, and was a most ingenious combination of mechanism—not "ingenious" in the sense often alluded to by Mr. Crisp, which generally meant both complicated and useless, but in the sense of combining inventiveness and efficiency. The questions to be solved were (1) To provide means to adjust a diamond edge to any angle (within required limits); (2) to balance it truly so that the weight-pressure for ruling might be perfectly controlled; (3) to raise and lower it strictly in one plane—that is to say, mechanically free from lateral play, so that the consecutive divisions of the ruling depended solely on the motion imparted to the glass plate by the dividing engine; (4) to cause the diamond to oscillate freely in one plane; (5) to control the length of the lines to be ruled; (6) to connect the whole with mechanism to insure an even rate of speed in the ruling movement of the diamond. These matters had been worked out by Herr Nobert with extraordinary perseverance, as evidenced by the elaboration of the adjustments. From the point of view of so accomplished a mechanician as Dr. Hugo Schröder—to whom he (Mr. Mayall) must publicly express his obligations for explanations connected with the machine—the design of this portion of the machine might be much simplified without loss of accuracy or delicacy of action. In particular Dr. Schröder noted that the whole of the movements might be made to act automatically, whereas Herr Nobert went through the process of adjusting the dividing engine and winding up the train of wheels for each line ruled on his test-plates—a labour demanding prodigious patience. It should be observed, however, that Herr Nobert had always to work with very limited means. The success of his efforts must be estimated by those who were familiar with his ruled plates, and who had compared them with others. For the production of diffraction gratings and ordinary micrometers, where the equidistance of the lines was an essential factor, and where the breadth of space covered by the lines was so large that the lever motion in arc of the dividing engine would have introduced errors in the evenness of the division, Herr Nobert removed the bent arm from the centre of the division plate and substituted a vertical cylinder, on which he coiled an extremely thin flat steel spring having a hook at the free end; this hook was attached to a stud beneath a straight cylinder of polished steel, which carried the glass plate to be ruled under the diamond, and which took the place of the more delicate arrangement for the test plates. The rotation of the division-plate caused the vertical cylinder in the centre to rotate, coiling the steel spring, and thus, after the manner of a windlass, hauled along the diffraction-plate carrier at right angles to the ruling motion of the diamond. Presumably Herr Nobert used the stud and "dots" of the division-plate to divide the diffraction plates and micrometers, for the verification of 12,000 consecutive divisions (of which some of his diffraction gratings consisted) by means of the microscope, would have been too much for even his patience. Mr. Mayall then referred briefly to the preparation of the glass plates for the rulings, which he said were of specially "mild" composition. He believed that Herr Nobert's earlier rulings were upon artificially prepared surfaces on the slips themselves, and that later on (about 1860) he came to the conclusion that the melted surface of cover-glass was better for his test-plates. Subsequently Dr. Schröder instructed him in a method of polishing the "mild" glass, which induced him to revert to artificial surfaces again. The later test-plates were probably all ruled on the prepared "mild" glass, thinned down to suit high-power objectives. Mr. Mayall said he must defer his remarks on the diamond points till the next meeting; he mentioned that the ten diamonds that accompanied the machine presented varieties of preparation. Some had two worked surfaces brought to a knife edge; others one worked surface and one surface of fracture meeting in a knife edge; others had two surfaces of fracture meeting in a knife edge. By reference to Herr Nobert's memorandum book, Mr. Mayall said he hoped to be able to explain the character of the diamonds which were noted upon as being successful. In conclusion, Mr. Mayall said it was abundantly proved by Herr Nobert's work that the perfection of the mechanical part of the dividing engine was not the only difficulty which he had understood and conquered. There was a still greater difficulty which he had understood, and which he had met with a success that gave him pre-eminence in this department of micro-physics, and that was the preparation of the diamond ruling points.

The President expressed the thanks of the meeting to Mr. Mayall for his description of a machine which exhibited such an immense amount of commendable ingenuity in its construction. He thought it must be a source of gratification to the society to know that as the machine now belonged to Mr. Crisp, they might hope at some future time to hear more about it, and to see something of its performances.

Mr. Beck said that a paper upon this machine, giving all the details of its construction with illustrations, would be extremely interesting, and he hoped that Mr. Mayall would not only describe its perfections, but would also point out all its weak points, which were sometimes even more interesting and instructive, as showing the manner in which the inventor had been able by practice to overcome them. He remembered that many years ago the micrometer ruling machine by Mr. Jackson produced in his hands some of the best work of its kind that had then been seen; but when after his death it passed into other hands, some of the worst productions resulted. Mr. Jackson had, no doubt, found out all its weak points, and had overcome them by the exercise of his own manipulative skill; and it would be very interesting to know how Nobert had got over all his difficulties, so as to be able to produce bands of lines which stood altogether unrivalled.

Mr. Crisp said that Mr. Mayall had kindly undertaken to describe and illustrate the machine in a future number of the *Journal*.

Mr. Mayall said that on looking over Herr Nobert's memoranda, he found that in ruling his 30-band plate, after satisfying himself that the diamond point was in order, his next care was to ascertain exactly what weight was required to give the necessary pressure, and no more. The memoranda showed that he began the first band of lines with a weight of 30 grammes, and reduced the weight for each successive band until he arrived at about 3 grammes for the highest band.

Dr. Matthews inquired if there was any provision made for dropping the point upon the plate on commencing a line?

Mr. Mayall said this seemed to be one of the weak points of the machine, for it would be seen, on examination of the test plates, that there was frequently a small fracture at the beginning of a line, and that at the end of it there was a slight hook-shaped irregularity. A very delicate arrangement had been devised for causing the point to be lifted automatically; but the shock produced by the sudden arrest of motion was translated on the end of each line by a hook.

Mr. C. Beck exhibited a modification of the "Complete" lamp, fitted with a shallow glass reservoir instead of the original one of metal. It was thought this alteration would tend to prevent condensation or "sweating" of the paraffin upon the surface. He also exhibited a "Vertical Illuminator," with a new form of diaphragm.

Dr. Van Heurck's note was received sending a copy of Prof. Abbe's opinion on the photographs of the "beads" of Amphipleura pellucida, in which he stated that he had no reason to doubt the reality of the beads.

Mr. Crisp said there was one very curious misapprehension in connection with this diatom discussion. Dr. Flögel, it would be remembered, inveighed somewhat strongly against Prof. Abbe's theory, which he considered to be antagonistic to his researches. The fact was, however, that Prof. Abbe had always considered Dr. Flögel's methods of investigation as the only proper and rational ones in regard to diatom striæ, and his own theoretical views strongly confirmed this.

Dr. J. D. Cox's note was read as to actinic and visual foci. Statements have recently been made that with modern undercorrected microscopic objectives there is no difference between these foci, and that no allowance need therefore be made in focussing. Dr. Cox, while finding this correct for the generality of objects, remarks that it does not apply when large amplifications are in question. When powers of 1,500 and 1,600 are used for photo-micrography, there is a distinct difference between the two foci, and it is, therefore, still necessary to give particular attention to the focussing in order to obtain sharp photographs.

Mr. J. Kitton's remarks on Balsam of Tolu were read as follows:—It is stated in the February number of the *Journal* that this medium is objectionable for mounting purposes, as crystals are apt to form in it sooner or later. I tried it shortly after reading Dr. Kain's recommendation (early in September last) and have now over one hundred preparations in this medium. In February I went through them with some trepidation, but was gratified to find that no symptom of crystallisation had appeared. This I should have attributed to the short time that had elapsed since the preparation had been made, had it not been stated that recent preparations (made about the same time as mine) are already full of crystals. I can only account for this by supposing that either Tolu is variable in its composition, or that my method of preparing and using it prevents crystallisation. Dr. Kain recommends alcohol or chloroform as solvents; I employ benzole. I remember some years ago inquiries were made as to the cause of crystals sometimes occurring in preparations made with balsam or dammar dissolved in chloroform: as I never found them in my own preparations made with pure balsam I attribute them to the chloroform. Shortly after I began using Tolu a correspondent informed me that some of his slides were spoilt by a kind of crystallisation, which he described as being like a delicate cobweb. Having noticed a similar appearance in balsamed slides that had been overheated and in consequence the balsam had become brittle, I have sometimes seen the formation of it when cleaning off the superfluous balsam. A sudden change of temperature, such as the heat of the hand, will produce it. The appearance is caused by innumerable fissures permeating the film of balsam. Tolu, if hardened too much, will, no doubt, act in the same manner. Tolu being of slightly higher refractive index than Styrax is useful for many forms, and I hope that the defect may be remedied either by the use of benzole or by making the Tolu less hard.

Dr. G. D. Brown's letter was read as follows:—In the current No. of the *Journal*, in a review of Mr. Busk's "Report on the *Challenger* Polyzoa," it is stated that the use of the chitinous element as an aid in the classification and descriptive geology of the Polyzoa is entirely due to Mr. Busk. Allow me to call attention to Mr. Busk's first mention of the subject—viz, in the *Journal* of the Linnean Society, Zoology, Vol. XV. (1881), p. 357. In this paper he adopts and develops the facts corroborating the opinion of the importance of these organs in this connection; but he himself states that he is indebted for the suggestion to a paper by Mr. A. W. Waters in the *Proceedings* of the Literary and Philosophical Association of Manchester, 1878.

Mr. Crisp said that undoubtedly Mr. Waters should have the credit of priority as acknowledged by Mr. Busk. The review in question, however, was written by so eminent an authority (Prof. Allman) that it had been printed without the thought that any correction could be required.

Dr. Ord exhibited and described some objects illustrating the erosion of the surface of glass when exposed to the action of carbonate of lime and a colloid. From experiments made by Mr. George Rainy, it seemed that when lime was deposited upon glass in the presence of a colloid, the globule it formed adhered so firmly as to require removal by means of an acid. After this it was seen that the surface of the glass was dimmed, and microscopical examination showed that this was due to the presence of numerous little pits, which evidently corresponded to the points of adhesion of the globules, although no chemical substance capable of eroding glass had been employed. Further experiments by the speaker were detailed, showing that he had caused lime to be so deposited by mixing carbonate of potash and chloride of lime in solutions of gum, albu-

-men, glycerin, and gelatin, and that in each case, except that of gelatin, the dimming of the glass from the same cause had been observed. Some slips of ivory and mother o' pearl were also eroded in the same way by the glycerin solution, and it was inferred from this that the substances mentioned had been eroded by purely molecular action. The observation, it was considered, offered an explanation of the effects of boring sponges upon shell and rock, as well as of the phenomena of the similar removal of shell and bone in the process of their remoulding.

The president thought that Dr. Ord's communication was one of remarkable interest which appeared to open up a new matter for promising investigation, and which he hoped Dr. Ord *himself* would develop at greater length in a form for publication.

Mr. J. Charters White mentioned, as bearing upon the subject, the molecular disturbance which took place on the surface of glass in the case of photographic negatives.

Dr. Matthews said there were certain kinds of glass which appeared to undergo spontaneous decomposition; this was particularly noticed in the case of the very old glass found in tombs and causing the iridescence.

Mr. G. D. Brown said that a somewhat similar effect had been observed in the case of old glass in windows; particularly those which faced the south-west.

Prof. Stewart thought that the disintegration of glass which was the cause of the colours referred to, belonged to a different category, as indicated by Sir David Brewster in a paper which he published upon the subject. In examining decomposed glass the primitive surface might be frequently observed to be broken up into concentric films, frequently following definite lines. When this layer breaks off it leaves the surface pitted with spheroidal depressions. There were, he thought, some difficulties to meet in endeavouring to account for all the phenomena by molecular movement, as, for instance, in the case of *Hydractinia arborescens*, where a film of chitin separated the protoplasm of the organism from the incrusted shell. As regarded the boring powers of certain sponges and the removal of lime, he thought that the suggestion of Dr. Ord was very likely to be correct, and that the movement of the heavy molecules of the colloids might, sledge-hammer-like, increase the motion of the molecules of the body acted upon, and finally produce the observed effects.

Mr. Cheshire thought that there was a curious mathematical side to this question as bearing upon the velocity imparted by the stroke between the heavy molecule of the colloid and the lighter molecule of the lime.

Dr. Ord replied to the remarks that had been made, and exhibited a specimen and also enlarged diagrams of a spheroidal calculus of uric acid, found in the kidney of a patient, surrounded by a layer of a chitinoid nature, and showing extensive erosion of the uric-acid nucleus by its colloid investment.

Prof. Stewart mentioned a case of the peculiarly resistent substance of oxalate of lime calculi being similarly eroded.

Mr. J. W. Stephenson read his paper "On a New Catadioptric Illuminator," having an aperture exceeding that of any existing objective—or equal to 1·644 N.A. in flint glass, and 1·512 N.A. in crown glass. The subject was illustrated by diagrams and by the exhibition of the apparatus.

The President thought that all who were in the habit of using high-angled lenses would feel indebted to Mr. Stephenson for giving his attention to this subject, which was one of great practical interest in these days of extended research on micro-organisms. He regarded as of special practical value the power of obtaining black ground illumination with objectives of the largest aperture.

Mr. Cheshire and Mr. Cheyne's paper "On the Pathogenic History of a New Bacillus (*B. alvei*)" was introduced by Mr. Cheshire, who said that attention had been called to a very serious disease which had prevailed amongst hive bees, attacking the larvæ to so great an extent that in some instances whole stocks had been exterminated. The disease was known as "foul brood," from the disagreeable smell which came from the affected hives, and from the idea that it was confined to the larval state. On careful investigation, however, it appeared that the disease was due to a bacillus, and that the bees themselves, including the queen, suffered from it. It was very satisfactory to be able to announce that they had discovered that the disease yielded very readily to treatment, which consisted in feeding the larvæ with a syrup containing 1-600 per cent. of phenol.

Mr. Cheyne followed with a detailed explanation of the methods adopted in tracing out the life-history of the *Bacillus*, and exhibited in illustration a series of tubes and bottles in which its propagation had been carried on. It was not possible to rely upon the shape as determining whether the *Bacillus* was a new form or not, but the completion of a series of experiments and observations enabled him to say that this was a new form, and that it was really the cause of the disease. It had been named *Bacillus alvei*.

Mr. Dowdeswell regarded this communication as one of great interest, and especially remarked upon the fact that this was the only instance he had heard of in which the virus of the disease had been taken in with the food instead of being communicated by inoculation. He felt that they were greatly indebted to Mr. Cheyne for so clearly demonstrating the methods employed for the observation of the development of the organism.

Mr. Crisp said that that was not the only claim which Mr. Cheyne had upon their admiration, as it would be remembered that it was he who had organised the Biological Laboratory at the Health Exhibition, which had proved so great a success.

The President expressed his regret that the hour was so late as to preclude the possibility of further discussion on the paper, in which there were many points of exceptional interest.

Mr. Fowke read a paper "On the First Discovery of the Comma Bacillus of Cholera," illustrating his remarks by photographs and drawings. He showed that the bacillus was known and recognised 35 years ago by two Englishmen, Messrs. Brittain and Swayne.

Mr. Maddox pointed out that it was by the breaking up of the rings discovered by the original observers that the so-called "comma" bacilli were formed.

The President announced that the second conversazione will be held on April 22nd. Sixteen new Fellows were proposed and elected.

## LIVERPOOL ASTRONOMICAL SOCIETY.

THE sixth meeting of the session was held on March 9th, the president occupying the chair. A paper by Dr. Klein was read on the dark spots between Copernicus and Gambart. These spots were only visible under a high illumination, and had, up to the present time, remained an enigma to the observer. Schmidt had reported on them in his work on the moon; but he did not include them in his map, because they were of too evanescent a character, and being only visible when the sun attained a high altitude, and, of course, when the true shadows had departed. They were traversed in every direction by rays, and it was almost impossible to determine their exact positions. Schmidt had, however, always been anxious that their mystery should be solved, and he had urgently commended a close study of their appearances and positions. For a more exact knowledge of the physical nature of the moon, the discovery of the true nature of these spots was of the greatest importance. Respecting his own observations, which had been already reported, he had not been able, during a considerable number of years, to perceive anything that would tend to a decisive conclusion as to the real nature of these formations; but, after many vain efforts, he had been able, only last January, to fix the positions of a number of these spots, so that their identity under high illumination could not leave any uncertainty.

The region E. of Copernicus showed numerous dark and frequently isolated hills, from about 328 English feet in height down to the finest spots, which had the appearance under a high power of isolated masses of rock, and which were only visible under the most favourable circumstances. Quite different was it on the W. and brighter part. There the number of the smallest craters, whose diameter could not exceed 500ft., was quite enormous; the minute craters between Copernicus and Eratosthenes appearing of great size by comparison. On January 25, 1885, he was induced by the wonderful clearness and tranquility of the air to scrutinise them very carefully. At this time the remarkable crater, indicated by Schmidt as *m*, had already shown its grey nimbus very distinctly, and the whole area towards Gambart C appeared perforated, like a sieve, with the smallest craters. He had been observing a faint dark streak which appeared to be sweeping over that region from S.W. to N.E., when, at 7h. 3m. p.m., there suddenly came forth a small black spot at the S. border. It appeared in the region where numerous craters of the very smallest kind exist, but could not be identified with one of them, and it certainly had not been visible a quarter of an hour earlier.

Mr. W. S. Franks, F.R.A.S., was glad to see that Mr. Gage was taking up star colours, which, he thought, was an interesting but neglected branch of astronomy. Ever since the time of Sir W. Herschel the colours of *double* stars had been carefully registered to the almost utter exclusion of naked eye stars which did not happen to have *comites*. The Rev. T. W. Webb was, he believed, the first to call attention to the colours of single as well as of associated stars, and it was by his advice that he had made some observations of the colours of nearly all the naked eye stars visible in these latitudes between 1877 and 1878. He intended, probably next winter, to form a new catalogue of star colours, and proposed that the objects should be simultaneously observed.

The president said Dr. Copeland, of Dun Echt, had been kind enough to call his attention to the occultation of Jupiter's II. satellite by its own shadow on the night of February 19th. The evening, which began exceedingly clear, had, however, turned foggy later on, and he missed the most important part of the observation. He presented a list of 32 red stars, which, so far as he was aware, were not included in Birmingham's or any other red star catalogue. Several of them had been discovered by photography. In the zone at present being photographed, the great nebula in Andromeda occurs. The nebula appears much more sharply defined on the *p.* side, and several dots appear on the negative *s. p.* the nucleus, which are probably additional stars; though the difficulty of determining which were stars and which were specks on the plate was very considerable, and it was quite possible that some of the stars entered in the drawing would turn out not to be stars at all. On the *s.f.* side of the nebula a star of 6·5 mag. is buried in the nebulosity, which seemed more diffused at this part, the north being very sharp. The limits of the nebula, as laid down by Argelander, and those on the negative agreed very fairly, with the exception of the *s p.* portion, which seemed to be less in the photo. than in the telescope. The nebula was, no doubt, deficient in photographic light; whilst the Orion nebula, on the contrary, very quickly penetrated the sensitive film. The equivalent star magnitude of the centre of the nebula varied in Pickering's photometer from 6·1, on the 17th of September last to 4·8 on the 5th November, whilst the photographic magnitudes of both these periods was 8·3.

Prof. Piazzi Smyth, Astronomer Royal for Scotland, described some interesting phenomena attending the disappearance of Aldebaran at the last occultation. At 5 p.m., the moon being high, up in the sky, and with the star close outside its dark limb, formed a very pretty but faint group in the little telescope, for the sun was still shining. Unfortunately the air, although quite free from actual cloud, was so full of illuminated coal smoke as to quite conceal any trace of the dark limb whereat the star was to be presently occulted. Presently, while he was still earnestly looking, the star disappeared, so suddenly and completely that he called to his assistant "mark," with the utmost confidence, though, fortunately, without taking his eye from the telescope. Almost immediately he saw the star again for 2·6 seconds, when it disappeared once more, and this time finally. As to the heretical feature of seeing two immersions of the star, he gave it simply as it occurred; though he would have had more confidence in its being a reliable observation if the dark limb had, at the time, been visible, or if the telescope had been larger and under the protection of the dome on so gusty and inclement a night.

In submitting a voluminous report from the planetary section on Saturn, Mr. W. S. Franks said few prefatory remarks were needed. He had issued a circular last October directing the attention of the members to such salient features as might be best studied during the then approaching and unusually favourable opposition. Thirty-eight sketches of the planet were given in, accompanied by careful notes by the observers, who included the Revs. S. H. Saxby, T. Perkins, J. Bone, and Messrs. J. M. Offord, G. T. Davis, S. M. B. Gemmill, J. Ellis, E. Miller, and A. F. Miller, of Toronto.

Mr. R. G. Leigh described an observation of the dark transit of Jupiter's IV. satellite. At 10 o'clock on the night of the 27th February the satellite was well on the disc of Jupiter, and just below the S. belt. It appeared in his 6½in. Calver equatoreal as a conspicuous dark spot of a dark brown or chocolate colour, many shades darker than the belt, which was of a light reddish hue. When the shadow immerged the contrast in colour was very apparent, the satellite being still of the same tint, whilst the shadow was almost black.

Mr. R. C. Johnson, F.R.A.S., in observing the same transit through one of Cooke's 7in. refractors, had been particularly struck with the dark colour of the satellite. It could, in fact, only be distinguished from its shadow by its smaller size and the position it occupied on the face of Jupiter. Five large photographs were presented to the society by Mr. A. A. Common, and a monograph of the Orion nebula by Mr. W. S. Franks. A unanimous vote of thanks was accorded to the donors. Eleven gentlemen were elected members, and 11 candidates were proposed.

THE American production of Bessemer steel last year amounted to 1,538,355 tons, being a decline of 116,272 tons from the figures for the previous year. The American production of rails was 1,140,932 tons.

As far as can be at present estimated, there were about 3,572,155 tons of pig iron made in Germany last year.

# SCIENTIFIC NEWS.

WE learn from Dun Echt Circular No. 93 that M. Raoul Gautier, of Geneva, has communicated some interesting particulars respecting the return of Tempel's periodic comet 1867 II. It appears from M. Gautier's calculations that the disturbing action of Jupiter, in the interval 1879 to 1885, will retard the comet's approach to the sun by 148 days, besides considerably enlarging the orbit while decreasing its eccentricity. As the comet will not approach the earth within one and a half times the distance of the sun, it is doubtful if it will become visible even in the most powerful telescopes. The following ephemeris gives its calculated place for Berlin midnight (11·6 G.M.T.):

| | R.A. | N. Dec. |
|---|---|---|
| March 21·5 | 12h. 5m. 12s. | 18° 28·4′ |
| April 10·5 | 11h. 49m. 24s. | 18° 57 7′ |

M. Borrelly, of Marseilles, discovered another minor planet on the evening of the 13th inst. Its position at 9.7 on that evening was R.A. 11h. 6m. 13s., N. Dec. 7° 9′ 17″. This is the thirteenth minor planet discovered by M. Borrelly, and, according to the *Times*, is the first discovery amongst these bodies during the present year. If so, it will reckon as No. 245; but we believe that Mr. Pogson, at Madras, discovered the first this year, whilst searching for Isis on the 6th of February.

Observers in the West of England will have a chance of observing the occultation of Aldebaran on March 21, as it will have an altitude of 4½°.

The Royal Society of New South Wales offers prizes for the best communication on each of the following subjects, by way of encouraging original research: — The Anatomy and Life-history of the Echidna and Platypus; the Anatomy and Life-history of Mollusca peculiar to Australia; and the Chemical Composition of the Products from the so-called Kerosene Shale of New South Wales. The communications must be sent in not later than May 1, 1885, and provided it is of sufficient merit, the best on each subject will be awarded the society's medal and £25. The subjects for 1886 are: — On the Chemistry of the Australian Gums and Resins; on the Tin Deposits of New South Wales; on the Iron Deposits of New South Wales; and List of the Marine Fauna of Port Jackson, with descriptive Notes as to Habits, Distribution, &c. The subjects for 1887 are:—On the Silver Ore Deposits of New South Wales; Origin and Mode of Occurrence of Gold-bearing Veins and of the Associated Minerals; Influence of the Australian Climate in producing Modifications of Diseases; and On the Infusoria peculiar to Australia. For each subject the prize is £25 and the Society's medal, and the communications must be addressed to the hon. secs. at the Society's house, Elizabeth-street, Sydney, and reach them not later than May 1 in each year. The Society is fully sensible that the money value of the prize will not repay an investigator; but it hopes that the honour will be regarded as a sufficient inducement and reward. The competition is open to all, but a prize will not be awarded to a successful competitor should he happen to be a member of the Council. Communications to be successful must be either wholly or in part the result of original observation or research on the part of the contributor.

The Minister of Education in France has appointed a commission to report on the opportuneness of extending the decimal system to astronomical distances and time.

A plan for the transmission of the mails between Paris and London by the pneumatic process, devised by a M. Berlin, is attracting considerable attention. The pneumatic tubes or subway would be laid down along side the existing railways for convenience sake. The total distance between the two capitals is 475 kilometres (295 miles)—viz., Paris to Calais (rail), 184·5 miles; Calais to Dover (Channel), 24·2 miles; and Dover to London (rail), 86·3 miles. The pneumatic subway would be constructed of cast-iron pipes of 15·3in. in diameter and 13ft. lengths, connected by means of indiarubber joints. This arrangement is claimed by the inventor as giving great flexibility and elasticity to the whole, and of making it water-tight besides. The carriage suggested is composed of a wire frame covered by a sheet of asbestos cloth with a metallic warp. This covering would have a kind of metallic brush coating, to enable the compressed air to dilate to a certain extent around the truck and cool the latter, thus counteracting the heat produced by the friction. The truck would travel the distance between the two capitals in one hour, and a truck could be despatched every ten minutes. An engine of from 20 to 30 horse-power would be sufficient to produce the required vacuum.

"F.R.S.," writing to the *Times* in reference to a recent colliery disaster, expresses astonishment at the neglect of owners to avail themselves of the simple means which science places in their hands for enabling explorers to carry out their humane work with comparatively little danger from suffocation by the deadly afterdamp. Mr. Lindsay's plan for placing iron nails in the mouth is practically valueless, as the quantity of carbonic acid gas thus absorbed is inappreciable; but a respirator filled with cotton-wool and slaked lime or caustic soda, or. better still, a cylinder filled with the same material carried on the back with a flexible breathing tube and mouthpiece, will enable an explorer to remain for some time in an atmosphere charged with choke-damp which would be at once fatal if inspired directly.

A Skrivanow battery, which is contained within two small boxes 10in. long, 8in. wide, and 6in. high, is said to be capable of supplying an arc lamp of 600 c.p., or 75 small incandescent lamps. It is the chloride of silver form of the Skrivanow battery, and a large number of cells can be put into a small compass. Extraordinary statements about this battery may be expected, and one of the electrical periodicals warns local authorities to "consider what is being done to provide at far less than the cost of gas a more brilliant and beautiful illuminant."

Prof. Ayrton having been appointed to the chair of Physics at the Central Institution of the City and Guilds of London Institute, Prof. Silvanus P. Thompson has succeeded him as principal and professor of physics at the Finsbury College.

Dr. Venable contributes a paper to the American Chemical Society, in which he shows that spring water which had passed through 200 yards of galvanised iron pipe took up 4·29 grains of zinc carbonate per gallon. The French Ministry of Marine prohibited the use of galvanised-iron tanks on board men-of-war some time ago; but they are extensively used in this country, and so are zinc-lined cisterns. It would be interesting to learn how much zinc is contained in our cistern water.

Prof. Charles E. Munroe reports in the *Journal* of the American Chemical Society a case of spontaneous decomposition of "explosive gelatine." The liability of this substance to decomposition cannot be too widely known, as it is now largely used for blasting purposes.

An electrical exhibition will be held in the galleries of the Paris Observatory, under the auspices of the Société Internationale des Electriciens. It will be inaugurated on the 21st inst. by M. Grévy, president of the Republic.

The photographic work is being successfully continued at the Paris Observatory by MM. Paul and Prosper Henry. One of their latest productions is a fine photograph of the cluster in Perseus, showing the stars down to the 13th magnitude. The negative was obtained in 50 minutes with a 6·3in. object-glass of 83in. focal length; it has been enlarged four times, and reproduced by helio-engraving. These copies are on a scale of 5in. to a degree, and contain 509 stars.

**Soluble Glass.**—To apply soluble glass for the preservation of porous materials, take a solution of silicate of potash of 35° Baumé, dilute it with twice its weight of water, paint with a brush or inject with a pump, give several coats. The *Pottery and Glassware Reporter* says:—"Experience has shown that three coats applied on three successive days are sufficient to preserve the materials indefinitely, at a cost of about 15 cents per square yard. When applied upon old materials, it is necessary to wash them thoroughly with water. The degree of concentration of the solutions to be used varies with the materials. For hard stones, such as sand and freestones, rock, &c., the solution should mark 7° to 9° Baumé; for soft stones with coarse grit, 5° to 7°; for calcareous stones of soft texture, 6° to 7°. The last coating should always be applied with a more dilute solution of 3° to 4° only."

# LETTERS TO THE EDITOR.

*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

*All Cheques and Post-office Orders to be made payable to* J. PASSMORE EDWARDS.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

## THE TOTAL SOLAR ECLIPSE IN SEPTEMBER, 1885.

[23950.]—So many inquiries have been addressed to me recently by readers of the ENGLISH MECHANIC resident in New Zealand, and so much interest appears to be taken in reference to the forthcoming eclipse of the sun, the central line of which passes through that colony, that I have thought it worth while to compute the circumstances for various places mentioned below by the partially graphic method which I have recently devised, and which is so admirably adapted for the purpose. A *total* solar eclipse is a rare and unique phenomenon in England; such an event has not occurred for many generations, and many generations more must occupy our places before there will be an opportunity of witnessing such a spectacle. The inhabitants of New Zealand may therefore congratulate themselves that they are permitted to behold a sight which the oldest inhabitant of the mother country has been precluded from seeing, and it is to be hoped that some useful additions to our knowledge in regard to the constitution of the sun, its chromosphere and corona, may be the outcome of the observations which scientific people at the Antipodes may make on this auspicious occasion.

I proceed, then, to give the following as the times and angles which mark the course of this eclipse at different places:—

At Wellington, lat. 41deg. 20min. South, geographic; long. 11h. 39min. East.

| | h. | m. | s. | |
|---|---|---|---|---|
| The eclipse begins at | 18 | 40 | 15 | Mean astronomical time at Wellington. |
| ,, middle ,, | 19 | 44 | 45 | |
| ,, ends ,, | 20 | 56 | 20 | |

Duration of totality, 1min. 53sec.

Angle from vertex at beginning, 50deg. towards West.

Angle from vertex at ending, 107deg. towards East.
For direct image.

At this place the eclipse is *total.*

At Castle Point, lat. 40deg. 54min. South, geographic; long., 11 hours 44min. 56sec. East.

| | h. | m. | s. | |
|---|---|---|---|---|
| The eclipse begins at | 18 | 45 | 47 | Mean astronomical time at Castle Point. |
| ,, middle ,, | 19 | 52 | 0 | |
| ,, ends ,, | 21 | 2 | ·0 | |

Duration of totality, 1min. 58sec.

Angle from vertex at beginning, 62deg. towards West.

Angle from vertex at ending, 106deg. towards East.
For direct image.

At this place, also, the eclipse is *total.*

At Masterton, which is not very remote from Castle Point, the eclipse begins at 18 hours 44min., and ends 21 hours 0min. Castle Point mean astronomical time. The eclipse will be total, and the angles the same as those at Castle Point (nearly). The time of commencement and end of totality may be computed by subtracting and adding the semi-duration of totality from and to the time of the middle.

At Napier, lat. 39deg. 30min. South, geographic; long. 11h. 48min. East.

| | h. | m. | s. | |
|---|---|---|---|---|
| The eclipse begins at | 18 | 47 | 20 | Mean astronomical time at Napier. |
| ,, ,, middle ,, | 19 | 54 | 50 | |
| ,, ,, ends ,, | 21 | 5 | 40 | |

Magnitude = 0·98—i.e., 98 parts of 100.

Angle from vertex at beginning 58deg. towards West.

Angle from vertex at ending 105deg. towards East.

For direct image.

At this place a thin rim of the solar disc will be seen on the *upper* part of it.

At Dunedin, lat. 45deg., 50min. South, geographic; long. 11h. 22min. East.

| | h. | m. | s. | |
|---|---|---|---|---|
| The eclipse begins at | 18 | 30 | 40 | Mean astronomical time at Dunedin. |
| ,, middle ,, | 19 | 35 | 20 | |
| ,, ends ,, | 20 | 42 | 20 | |

Magnitude = 0·94—i.e., 94 parts out of 100.

Angle from vertex at beginning 67deg. towards West.

Angle from vertex at ending 109deg. towards East.

For direct image.

At this place a thin rim of the solar disc will be seen on the *lower part* of it.

The inhabitants of Australia will only see this eclipse as a very partial one, and the only place for which I have obtained results is Sydney. The mists and fogs of the rising sun will, most probably, prevent any distinct vision of it; but it will be interesting to see the sun emerge out of the ocean, partially eclipsed, with considerably more than half of the *lower* part of his globe hidden, or rather *cut out* by the disc of the moon, if the weather should prove favourable. Twenty minutes, however, will have elapsed beyond the time of greatest phase at the instant of sunrise.

At Sydney, lat. 33deg. 51min. 41sec. South, geographic; long. 10h. 4m. 51s. East.

| | h. | m. | s. | |
|---|---|---|---|---|
| The eclipse begins at | 16 | 57 | 20 | Mean astronomical time at Sydney. |
| ,, middle at | 17 | 50 | 0 | |
| ,, ends at | 18 | 51 | 0 | |

The sun rises at 18h. 10m., and the magnitude at greatest phase, which, of course, will be invisible, will be 0·85, or 85 parts out of 100.

Angle from vertex at beginning 40deg. towards W.

,, ,, ,, ending 142deg. ,, E.

For direct image.

**James Pearson, M.A., F.R.A.S.**

Fleetwood Vicarage, March 12.

## BESSEL.

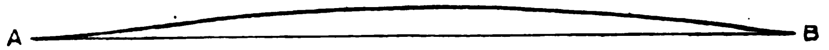
[23951.]—THE question of the shadow of Bessel being double-peaked was discussed some time ago, and in the *Astronomical Register* for January, 1884, there is a paper by Mr. T. Gwyn Elger on the subject. It may be worth recording that on February 20, 1885, 8h. to 9h. 15m., I saw it with two considerable peaks, the crater being full of shadow and the terminator on Eudoxos. The edge of the shadow was somewhat ragged, and it was rather broader on the sonthern wall of Bessel than on the northern. Its shortest length, half-way between the peaks, was about half the diameter of the crater. As it grew shorter it still preserved the two peaks, and was thus seen up to 9h. 15m. I made two sketches, one at 8h. 25m. the other at 9h. 15m. I have now seen Mr. Birt's sketch which led to the discussion, and which was also made at morning illumination with the terminator on Eudoxos. The other sketches mentioned were, I believe, made at sunset. My sketch does not show the horns so long as they are in Mr. Birt's, or the hollow between them so deep. **M. A.**

## OCCULTATION OF ALDEBARAN.

[23952.]—THE disappearance at the occultation of Aldebaran on February 22 was not seen, owing to clouds, but a few minutes before the reappearance they cleared away, leaving the moon perfectly clear in a blue sky. The moon was crisp and bright, though at moments there was a little passing mist. The edge was rippling gently at first, but scarcely at all when the star appeared. Its appearance was very sudden, and its progress till its final clearance from the limb very rapid. The first thing seen was half of two diffraction rings, which suddenly sprang into view; in about two seconds more the star itself appeared equally suddenly, and in six or eight seconds more it was perfectly clear from the limb. When the star itself appeared two wings started into view from it, and remained until it was quite clear from the limb. Then it assumed its ordinary appearance, with the diffraction rings surrounding it equally on all sides. When the star first appeared it was a very deep crimson. I believe this crimson hue was also visible on the two rings that preceded it, and that it became much more intense as the star appeared; but whether it was on the rings as well as the star I am not quite sure—the star came into view so rapidly after the rings, and the first impression was of an intense crimson. A few seconds after, before the star was quite clear, I think there was a shade of green; but, if so, it was but slight. **M. A.**

## JUPITER—DARK TRANSIT OF SATELLITE III.

[23953.]—WE have at last been favoured with some remarkably fine observing weather. The prevailing wind has been from the east, and during it, as I find frequently to be the case here, definition has been very good. Several changes have taken place in the markings of Jupiter since last season: the great south belt seems to me rather paler in colour, and the great north belt somewhat darker. The outline of the Great Red Spot is still very plainly visible with my 8½in. Calver as a pale red oval line; it is preceded in the same latitude by a small dusky grey spot, and is followed at an interval of about 1¾ hour by a dark crimson streak, which is followed after 1¼ hour by a small crimson spot, and this again by another somewhat longer. These three last lie just within the southern edge of the great south belt. About 3½ hours before the Great Red Spot reaches the central meridian, a dusky patch a little north of the Equator crosses the c.m. Several brilliant spots are to be seen in the Equatorial regions, and a long wavy bright streak in the South Polar regions.



On March 13, on going to the telescope at 19h. 30m. to make a drawing, I noticed a round grey spot, just within the north edge of the great North red belt. This I suspected to be a Satellite, as it was not dark enough for a shadow. On reference to the *Nautical Almanac* my suspicions were confirmed, as I found that III. was in transit. Thin clouds scudding before a high wind, at times blotted out Jupiter, but I saw the Satellite whenever the sky was clear until 22h. 10m., when clouds came up, and when they passed off at 22h. 25m. I could no longer detect the Satellite, which, however, at 22h. 30m. was seen bright as it approached the limb. The shadow of III. came on at 21h. 9m. and looked perfectly black, the Satellite all the time being dark grey, and not black.

Shaftesbury. **Thomas Perkins, M.A.**

## SATURN.

[23954.]—TO-NIGHT, during exceedingly fine air, I was surprised to see (with 800 on the 10in. dialyte) a perfectly sharp, fine, black line, in place of Encke's division on the outer ring. I was unprepared for, and not looking for this line, so that there was no mistaking the appearance which was seen in both ansæ, and nearly all round the ring.

I am very glad to have this to add to my former remarks, and it would seem, in conjunction with my late observations of the bright inner edge of the outer ring, which was absent on this occasion, to favour the theory of variability. The night, however, was exceedingly fine.

**Herbert Ingall.**

Champion-hill, S.E., March 14.

## "A PLEA FOR GOOD MANNERS."

[23955.]—I HAVE read Mr. Ledger's letter in your issue of March 6th, and heartily concur with him in his wish to see personalities avoided, and a more serious tone adopted in criticising the grave evils of endowment hunting. I am fully willing to acknowledge differences of taste as to what is dignified and proper language to use in a scientific periodical, and to own that Clerk-Maxwell and De Morgan and other men of great weight have indulged a curious sense of the ludicrous without injuring their usefulness. But in an uphill battle, such as those who oppose the endowment party are attempting to fight, it seems to me that one cannot adopt too serious and Parliamentary a tone.

In remonstrating recently with a friend who feels quite as I do about the injury to science which is caused by the search after endowment, but who allows his indignation frequently to find vent in strong and not always dignified language, he replied to me: "I wonder how far Lord Randolph Churchill would have secured a hearing if he had adhered to the polite phrases you recommend?" My friend seemed to hold that we had arrived at an age when only slang will arrest attention. I do not agree with him. I think that, whatever may be his audience, an earnest man will always arrest attention, and his opinions will in time be examined. If he has a difficult case to argue, where the self-interest of his hearers is thwarted—and it may be presumed that at first they will be against him—he is likely to lose ground by using a single word which his opponents can take exception to. They will devote their time to criticising his language rather than to answering his arguments; and he will find that a large proportion of his hearers are so weak, that they will be led to believe that making an undignified joke is a crime, while helping a job is not. **A. C. Ranyard.**

## VIOLINS.

[23956.]—IN replying further to "Orderic Vital" (23916), I may add that excellency in violins is not confined to any special form of arching or outline, or to any exact thickness of wood, although it is now definitely known between what extremes of thickness success may be looked for. It may, however, be stated generally that the high model, by which is understood an elevation of more than about ⅝in. in the back and belly, conduces to a sweet and mellow tone without much power; and in the best instruments of this class there is often found a quality of tone more or less wanting in the majority of flat models. Some of the violins of Steiner are so high as to appear quite "tubby," and the tone is described by Davidson as being pure and liquid, but not powerful, which renders them particularly well adapted for use as chamber instruments. The makers who followed the Amatis, the chief of whom was Stradivarius, gradually found out that the flat model was the best for the production of an intense, deep, full, and broad tone, and that the curvature should be gentle and easy, and free from any abrupt elevation. Violins of a flat model are often found to possess power at the expense of quality. The most renowned makers combined these two desiderata with more less success; but to Stradivarius belongs the honour of having combined in the highest degree all the different qualities which can be desired in a violin. His finest instruments are described by Davidson as "possessing the following esteemed qualities: delicacy, mellowness, free power, penetrating brilliancy, and roundness of tone." The character of the curves vary very much in the high models, but in the finest Strads they are gentle and harmonious with an elevation of about ½in. The accompanying sketch is reduced from a full-sized working drawing of a Strad of the most finished elegance in a recent work, entitled "Violin Making, as it Was and Is," by Edward Heron-Allen. The curve is that of the belly lengthwise, and it will be noticed that there is rather more dip at the neck end, A, than at the tail, B. It is, however, difficult in a reduced drawing to catch the exact character of a curve which cannot be drawn with compasses.

The difficult question as to what constitutes the superiority of one violin over another remains yet to be solved. It cannot altogether be in form and workmanship; otherwise copies would more frequently be equal to the originals. One of the most important points (if not *the* most important) is, undoubtedly, the quality of the wood. We know that old makers paid great attention to this, and that sometimes they only used wood cut from the south side of the tree. Many of the Cremona fiddles have pieces added on to the widest part of the back, in order to utilise wood of good quality, which would otherwise have been too narrow. The climate of Italy may also be specially suitable for the seasoning of the wood. We have heard a good deal lately about the Italianising of the human voice by breathing artificial Italian air. Possibly we may next hear of the Italianising of wood for fiddle makers! It is now well known that violins made from wood artificially seasoned by heating or steaming, are, in the long run, a complete failure. Another most important point is the suitability of the back and belly to each other. Each may be good in themselves, but when unsuitably mated (like human beings) discord, instead of harmony, prevails. Every piece of wood gives out some note, and it has been found that there is a difference of about one note between the back and belly of those of Strad.'s best fiddles which have been dissected. It has also been found that the mass of air in the best instruments of Strad. and Guarnerius gives a note of 572 vibrations in a second. There is, however, no evidence that these and similar theories were known to the old makers. There is considerable difference of opinion as to the theoretical knowledge which they possessed. There are the *premeditation* and the *consequential* theories. The author of "How to Choose a Violin" states the following facts in favour of the latter: "That the Cremona neck was shorter than at present; that the standard of pitch was much lower; that, therefore, the tension of the strings and general pressure was much less; that the old instruments well bear the additions of long necks, thicker strings, and much increased strain; that, being strong enough to do so now, they must originally have been much too strong in proportion to the then existing strain to produce the best tone; and that the makers consequently could not have known the full capabilities of their instruments, as they did not realise the amount of strain they would be brought to bear." It should be clearly understood that fiddle making is as much an art as it is a science, and the old makers were artists in the true sense of the word. While some give them credit for a theoretical knowledge more complete than that possessed by any of their successors, there are others who think, as I am inclined to do, that their knowledge of mathematics and acoustics was of a very limited description, but that they combined perfect workmanship with a correct judgment in the selection of wood acoustically good; that they were able to tell intuitively by an artistic eye and touch, and perhaps by some rough and ready experiments, the suitability of bellies and backs to each other; that they were able by the same means to adjust the thickness to suit the varying qualities of the wood and the curvature of the instrument; that, having found out that a low model, with a gentle and flowing curvature, gave the best results, they then in all other matters simply strove to please the artistic eye. It is related of Turner, the painter, that, on first reading some of Ruskin's elaborate criticisms of his works, he said: "That man puts thoughts into my head that I never had before." Possibly the old Cremona makers might make a similar remark could they read some of the learned theories on the construction of their instruments. Sometimes a cheap and roughly-made fiddle turns out to be very good, but not often. Scarcely any manufactured article varies so much in price as the fiddle, ranging as it does from 2s. 6d. to £1,000. The following extract from Mr. Heron-Allen's book is interesting, as showing the actual cost to the manufacturer of the common shop-window fiddles, which are sold at prices varying from 10s. to 30s.: "The manufactories at Mirecourt turn out many thousands of crude 'noise boxes' annually, labelled, as a rule, "Antonius Stradivarius," "Joseph Guarnerius," &c. These are extraordinary for their quantity and cheapness. M. Gallay, in his report on the Vienna Exhibition, noticing the establishments of Thibouville-Lamy (who have a London house in Charterhouse-street), quotes, as follows, the actual cost of the manufacture of one of these fiddles: Wood for back 2d., wood for belly 2d., manufacture of same 1½d., wood for neck ½d., making same 1½d., finger-board (stained) 2d., cutting 1½d., moulding back and belly 12½d., varnish 10d., fitting-up, strings, tail-piece, bridge, &c., 7½d.; total 4s. 2d. M. Gallay goes on to say that he heard such a fiddle as this, chosen from a number of similar ones and carefully mounted and strung and played, the tone and results obtained from which, at a concert in Vienna, were most satisfactory."

**A Country Parson.**

## VIOLINS.

[23957.]—I FIND a great improvement in the tone of my violin by rubbing the strings once or twice a week with neatsfoot oil. I put my first finger to the neck of the bottle containing the oil, and rub the strings over from tail-piece to nut, until all the strings are moistened. I generally do it when I have done playing for the night; and the next time I require the instrument I wipe the strings before commencing. Some of "Ours" please try it and report results. I have tried other oils, but never found them make the same improvement.

**T. R. S.**

## A NEW METHOD OF FORMING CRYSTALS BY PLAITING.

[23958.]—YOUR report of a meeting of the Liverpool Science Students' Association on page 7 reminds me that a new process of plaiting is lying idle on the table of the inventor of the pupil-photometer, which I described in your last volume, and this process is lying unused because publishers do not care to publish a new book on crystallography while the study of that science is confined to so few.

After a careful analysis of the zones of the primitive forms of mineral crystals, Mr. Gorham has discovered that models of all may be formed by calling in the aid of the ordinary plait of three or four fillets.

Fig. 1 represents the ordinary plait of three fillets. In this we notice that the fillet A passes twice over B and twice under C; the fillet B passes twice under A and twice over C; the fillet C passes twice over A and twice under B.

Having noticed how the fillets intersect, we unravel them, mark them with the same numbers, and arrange the fillet C at right angles to the other two (Fig. 2). The mark – before a number implies that in plaiting that number goes under the same number which has not the minus sign. Plaiting according to the way indicated we get a *cube*.

Having by this simple process formed a cube, it is to see that the process may be extended to any form having the same number of faces, edges, and solid angles; and, further, the process may be extended to forms having 8, 12, or 24 faces.

Now take a plait (similar to Fig. 1) of four fillets, and going through the same process we get Fig. 3. The plans 11 and 12 are repeated to get starting-points and to lock the plates. We obtain a second cube, and from these two cubes we may obtain the primitive crystalline forms. I will now mention a few of these forms, and reserve a few of the more complex for another letter, if the Editor will be kind enough to insert it for me.

*Cube.*—Bounded by six square faces—

$$\angle \text{ of inclination of faces} = 90^\circ$$

$$\therefore \text{plane of } \angle a \text{ of faces} = 90^\circ$$

The cube is an intermediate form betweeen the obtuse and acute rhombohedrons A formula, which enables us to find the plane ∠ *a* of a cube when ∠ of inclination of lanes A is given, enables us to find the plane ∠ *a* of any rhombohedron.:

We have—

$$\frac{1}{2\sin.\frac{A}{2}} = \cos.\frac{a}{2}$$

But—

$$A = 90^\circ;\ \tfrac{1}{2}A = 45^\circ$$

$$\angle \sin.\frac{A}{2} = 9{\cdot}849485$$

$$\therefore \angle \frac{1}{2\sin.\frac{A}{2}} = 9{\cdot}849485$$

$$\therefore \angle \cos.\frac{a}{2} = 9\ 849485$$

$$\therefore \frac{a}{2} = 45^\circ$$

$$\therefore a = 90^\circ$$

*Right square prism*, bounded by four oblong and two square faces.

L of inclination of faces = 90°
Plane angles = 90°

Six planes, twelve edges, eight solid angles.

To obtain this, therefore, we alter Fig. 2 into Fig. 4, and plait according to the indications.

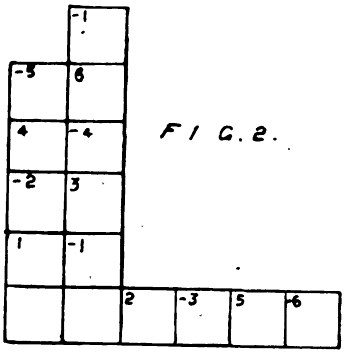


FIG. 2.

FIG. 1

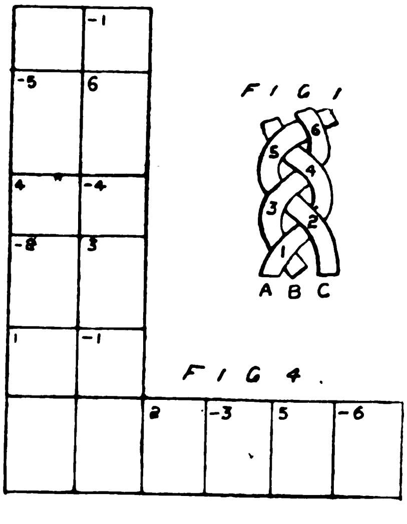


FIG. 4.

I have no doubt that from this imperfect description many readers of the "E. M." will be able to understand a portion of what I mean. As Mr. Gorham has kindly placed his manuscript in my hands, I shall be able to extend this letter in future communications. But as a figure will be necessary with most of the forms I mention, I will endeavour only to mention typical forms. By far the best material for making the models of is glazed cambric, and I do not hesitate to say that any reader will find the time he may spend in making the models well repaid by the beauty of the result. The diagrams inclosed are not very accurately drawn ones; but I hope they will be sufficient to convey an idea of my meaning.

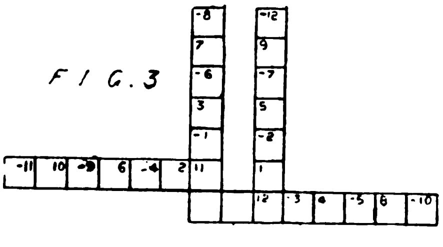


FIG. 3

Park House, Tonbridge. **E. A. Tindall.**

## LATHE MATTERS.

[23959.]—MR. WENHAM (23946) may assume that which I do not say; but it is rather an anomaly on his part to state that the best makers true up their mandrels by means of diamond tools, and afterwards that there is no need for such a process, because they can be hardened perfectly true.

I have not personally attempted to harden a mandrel for many years; but I have old and tried workmen whom I taught myself, and as I pass their lathes it is a pleasure to observe how beautifully true to the eye a new mandrel will appear on its first trial after being hardened; but the application of the finger nail destroys this illusion, and although by many it is possible this would be considered near enough, it has to pass the ordeal I have previously mentioned to come out with that degree of perfection which it has always been my study to obtain.

If Mr. Wenham has indeed "made mandrels innumerable, from the heaviest to the smallest," it is very remarkable that he should give such directions as he does for the hardening of our traversing lathe mandrels. When brought to book for the address of "some of our best lathe makers who now prefer to true up their hardened steel mandrels by a diamond splinter," it is remarkable again that Mr. Wenham evades the question.

We all know that it is possible to use a diamond for such a purpose; but the diamond so frequently breaks or gets loose, and the cut taken is so small, that no one would think of using it when a 2s. 6d. emery wheel answers every purpose quickly, safely, and cheaply.

As "Vulcan" has also pointed out, Mr. Wenham is altogether wrong in imagining that a revolving V-cutter or V-lap wheel produces a distorted thread—there is no difference between a thread so produced and that of an angular tool in the slide-rest; but there is this great advantage—that the fixed point tool does not produce a cut of its own full angle unless it is centred exactly and put in on a true radius of the cylinder which is being screwed; with the revolving cutter the cut is always upon the line of centres, and therefore cannot go wrong. This is why, in modern steel standard taps and other tools, the revolving grinder has been adopted.

Mr. Wenham is, as "Vulcan" explains, all wrong, because he imagines the contact between a revolving cutter or grinding wheel to be a surface. The contact is a line not a surface, and the convexities of the angular spiral thread and of the cutting wheel cause them to abundantly clear each other as the cylinder revolves; the case is not, in fact, the same as that which he argues from.

Mr. Wenham's remarks upon the model mandrel are equally at fault; it is well established that a screw cannot be used to centre accurately with: if such an accurate screw were made the first bruise on the end of the mandrel would spoil it. Dr. Edmunds intentionally leaves his screw rather loose, and makes the cylinder base produce the centring and prevent eccentric variation: the width of the face is necessary to prevent angular variation; but, of course, for less perfect interchangeability, a face zone of smaller diameter might be used. This is a mere question of degree, as has already been shown by other writers besides

Griffin Works, Norwich. **Edward Hines.**

## LAMINATED ARMATURES.

[23959*.]—I IMAGINE that the laminated armature condemned so strongly by Mr. Chaster in his article upon "Electromotors" is the one described by me on page 136, Vol. XL., of the ENGLISH MECHANIC. In that case, I may state that it in no way resembles Mr. Jones's patent laminated H-armature, nor are either of the types of armature a "clumsy imitation of a Siemens."

I am not surprised to read that the armature was difficult to wind, and that sufficient wire could not be wound upon it, as I am well aware that successful winding of armatures is only obtained by long practice, and it is of rare occurrence that an amateur electrician makes a good job of his first two or three armatures. The fact that the strips of iron became loose, and so destroyed the insulation of the coils, is only to be attributed to neglect in not properly tightening the nut upon the spindle, such strips of iron requiring at least 1in. of compression before the armature can be safely tight, and then it is a moral impossibility for the discs to shift during rotation.

It is evident to all practical electricians that the old solid H-armature contains too much iron either for a motor or generator, and, therefore, the reduction of the mass of metal by lamination has a three-fold advantage, in that it provides an increased surface in actual contact with the air, so keeping the coils and core perfectly cool; also that such lamination prevents to a great extent the circulation of Foucault or "eddy" currents," and thereby increases the efficiency of the machine, while in the Jones's patent armature exactly the same amount of wire may be wound upon the core as on the same size of solid H-form.

**Fredk. Walker.**

## THE FUTURE OCCULTATIONS OF ALDEBARAN

[23960.]—A reference to the *Nautical Almanac* of the present year shows that eleven occultations of Aldebaran take place in 1885; and out of this number four are recorded as being visible at Greenwich. Much attention having been bestowed on that which occurred on Feb. 22, it is probable that many observers will await with interest the succeeding one, which is set down for March 21. It is to be feared, however, that any expectations in reference to this phenomenon will end in disappointment. The moon will be sinking too low in the west at the time of immersion, whilst at the time of emersion the star will have actually set. In any case, the fogs and mists of the horizon will seriously interfere with any accurate observation. It commences at 11h. 43m. p.m., and ends at 12h. 32m. a.m., as seen at Greenwich. The occultation on April 17 will be wholly invisible in Great Britain and Ireland. None will take place in May or June; but there is one which takes place on July 8, to which I desire to call the attention of amateurs. It occurs in the *daytime*—in fact, almost at noon, and for that reason, I suppose, no details of it are given in the *Nautical Almanac*; but to those who take pleasure in daylight observations this occultation will be both instructive and interesting. At the time of its occurrence the moon will be twenty-five days old, a small waning crescent, but still distinctly visible in the field of any common telescope, and Aldebaran will also be plainly perceived by the same means before disappearing behind the moon's bright limb. The immersion takes place on July 8, at 23h. 23m. 26s. astronomical reckoning; in other words, on July 9, at 23m. 26s. past 11 o'clock in the morning civil time. The emersion takes place in the afternoon at 15m. 16s. past noon. The Angle from Vertex at immersion is 83deg., and at emersion 351deg., reckoned towards the right hand in an inverting telescope: and the least distance of the centres is 10·5′. Such are the details of the phenomenon, and if the weather be favourable the observation will afford as much pleasure as any occultation observed at night. The moon will be declining towards the west at an hour angle of 2h. 4m. at immersion, and of 2h. 56m. at emersion. The occultation of Aug. 5, may give pleasure in other climes in the opposite hemisphere, but not in ours. In September, however, fresh opportunities are afforded. That which occurs on Sept. 1 is described at length in the *Nautical Almanac*, although the immersion alone is visible, and that, too, at the untimely hour of 20 minutes before 2 o'clock in the morning. There is another occultation, however, on Sept. 29, which deserves, I think, some recognition in our national ephemeris, even though it also takes place in the daytime, and so I will proceed to give some particulars of it. At the time of immersion—viz., 33min. 9sec. past 8 o'clock on the morning of that day, the moon will be declining towards the west at an hour-angle of 4h. 37m., her age being 20 days, or six days past full. The emersion takes place at 19m. 54s. past nine the same morning, the least distance of the centres being 10·0′. The angle from the vertex at immersion will be 175°, and at emersion 273°, the angles being reckoned as before. October brings no favourable occultation, but on Nov. 22, at 9h. 48m., the star will immerge behind the moon, reappearing again at 10h. 57m. This is the last of the season, and is described in the *Almanac*; but what I wish to observe is, that as far as amateur astonomers are concerned, the *daylight occultations* of July 8 and Sept. 29 are quite equal in interest and importance, and are quite as favourably circumstanced for observation as those of which the particulars have been more fully calculated by others, as I have done these for Greenwich.

**James Pearson, M.A., F.R.A.S.**

Fleetwood, March 9.

## THE NEW TIME.

[23961.]—I cannot agree with Mr. Hopkins, p. 36, that it is a matter of "considerable uncertainty" whether or not the "new time" will ever become part and parcel of our everyday life. It is a long fly from here to "ever"; but at present I have not been able to discover a single valid reason why the change should be introduced, though I can quite understand that for records of meteorological and astronomical observations, including time-tables and the *Nautical Almanac*, there is an obvious advantage in using a day of twenty-four hours. It is not easy to make a change, but before the public is asked to talk about "Come to dinner at 18 sharp," I think the astronomers might be requested to use at least a natural day, and commence a new one at midnight instead of noon. That may be advisable, but I think it is tolerably certain that the public generally will still divide the day into two halves of 12 hours each. In what way would railway time-tables be "less liable to confuse" if the abbreviations a.m. and p.m. were rendered unnecessary? The "masses" do not consult time-tables, and what sort of people are they who are "confused" now. On p. 367 of the last volume I asked "Is there any hour in the whole round at which a mistake could be made" in connection with the ordinary purposes of life? and I am still waiting for an answer. I suppose Mr. Hopkins did not see Sir E. Beckett's letter in the *Times* of Feb. 2nd, and I will, therefore, ask you to preserve some portions of it in these columns for the benefit of those who still appear to think that every change is an improvement. Says Sir Edmund: "I have asked everybody who has proposed such scheme to me what he thinks will be the good of it. I have never yet got anything in the shape of a practical answer except that it 'will save so much trouble and prevent so many mistakes in doing Bradshaw.' Will it? I answer. Have you ever considered whether four figures in a Bradshaw column, such as 12.45 (which is the way they are printed) are nicer to read and less liable to mistakes than 2.45 or a space equivalent to the spot, which would become 14.45? To that I have never got an affirmative reply, and of course not to the further question whether they have considered how many more figures the whole of Bradshaw will have to hold when all the most working hours of the day—i.e., from 1 till 9 p.m., will want four figures instead of three. There is practically no confusion between the "mrn." and "aft." of Bradshaw, and they occupy no space that could be saved or used otherwise. I have been looking for a page in which one could make a mistake without gross carelessness, and I cannot find one, though I do not profess to have examined every one. It occurs to me, however, that time-tables might well adopt 0 instead of 12 for either noon or midnight, by agreement, which would catch the eye still more.

"It is, no doubt a curable difficulty by Act of Parliament, like the permissive use of that French blunder which Sir J. Herschel always wrote against, the metric system, founded moreover on a wrong measure of the earth's axis, but there is no such legal time in England at present as anything beyond 12 o'clock. Scientific men may indulge in the affectation of millimètres and kilomètres and kilogrammes, and imagine that anybody realises those fantastic designations of lengths and weights except themselves, if they do. But we cannot have two kinds of time going at the same time. And so for the purpose of considering practical results we must take it that all public and most private clocks are to be reconstructed to show and to sound up to 24 o'clock! Have people considered what that means?"

After some remarks about the striking of the hours and the pointing of the divisions on the dials, Sir Edmund proceeds:—

"And what is the basis of all this nonsense? Simply the priggish notion that it is the scientific and correct thing to do, whether anybody wants it or not; and that it is going to be the fashion and therefore we must adopt it at once. Who does want it? The paragraphs sent to you and other newspapers go on asserting the absolute fiction that the astronomers at the 'Prime Meridian Conference' want it. If they did it would not signify a farthing unless they could show us what real good it is to do. But they never said a word of the kind. It is true that our new astronomer at Greenwich wrote something about 'the public meeting him half-way' when he set back Sir G. Airy's Greenwich gate 24-hour clock, which astronomers always note their observations by, to its new zero at midnight of last 31st of December instead of noon on the 1st of January. But what reason is that for our reconstructing all our clocks and half of our language about time? The celestials altered their zero for their own convenience and good reasons. Twenty-four hours still suit them best, only with our zero instead of their old one. Twelve suit us terrestrials best for a multitude of reasons; and for once the reasons are absolutely all one way, which seldom happens. And one alteration is greater infinitely than the other. Noon is in itself a substantial and real physical epoch for reckoning our hours from, though it is not so good a one as the dead interval between two working days to reckon days from. It is altogether a confusion of those two ideas to have a time running through the great epoch of the day and treating it like any of the more arbitrary divisions, such as 11 or 1 o'clock."

"The watchmakers are bewildered to know whether they should put their XXIV. at the handle, or 'pendant' (as we call it at the Horological Institute) or leave the XII. there and turn the XXIV. upside down. I can only give the well-known answer, 'which you please, my little dear;' there is no wrong nor right in such a matter, except that either is absurd and wrong, and will never be got into use. People talk boldly and largely about some other countries using it. But I also hear that they do not really use it. Not that I care if they do. That does not make it a bit more convenient than it is. That will not make 300 strokes a day of Big Ben or the clocks on our stairs as easy to strike or to count as 156; nor enable any human being to tell what o'clock it is by a mere glance at the position of the hands; nor any human mind to realise as rapidly the effect of 20 o'clock as of 8 o'clock; nor do any single thing for us that the old reckoning and the old machinery does not do better."

I think there is one addition needed—the watchmakers are no longer "bewildered"; those firms who went in for 24-hour watches find that after the first "rush" they don't sell at all, and look much like becoming dead stock; but, now, after all this, I hope if any one has a word to say in favour of the change, he will give some reason for it, and not deal in vague notions that it would prove a great advantage, and be a more "scientific method of dividing the day."

**Nun. Dor.**

## HINTS ON MAKING COLD CHISELS.

[23962.]—Of all the quackery in the workshop there is none to compare with the so-called "secrets" of hardening and tempering. Many smiths have a secret welding powder, the composition of which they would not disclose for less than a fortune; but welding fluxes are not in it with solutions for hardening. It is annoying, though, when somebody rather more intelligent than the average mystery-holder comes along and hardens a chisel or what-not in plain water just as well as can be done by the man with the "secret"—the possession of which has given him all the pre-eminence he is entitled to hold in the shop. The following remarks I saw recently in an American paper, and they appeared to me to be so much to the purpose, that I cut them out and posted them up in our shop for the benefit of all who would care to read. I send them to you in order that they may be criticised by those who are competent for the task. The writer says:—"I have seen smiths heat a drill or chisel for about ⅝in., and then strike 300lb. blows to draw the steel, just back of the hot place. It causes terrible strains in the chisel, and if a fire crack comes in and about half the width of the chisel breaks off, they pitch it into the scrap heap, or tail-race, and cuss the man that made 'that poor steel.' Everybody writes in the papers against heating steel too hot, or 'burning it,' but half the trouble with cold chisels is caused by too little heat. Heat steel as hot as it will bear, and work it while hot. If you wish to work ¾in. of the end of a chisel, do the heating back of where you intend to hammer. Heat 1¼in. of the tool. It takes a trifle longer, but you can work it much better. It will hold the heat and work easy. Don't try to temper a chisel with the remains of the forging heat. Use a fresh heat for tempering, and heat enough to harden. Leave all tempering 'medicines' for somebody else; if you cannot get a temper with good fire and water, you have mistaken your vocation, and had better try some other track. When tempering cold chisels, or any other steel articles, heat to a very dull red and rub with a piece of hard soap, then finish heating, and harden in clear, cool water. The soap prevents the oxygen of the atmosphere from uniting with the steel and forming rust or black oxide of iron. The article will need no polishing to enable the colours to be seen. Never 'upset' a cold chisel. It is sure death to the steel. Make chisels short for hard, rough work. They transmit the power or force of a blow much better. Long chisels are apt to 'broom up' on the hammer end, as the long steel through which the blow passes has more chance to absorb the force of the blow. The harder the metal to be worked, the quicker the blow should be transmitted. Cast iron works much better with a short steel chisel and light hammer than if the blow was struck upon a very long chisel with a heavy wooden mallet. In one case the blow is delivered 'all at once,' in the other it takes time, and much of the force is absorbed.

"If the head of a chisel 'brooms up,' don't forge it into shape again, but grind off the steel that curls over. Never harden the hammer end of a chisel. It is a nasty trick. The first thing you know a piece of steel will fly and strike your hand. It will cut where it hits, no matter whether it strikes hand, face, or eye. Keep the chisels nicely ground. One end needs grinding as much as the other.

"We cannot tell what 'colour to draw to' when tempering. We don't know, neither does anybody else, until he has worked the steel. If it works easy and appears rather soft, it is safe to assume that it will stand a harder temper than if it took two blows of the hammer to make one dent. I have used the hot sand bath and melted lead for drawing temper, but I must acknowledge that I like an open charcoal fire the best. Hold the article high up over the fire—just above the flame is the best place. Keep it in motion, turning over and over, and never hold still in one place. Let the temper down slowly. If a chisel, you can get ½in. of the point down to colour. If you run it down quick, the extreme point only will possess the right temper, and if it gets broken off a little it will be too soft after grinding out. Taps, tempered slowly, work much better than those which are drawn upon the jump."

**Essar.**

## THE MUSICAL SCALE.—TO S. E. HUNT.

[23963.]—The point in dispute between Mr. Child and myself is not quite as you put it in your letter on page 11. I do not suppose that I "create" a scale; but that, having certain tones and semitones, I arrange them in different ways, and call each variation the scale of such and such a keynote. It is just as if we arranged a number of colours in stripes: we may consider each particular arrangement of the order of the colours as a different pattern, and name the pattern from the particular colour that we make our first stripe. I, in common with, I suppose, 999 out of every thousand musicians, refer to and treat each pattern as distinct in itself, while Mr. Child prefers to call them "modifications." Of course, he is at liberty to do so; but it certainly savours considerably of impertinence when he declares that all those who differ from him and prefer the ordinary nomenclature are "misled," and so forth.

As regards the relationship of the tones to one another, your table of intervals is just what I wanted. I have now obtained the intermediate ordinates of the curve referred to in my former letter (the lengths of the octaves being taken as the primary ordinates), and have placed the results side by side with your own. A comparison between the figures is interesting, as showing to what extent the ratios, as determined by the musical ear, differ from the regular progression given by the mathematically-determined curve.

I have not made a distinction between D sharp and E flat, nor between A sharp and B flat; but if I had done so, there would probably have been a closer agreement between our figures at those points of the scale. I should perhaps add a line to inform Mr. Child that his recommendation to make some organ pipes comes a good many years too late; that my opinion "now" is just the same as it has been throughout the controversy, and that the information which he was unable to supply was quite clearly asked for at the time.

| | S. E. H. | Curve Ordinates. |
|---|---|---|
| C ............ | 1·0000 | 1·0000 |
| C sharp ....... | ·9375 | ·9438 |
| D ............ | ·9000 | ·8909 |
| D sharp ...... | ·8888 | ·8404 |
| E flat ........ | ·8333 | |
| E ............ | ·8000 | ·7937 |
| F ............ | ·7500 | ·7491 |
| F sharp ....... | ? | ·7071 |
| G ............ | ·6666 | ·6674 |
| G sharp ....... | ·6250 | ·6299 |
| A ............ | ·6000 | ·5946 |
| A sharp ....... | ·5625 | ·5613 |
| B flat ........ | ·5555 | |
| B ............ | ·5333 | ·5297 |
| C ............ | ·5000 | ·5000 |

**A. S. L.**

## HOW TO MAKE A SQUARE.

[23964.]—The following is at once so amusing, and so much to the purpose, that I venture to ask you to print it for the benefit, not only of apprentices, but also for the instruction of some of your older readers. It is from the pen of Mr. J. F. Hobart, and I found it in the *American Machinist*:—

"Tom has been promoted. He learned to chip castings and hammer his thumb. He did his first piece of 'Government work' by making himself a hammer, and now he has just spoiled his first iron with the bolt cutter, and his entire mind is bent upon making a square, while the background of the future is lined with visions of calipers, straight-edges and a surface gauge. Tom has got a piece of steel all ready, he has annealed it very soft, and is aching to begin his square. When he gets a chance, he marks out a square and begins to chip it out with a cold chisel. It was slow work. 'Guess I'll drill a hole in the corner,' said Tom. A good idea: it worked so well that Tom kept drilling holes until the whole square was cut out.

"What a time Tom had with that tool. He planed it all nice and smooth, rubbed it with file and emery paper, and wished he had a steel stamp to mark his name on it with. The first time Tom got a chance, he tried his square on old Tim's. What was the matter? Tom's square did not fit. It was open at the toe of the tongue when tried inside Tim's square, and 'wasn't anywhere' when tried outside. Poor Tom. He stuck that square in his breeches pocket, sneaked back to the bolt cutter, and kept thinking the rest of that day. Tom worked all his spare time on that square for the next two weeks. He filed, draw-filed and emery-papered until he was sick of it, and sick of squares too. It was awful work. Got the tongue so it would reverse on a line drawn across the planer bed, and Tom found the blade to be just a little 'hollow,' and by the time he got the blade in shape again, then the tongue was 'out.' Tom worked at the thing until the tongue got too narrow, and then he laid it up with his first hammer, which had a circle of fire cracks around its edge. Tom was bound to have a square. He intended to have a good one, too. He tried it again, and got three pieces of steel ¼in. thick, and big enough for blade and tongue. The two pieces for the blade Tom planed, filed and scraped. The blade to this square was to be thicker than the tongue, and was made in two pieces, riveted together, and Tom worked them out the same width. He got the surface plate and made one edge of each piece fit thereon. He didn't trust file and emery this time, not a bit; he got a scraper and did his best to make twins of those two pieces of steel. They were tried together on the plate until they would stand up square, close together, until they were just of a width and could be changed end for end, bottom side up or laid down flat-wise without showing an error.

"When Tom had done his best with the blade, he scraped the tongue true upon its flat sides, filed out the blade half the thickness of the tongue from each half, and scraped them to a fit. He kept trying together on the surface plate, and made the tongue stand true flat-wise. He fitted it so that it was a little less than 90° with the blade; then he was sure that no scraping must be done close to the blade, but whatever the error might be, it could be corrected at the toe of the tongue. Tom didn't try to make the tongue as he did the blade, that is, parallel edges, and fitted into the blade just 90°, or "square." He learned better than that when making his first square. After drilling the holes, reaming them, and riveting all together, being very careful not to 'cripple' a rivet, or spring the blade out of true, Tom was ready to true up the tongue with the knowledge that the blade was *right*, and nothing need be done to it.

"Our Tom has arrived at the dignity of running the 'Fitchburg Lathe.' He puts a piece of iron cut from a 4in. shaft, between the centres, and turns it as true as he knows how. He does his best to make both ends of that piece of iron the same size. When he can't make it any better, Tom cups out one end of the iron, leaving $\frac{1}{16}$in. around the outside, cutting the centre back so the iron will stand true on that head. Tom stands it on the surface plate and scrapes the outside of his square tongue until it is a fit. He tries that square all around that piece of iron, and cannot find a single place where it is 'out.' To true the inside of the tongue, Tom worked with the calipers, testing for straightness on the surface plate, and trying the square on the turned iron, letting the blade extend across the end, or cupped portion, and fitting the tongue to the side. When that square was done, Tom could draw a line across a straight edge, turn the square over, and draw again; draw two more lines along inside of the blade, and leave but a single line across the straight edge. It was a good square; Tom was proud of it, and everybody knew it, too. But Tom says the next time he wants a square, he will go to the store and buy one of Stubbs', or Brown and Sharpe's. If anybody catches him again working 82 hours on a square which he could buy for 2.50 dols., then he hopes to be a candidate for a lunatic asylum, or a job in the navy yard." **Economy.**

## A NEW AMERICAN LOCOMOTIVE.

[23965.]—The following particulars of a new design in American locomotives will, no doubt, interest some of your readers. It is known as the Cooke 10-wheeler, and is one of seven recently built by the Cooke Locomotive and Machine Company, Paterson, N.J., for the Elmira, Cortlandt, and Northern Railway. The most prominent peculiarity about the engine is that a four-wheel engine truck is placed entirely in front of the cylinders. This is, however, not the only point in which the design departs from the ordinary accepted American practice. The boiler, which is of the waggon-top type, has the cylinder part 54, tapering to 55¾ inches diameter, and is intended to carry a working pressure of 175lb. to the square inch. To sustain this extremely high tension the boiler shell is made of steel $\frac{7}{16}$in. thick. The longitudinal seams have welts on the inside, with rivets alternately on each side of main seam to strengthen caulking edge. There are 200 tubes, 2in. diameter and 10ft. 8in. long, fastened with copper ferrules at both ends, and brazed to flue on the fire-box end. The fire-box, which is made of the best Otis steel, is 73in. deep, 72in. long, 33½in. wide, and has a water space of 3½in. between the sheets. This boiler supplies steam to cylinders, 20 × 24in., which transmit the power to three pairs of coupled driving wheels, with 54in. centres. The valves are the Richardson balanced; pistons, cast-iron, corrugated shape, with three cast-iron packing rings ½in. square section. The boiler is covered with asbestos lagging; two sand-boxes are placed on top of boiler; an extended smoke-box and open stack are used. The engine is fitted with the Eames brake equipment, and the shoes are applied to both sides of the driving wheels. No pumps are used, the boiler feeing being done by two Hancock inspirators, one on each side. **E. A. M.**

## A FEW NOTES ON THE LEICESTER AND SWANNINGTON RAILWAY.

[23966.]—The recent correspondence relating to early locomotives has directed attention to this line, some notes upon which may therefore prove of interest to your readers.

The Leicester and Swannington Railway is one of the most ancient and most interesting lines in the kingdom, but probably the least known; in one respect it is perfectly unique—namely, that whereas all the other early railways have been very greatly improved, and the systems of working entirely modified, a considerable portion of the Leicester and Swannington line remains, and is worked to-day, upon the old style, adopted nearly fifty years ago; on this account it is frequently visited by engineers who desire to see links in railway history. The Company's Act received the Royal Assent 29th May, 1830, giving power to construct a railway from the navigable part of the River Soar, near West Bridge, Leicester, to the northward end of the village of Swannington, together with four branches, extending to the Whitwick, Ibstock, and Bagworth collieries, and from the ancient Fosse-road to the North Bridge, Leicester. The three former branches were constructed at the expense of the colliery owners; the latter, to the North Bridge, was never made. The line was commenced towards the close of the year 1830, and opened, amid great rejoicings, on the 17th July, 1832. It was the first railway in the midland counties, and, as it follows the short line from Canterbury to Whitstable, is believed to be the second south of Manchester. It now forms the oldest portion of the Midland Railway (the above remarks, of course, refer to locomotive railways, and do not include old tram-roads worked by horses).

From the commencement of the line and the completion of the board-room, until the year 1869, the whole of the official documents remained at the West Bridge station, Leicester; but at that date they were all removed, a few to Derby; but a very large proportion of these interesting papers were destroyed and sent to the papermaker, therefore much information relating to the line has been lost. The writer, for a number of years, took great interest in the history of this railway, and had fortunately taken copies of the sections and all the more important documents some years previously to their being destroyed. This fact being known to his engineering friends, he was specially asked to prepare and read a paper upon the subject. The early letters which passed between Mr. William Stenson, Mr. John Ellis, and Mr. George Stephenson, conclusively prove that the object of this railway was to supply Leicester with coal from the Leicestershire collieries. At the time Derbyshire coal was sent by canal, and the Leicestershire coal practically shut out of its own market. Mr. Stenson wrote: "Our carting beats us, but I see a way to relief if we can but get a railway. I've tried the ground with my theodolite, and find no difficulty."

Mr. Ellis and Mr. Stephenson went over the route, and the company was formed, a large portion of the capital having been raised in Liverpool, Mr. Robert Stephenson, at the age of 27, being appointed engineer. The length of the line (exclusive of branches) was 16 miles 5 chains, or 28,270 yards; it was single throughout, except at stations; the gradients were severe, but that was of little importance, as in a great measure they were favourable to the loaded coal trains. Leaving the West Bridge Station, Leicester, the railway runs past Glenfield, Ratby, Desford, Merrylees, Thornton, Bagworth, to the summit, the gradients being 1 in 147; level: 754, 480, 364, 211, 138, 119, 29, 97; thus, in a distance of 11 miles 30 chains, the line rose to a height of not less than 371ft. above Leicester, from this point it declined by gradients of 1 in 203-251, and 17 past Bardon-hill, the junction of the Whitwick branch, Snibston Colliery, and Swannington incline, to the level portion at the end of the line at Swannington.

The principal work on the line is the Glenfield Tunnel, about a mile and a half from Leicester. It is one mile one chain long, straight and level, built of brick. 500 yards of its course lay through loose running sand, the presence of which rendered it necessary to construct a wooden tunnel to support the soil while the brickwork was being executed; the construction of this tunnel was carried on from both ends, and from four large and ten small shafts. A serious mistake was made, either in the level of the rails or height of the engine chimney, for on the opening day the chimney of the engine drawing the first train was knocked down.

The gauge of the line was 4ft. 8½in., the rails being of the "fish-belly" pattern, weighing 28lb. per yard (for full details of the permanent way, reference should be made to Vol. XXXIX. p. 589).

The Bagworth incline was self-acting: the loaded waggons descending (by gravity) pulled up the empty ones by means of a rope, 1,000 yards in length, passing round a wheel fixed at the top. The Swannington incline was, and still is, worked by a stationary engine and rope. Some of the clauses in the early Acts are interesting, for instance, that of

1830 enacts: "That all persons shall have free liberty to use, with horses, cattle, and carriages, the said railway upon payment of tolls." Two lists of tolls are given, one if "propelled and provided at expense of the company," the other not by the company. These powers do not appear to have ever been exercised, and on the 10th June, 1883, another Act was passed, and states that: "Whereas the main line hath been constructed with a view to locomotive steam engines being used, it might be very injurious to the said railway, and inconvenient and dangerous if horses or cattle were used." They were, therefore, disallowed. The Act also gave power to construct a branch to Soar-lane, Leicester; this branch crosses the canal by a curious drawbridge, designed by Mr. Robert Stephenson, and still in use, the movable part being raised and lowered by means of chains at the four corners passing over pulleys and attached to counterweights. Branches were also made by private owners to the Groby granite quarries and to the Snibston No. 2 colliery.

By another Act of 1833, the Coleorton Railway Company made a railway from Swannington to join the ancient Ashby tram-road.

The Leicester and Swannington Railway was purchased by the Midland 27th July, 1846. An Act, 3rd August, 1846, was passed to alter and improve it; this was in the following year abandoned, and another Act passed 2nd July, 1847, by which the present Leicester and Burton line was made; also a deviation to avoid the Bagworth incline of 1 in 29. Six miles near Leicester, and 1¼ near Swannington remain unaltered, and are now practically as they were at first. The trains in 1832 consisted of coal and goods waggons, with passenger carriages attached, and so they do in 1885.

**Clement E. Stretton.**

### THE ACCIDENT AT ST. PAUL'S-ROAD JUNCTION.

[23967.]—I HAVE waited to see whether any of your readers besides Mr. Stretton would notice this question, and I now write to thank that gentleman for his letter on p. 519 last volume, giving the substance of Major Marindin's report on the collision above-named. With regard to Mr. Stretton's last sentence, I would ask, How can the public expect railway companies to take much notice of the reports and recommendations of the Board of Trade officials, when one of those highly-paid (£1,000 a year) gentlemen actually "passed" this very "junction," where it is clear to anyone that the down line from King's Cross ought to have been carried under the main up-line right away clear outside of Kentish Town Station? The direct cause of the accident was not the "combination" of the four reasons named, because, if the gas-pipes had been properly laid and fitted, the other three "reasons" would not have occurred. The direct cause of the accident was, then, the fact that the Midland Railway Company employs officials who cannot so lay gas-pipes as to prevent an accumulation of water, or who have never heard of means for drawing off water without stopping the supply of gas. It is also stated that "the position of the junction prevented the two drivers seeing the danger," a sentence that requires some explanation, for the driver of the down train would see just beyond the signal at the crossing the black darkness of the tunnel under Camden-square. I presume he thought the advancing lights belonged to a train going to King's Cross, while the driver of the main up might have thought the other was waiting for him at the signal-post, as frequently happens. If the gas-pipes had not been stopped by water, it seems clear that this collision would not have occurred. I cannot, therefore, agree with Mr. Stretton, that it was the result of a series of defects and errors of judgment, which were not of a character to necessitate any other verdict than "accidental." On the contrary, the collision could not have occurred except by negligence of the company's servants, or through defects in the arrangements for which the company is clearly responsible. As it happened, only a poor fireman was killed, and the company will not have to pay damages; but life was doubtless as dear to him as to any of us, and he and his fellows are exposed to quite enough risk, without having to run the gauntlet of such traps and snares as this junction has proved itself to possess. Of course a coroner's jury brought in a verdict of "accidental" death—just as they do when boilers explode because they are utterly unfit for the work they are put to do; but no one expects wisdom from them. "Accidental," as applied to railway disasters, means something that "could not have been foreseen," not merely something that "was not foreseen." I quite agree with Mr. Stretton as to the signal lights. I would suggest the use of blue or yellow for distant signals, or what would perhaps be better, red, with a broad bar of yellow across it.

**Nun. Dor.**

### EARLY CUT-OFF ENGINES.

[23968.]—THERE have been several letters lately in your paper respecting the advantages to be gained by the early cut-off engines. My own practical experience is that it is a fallacy; it has failed with me both in practice and in my own theory.

Some years ago I reproached one of my engine drivers for working his boilers at 50lb. pressure, instead of 65lb. pressure (these were a pair of simple condensing engines, with automatic cut-off). He informed me he could work with less fuel at 50lb. than he could at 65lb.; I, therefore, allowed him to do so, as he could do the same work with about 20 per cent. less than any other driver for the same load. At another firm I indicated an engine with automatic cut-off (single non-condensing). This engine cut-off at about one-tenth of stroke, the expansion line passing the atmospheric line at about six-tenths of stroke, the terminal pressure, of course, being below atmospheric line. I advised the firm to run the engines slower by altering the pulleys. This was done, and a saving effected in fuel of about one-third—60lb. pressure was carried on the boilers. Another firm had a patent automatic variable expansion engine, "horizontal, non-condensing," fitted with patent gear of every description: this engine consumed over four tons per week. This firm then fixed their old engine to be worked in case this patent machine required repairing at any time; this engine was a single horizontal non-condensing, with expansion plates on back of main valve, cutting off at four-tenths of stroke, 60lb. boiler pressure. The patent early cut-off engine being stopped for repairs, the old engine was, of course, started, and to the surprise of the firm, only consumed three tons of fuel per week against the other's four tons for the same work and same number of hours. These practical examples prove that early cut-off is a fallacy.

With simple early cut-off engines, according to the indicator card, they give a good result per pound of fuel used per indicated horse-power per hour; but this is a fallacy, because the method of calculating is incorrect.

With an early cut-off, say, at one-tenth, the full initial pressure is when the crank is at dead centre; and this is calculated the same as though the crank was at half-stroke or most effective and quickest speed. The present method of calculating these engines is, therefore, incorrect.

The speed of piston is variable, and the pressure per tenth of stroke being variable, the old system calculating by the average pressures and by the average speed is useless. For instance, an engine working at 400 piston speed per minute would have at half-stroke a piston speed of 628ft. per minute, when the crank was most effective; but when at one-tenth of stroke the piston speed would be only 172ft. per minute, when the crank was least effective and on its dead centre, the speed of crank-pin being 3·1416 the diameter or half-stroke. For the calculations at one-tenth of stroke, we must deduct something like 50 per cent. as useless effect, the crank being on dead centre.

By this method of calculating, we obtain three times the useful effect at half-stroke to what we do at one-tenth of stroke, theoretically and practically; six times the useful effect transmitted to the machinery (the supply of steam to an engine being intermittent, and not continuous) for the same consumption of steam and fuel.

When the position is at half-stroke, the piston and crank speeds are in unison; consequently, we must make our calculations by the normal, instead of the average, speed and average pressure.

In the compound engines, the steam can be carried to seven-tenths of the stroke, thus giving the greatest amount of pressure when the crank is at full leverage, or most effective.

This method does not apply to direct acting, non-rotative engines, the piston speed being almost constant, and effect constant. Any engineer will know that his engine will not start on dead centre, and that the steam is not so effective as when the crank is at half-stroke.

**Christopher J. Little, M.S.Arts.**

### A QUICK SPARK COIL.

[23969.]—THE following description of a coil I have lately made may be useful to some of "ours," though it is not offered as a specimen coil, as the secondary insulation is probably rather too heavy. This, however, if it has prevented my getting the full length of spark out of the wire used, has diminished the chances of breaking down the insulation from using too great battery power. Core: 12in. by 1¼in. No. 18 iron wire, softened in fire all night, bound with soft cotton tape, half overlap, and paraffined, primary (wound thereon) four rows No. 16 s.c., each row separated from next by layer of paraffined tape, last row finally surfaced with $\frac{1}{16}$in. paraffin over the tape. Over this is wound a layer of paraffined silk ribbon, and then a layer of silk tape half overlap, well paraffined, and with ⅛in. thereof for surface, secondary 3lb. 2oz. No. 35 s.c. wound from end to end, twenty-one rows altogether, narrowing from 9in. to 7in.; ends of secondary cleaned for about 6in., and twisted up with 6in. of No. 26 to attach to terminals, and lessen chances of breaking there. Each layer separated from next by one layer paraffined tape, three-quarter overlap at ends, and just overlapping in centre; last row bound with silk ribbon well paraffined, and coil made cylindrical with paraffin; ends ¾in. mahogany dried and varnished; stand half walnut (ditto), condenser (separate), 81 tinfoils 11in. by 7in., separated by paraffined white blotting-papers 12in. by 9in., five extra top and bottom; break horizontal. Terminals, arrangement, &c., similar to one described in "E.M." for 30th November, 1883. Battery: six small bichromates in series. Result: just 2in. spark, primary shock very strong.

**B. Harcourt.**

### USES OF A COMMON PARAFFIN TAPER.

[23970.]—THE following note, which owes its origin to Dr. B. W. Richardson, may be of use to many of your readers; but they should see that the tapers are really of paraffin:—

"A common white paraffin taper makes, I find, one of the best bougies for exploring the nasal cavity. I use a taper of from one-eighth to one-sixth of an inch in diameter, and about 10in. in length. For mere exploration I round off the end that is to be introduced into the nasal cavity, bend the taper into an easy curve, make it slightly soft by warming it in my hand, and then have it ready for use. The perfect smoothness of the surface of the bougie thus formed, the ease with which it bends, and the just sufficient strength given to it by the wick, are qualities which make this simple, inexpensive, and always ready instrument very effective. From its colour it is also readily discernible in the throat when it is passed into the pharynx.

"The taper has other uses. If it be wished to apply iodine evenly to the whole of the nasal cavity, the thing can be done at once by means of the taper. It is merely necessary to paint the end of the taper for a couple of inches with iodised colloid or with tincture of iodine, and then introduce it, to secure that all the iodine is left on the mucous lining of the nasal cavity. In ozena, patients can be taught to carry out this method for themselves at stated times. I have two patients now who have done this with the best effect.

"The taper admits of another useful application. If the cotton within it be nicely teased out at one end of a short length, the cotton makes one of the most convenient of brushes for applying iodine or other solutions to the throat. In scarlet fever and other affections attended with throat complication, I invariably instruct the nurse or attendant to be provided with a few tapers of different sizes, and to make them act as the brush for applications to the throat; and as soon as one brush has been used, to cut it off with scissors, burn it, and make another. The same kind of brush can be used with equal advantage for cleaning the tube after the operation of tracheotomy."

**S. R.**

### COMPOSITE PORTRAITS.

[23971.]—I DO not know whether any of our amateur photographic friends have tried their hands at composite portraits—e.g., amongst their own relatives; but they will, perhaps, be interested in reading the following notes on composite photographs of groups of members of the American Academy of Sciences, which was read by Prof. R. Pumpelly. The pictures are obtained, it will be remembered, by taking the photographs of a number of different individuals of the type to be compared, in as nearly as possible the same position. These pictures are then photographed on the same negative, being superposed one on the other, and each photograph being exposed for only a very short time, so that the resultant contains and combines all the features which the different photographs possess in common, but eliminates those which are due solely to individual peculiarities. The pictures are focussed on the eyes; and since the distance in eye differs in different persons, some indistinctness about the borders of the picture is inevitable. The mouth especially appears to lack decision, by reason of being somewhat blurred; yet, on the whole, the composite picture is such a one as would be at once recognised by most persons as a fair illustration of such a kind of person as the individuals which compose the class under observation. It is by somewhat such a process as this, in fact, that Prof. Pumpelly thinks that we usually form a mental image of different types and classes, whereby we recognise, for instance, at sight a Chinaman or an Indian. The pictures of members of the Academy showed in one instance a compound formed from thirty-one individual members. This picture may fairly be taken as a type-picture of the average scientist or the ideal intellectual man of the Caucasian type, being composed as it is of individuals the most eminent in America in various lines of scientific research. It shows, as must have been expected, a high and massive forehead, and that well known though indescribable cast of countenance which we all pronounce at once, without perhaps being able to assign any reason for it, to be intellectual, so that on seeing a countenance of this stamp we naturally infer that it is that of a professional man. It was observed, however, that the faces of three of the persons thus combined differed largely from thé average type, and in the subsequent experiments these three photographs were omitted for the purpose of securing greater clearness in the result, notwithstanding that the exposure of each picture to the camera was only two seconds, out of the total exposure of sixty-two seconds for all, so that the peculiarities of individual pictures would make only a very feeble impression on the combined photograph. The remaining twenty-eight pictures, then, were divided into two groups, and classified, according to the department of science most affected by the members, into sixteen naturalists and twelve mathematicians. On combining the mathematicians into one group and the naturalists into another, it was seen that, with apparently the same height of forehead, the mathematicians have a broader, and the naturalists a slightly narrower, forehead than the average. Prof. Pumpelly intimated that it was his intention to prosecute these inquiries in the direction of composite profiles, which he expected would produce some startling results. He regarded this as a method of much value in anthropological work. Major Powell stated that the same method had been applied to obtain a composite photograph of crania at Washington, but without success. Other members of the academy, however, indorsed Prof. Pumpelly's views. Prof. Peirce thought it particularly desirable to obtain a composite photograph of musicians, and also of mathematicians who were devoted exclusively to mathematics, remarking that the members of the academy represented were not of that exclusive mathematical type which he regarded as a very peculiar one.

Newport, R.I. **R. Scanlan.**

### THE STATE OF MAN.

[23972.]—I observe that objections similar to my own have been taken to "Priam's" statement that Moses was unaware of the legend of the Six Days' Creation. "J. H." meets me as I have hoped some able critic would do; but there is still a sticking-point.

In personally endeavouring to solve the difficulty which, be it observed, is one which a parson has to meet, I have stated it thus: "In the beginning God created heaven and earth." This I have supposed to stand as a positive incontrovertible fact, as the necessary foundation of the whole religious system to be presently set forth.

As to date of this fact, it needs none. It may have been millions of ages ago. Then in verse 2 commences the rearrangement or re-creation out of the above chaotic mass, which may have already, however, have seen divers previous restorations and subsequent destructions.

This seems also to be the view of "J. H." I am no Hebrew scholar; but I believe that "The earth *was*" without form, &c., may be read "became" without form, which would go far to substantiate this view.

But to quote from a most interesting volume, "The Conflict of Religion with Science"—"*Since* the advent of man we have to deal "with periods of incalculable length," — i.e., possibly from tertiary, and certainly from quaternary times. But if I understand "J. H." aright, he sets down these as geological periods, comprised in verse 1 of Genesis, and man's existence would thus antedate the six days' re-creation. Bible chronology makes man but 6,000 years old. Scientific discovery gives his existence with certainly hundreds of thousands of years. "It is difficult to assign a shorter date for the last glaciation of Europe than a quarter of a million of years, and *human existence antedates that.*" If Bible chronology is not, as I said, hopelessly at fault, geological chronology is. Commonsense will scarcely ask which is, in such a matter as this, to be trusted. I may observe that I do not consider that Christianity depends upon the Mosaic record of creation, which simply opens up, in my opinion, a field for scientific discussion. At the same time there are manifest reasons why one would be better satisfied if the theological and the scientific record could be reconciled. As to the glaciation which may have wrecked our world, I can understand that the gradual cooling of the materials may have arrived at such an extreme; but how did the revivifying or warming process begin?

Let me hazard another theory. The total glaciation of the globe took place at some remote period antecedent to the six days. Then came the gradual increase of temperature. The mass of ice was dissolved, and hence the universally diffused waters upon which the "Spirit brooded"—that spirit, or breath of God, then causing evaporation to take place, and so by raising the clouds "divided the waters from the waters," which was the first act of the renovation of the earth. Possibly Moses used the term "Spirit of God," for lack of a better, to indicate the revivifying influence of heat. Did glaciation make as positive a break as the above would suggest, or do geological and Mosaic periods merge into each other by imperceptible gradations?

**O. J. L.**

### CUTTING SCREW-THREADS.

[23973.]—Though I am perhaps trespassing a little, not having had such experience of revolving laps as would entitle me to be heard, or of weight in the present contention *re* cutting of screw-threads, &c., I take the liberty to point out further, as one who has been a responsible workman and draughtsman, that Dr. Edmunds is wrong anent the angle of his cutters or laps to make up his thread. If a thread were cut by an inclined lap set to average angle of threads acted upon, the angle in a plane of revolution of axis of screw would be a curved broader-based one, not a duplicate of cutter; in fact, as Mr. Wenham says, the thread would be deformed. The correct form of the lap could be obtained by cutting a thread with a chaser, and turning lap to linear contact for whole depth of thread at either side and at medium angle of thread.

It appears to me, however, that to cut threads with a lap having its axis inclined horizontally, but not vertically, to the screw axis, of small enough diameter to clear, and cutting one side at a time, would be the better plan. I have still a little doubt of the other, double-lap plan; though if wheel were small enough, with a sufficiently obtuse angle on the thread to be cut, sufficient clearness should exist, and the resultant thread of a properly shaped cutter should be correct in form.

Revolving laps are more a workshop than an amateur's—at least, the general amateur's—appliance, and I am confident do not contain the same possibilities of accuracy as bit-laps do, and the final finishing of the lapping should be done with the latter.

Mr. Granger proposes to use an extra and approved non-necessitous centring on the exposed outer end of nose, needlessly increasing complication. Perhaps he has looked up recent letters in the mean time, and found out how his proposal stands. **Vulcan.**

### INTERCHANGEABLE MANDRELS.

[23974.]—I do not wonder at Mr. Hines now asking *when* we may expect the Council of the Amateur Mechanical Society to publish its decision upon the thread-form for ornamental lathe screws and other fine purposes; also upon the details of a standard interchangeable mandrel. I confess that I am now tired of this discussion. I have considered very carefully all the letters that have been sent to me or published in the English Mechanic, and I think that now we ought not to wait longer in the hope of propitiating adverse influences. The vested interests upon this question are very strong. Costly lathes, constructed with screw-threads of 9·45, 13·09, 19·89, 22·12, 25·71, 28·88, 36·10, 39·83, &c., turns per inch, become really valuable milch-cows. But those who desire to purchase "a high-class ornamental lathe without any change" out of a five-hundred-pound note will always find Mr. Evans's factory at their service, and no one wishes to interfere. All we have to do is to sum up the outcome of our work upon this subject, and leave the matter in the hands of intelligent purchasers on the one hand, and, on the other, of manufacturers who are sensible enough to see what their real business interests are.

From the first, Mr. Evans, when still absolutely incredulous as to the practicability of my propositions, placed himself at the disposal of the Council of the Amateur Mechanical Society with a view to assist in the practical work of constructing the model screw-threads and mandrel-heads. I have, therefore, asked Mr. Evans to favour me with the conclusions at which he has arrived after following the discussion out, and after having himself manufactured the first of these model interchangeable mandrels. Mr. Evans writes me as follows:—

"1. I intend for the future to use nothing but aliquot threads throughout my apparatus.

"2. For all fine lathe-threads and other scientific work I shall adopt the Edmunds thread-form, as shown in cross section in the English Mechanic (No. 1040, page 562, Fig. C)—i.e., an angular thread of 50°, truncated so as to make its depth equal to the length of its base.

"3. All my best ornamental lathe mandrel-heads will henceforth be made with their chuck-bearing surfaces to the Edmunds model, screwed at the rate of ten turns per inch. For such lathes the transferability of the chucks will be absolutely perfect, and transfer chucks will no longer be required.

"4. For the cylinder-screws of the shifting headstock, I have adopted the thread of ten turns to the inch and a back circle divided to hundredths of a turn. This will make the shifting headstock useful for measuring certain work when between centres, and will at once give thousandths of an inch.

"I have a beautiful lathe in hand, recently ordered to be made to your pattern mandrel-head, which I will ask you to come and see when finished. Of course, as I have said before, my adopting these standards will not interfere with my making any other thread to suit the fancies of particular purchasers; and, for rougher purposes, I shall use the Whitworth standard bolt-thread of 55°, rounded off one-sixth at top and bottom."

The recent publication, at page 14, of Messrs. Whitworth's letter upon their lathe-nose threads is a valuable contribution. In one respect I must correct its statement, inasmuch as I know of one 3½in. lathe, recently made by Whitworth and Co. for a member of the Amateur Mechanical Society, and that lathe has a 1in. nose with a thread of "about 50°," rounded off one-sixth at top and bottom, but making *seven* turns per inch.

It seems as if Sir Joseph Whitworth had never systematised the threads of his lathe-noses as he did those of our standard bolts. An "average of about 50° angle" for the lathe-nose thread is not a standard that can ever be incorporated with scientific work. But the fact that Sir Joseph has never adopted his standard bolt-thread of 55° for his own lathe-noses is conclusive against our now adopting it for the ornamental lathe. We, therefore, fall back upon the angular thread of 50°, truncated so as to make its depth equal to the length of its base. I have no doubt whatever that this is destined to take permanent place as a thread of really scientific form, easily reproduced with exactitude, and free from all troublesome calculations. It yields out of a given cylindrical shell the greatest resistance to shearing or deforming stress, the largest amount of bearing surface, and a minimum of that wedging action which is the chief factor in the abrasion and deterioration of angular screw-threads.

Our model interchangeable lathe-mandrel will, therefore, have the chuck-bearing surfaces shown long since in the engraving in the Journal of the Amateur Mechanical Society, and twice reproduced in the English Mechanic. For the light 6in. and smaller lathe, the nose will be 1in. in total projection from the mandrel-face, and 1in. in diameter outside the thread. That portion which serves as the cylinder-base will be ·2in. long, and 1·05in. in diameter. The thread 50°, truncated so as to make its depth equal to the length of its base, and at the rate of ten turns per inch. The mandrel-face will be 2in. in the diameter of its bearing zone, and hollowed out inside so as to limit the chuck-bearing to a peripheral zone ·2in. in width; the shoulder to offer a rounded edge, which will adequately protect the edge of the true-face zone. For the heavier scientific lathe, a nose 1·25in. in total length, and 1·25in. in diameter, with its cylinder-base ·25in. long and 1·35in. in diameter, the same thread-form as the inch nose, but at the rate of eight turns per inch.

The question of thread-rates is one which will settle itself. For the scientific traversing lathe there should be six guides having 10, 12, 16, 20, 24, and 36 turns per inch. With the larger lathe an 8-thread guide will be necessary, and either 30 or 42 may be added so as to make up a set of eight guides.

The mandrel is bored throughout to ·4in.; the mandrel-tail is guaged to a diameter of 1in. and is fitted with a nut instead of a plug-screw, so that rods can be passed through from behind without unshipping anything. **James Edmunds.**

Grafton-street, Bond-street.

### LATHE MANDRELS, CHUCKS, &c.

[23975.]—My time is, unfortunately, limited, or I should have replied to Dr. Edmunds' question before; in fact, I had Figs. 1, 2, 3, and 4 drawn on the 28th ult., but have been so driven for time that if this appears in No. 1043 it will be entirely owing to the courtesy of the Editor. In spite of Mr. Hines's letter, p. 520, I am still not convinced of the great superiority of the cylinder and face fitting for interchangeable chucks and mandrels over the cone system. He says that the wear on the front portion of a *long* cylinder, combined with the wear upon the chuck, would be sufficient after a time to render its centrality imperfect; but upon Dr. E.'s *short* but enlarged cylinder base there would be no real wear. I submit that if the wear on the long cylinder fit is increased by reason of the extra distance the chuck has to pass over such cylinder fit, when screwed home, the surface of the cylinder which has to withstand this wear, is increased in area in like proportion; but the amount of force with which the chuck comes in contact with the cylinder base would not be augmented were the length of the cylinder increased, and it may be taken as constant; and therefore, were the cylinder's length doubled, the increased area would be subjected to only half, whatever that force might be, and if the length were made 1in., the surface would have to withstand only one quarter the force. Does Mr. Hines mean to say that the friction resulting from a pressure of 4lb. on 1 sq. inch would wear away such 1 sq. inch very much slower than if the 4lb. were spread over 4 sq. inches, where the pressure or weight would only equal 1lb.

to each sq. inch? Thus in this latter case a square inch has only to withstand a pressure of ¼ of the 4lb., or 1lb., and the total surface is four times as great. If I am wrong in my reckoning, will he be so kind as to show me where, and in as clear a manner as possible? and the long cylinder affords better opportunities for rounding the entrance of either chuck or mandrel, and the extreme south ½in. of mandrel and the north ½in. of chuck will have no greater distance to travel than in the standard mandrels; and therefore it seems to me that to continually insure the truth of chucks, mandrels should be constructed on one of the following systems—viz.,

System 1.—One cone of suitable taper, supplemented by some means of attachment, which may be a screw of square or angular thread, or bayonet-jointed, &c.

System 2.—One cone and one flat mandrel face.—In this case the cone must either, whilst perfectly fitting the mandrel, be made to slide towards the face, or the cone must take the form of an angular screw thread.

System 3.—*Two or more Cones opposed to each other.*—In which one cone with a plane base may be opposed by the advancing or spiral cone of an angularly-threaded screw, or by a series of such spiral cones provided by several complete turns of such angular threads. On page 431 I asked Dr. Edmunds to show a cause why a chuck fitted to its mandrel by a cone cannot be relied on to keep true, when the cone system answers so perfectly for the wearing parts of the mandrel. He replies by questioning the correctness of my analogy, and points to the "dead" centres as illustrating a means affording the attainment of extreme accuracy in work mounted between them; by which I presume he implies a centre fixed to a revolving mandrel, by cone or otherwise, cannot be so implicitly relied on to run true. If this supposition is correct it will be worth while to investigate the cause of failure on the part of the "live" centre, and we find that the error must exist either in the centre itself or in its attachment to the mandrel, or in the latter, and if it is allowed that the latter does run true in its conical or other bearings, we are reduced to the first two sources of error. Then the question presents itself: Can a centre be truly coned to, say, 50°, and, we will say, truly tapered so as to accurately fit a conical hole in the mandrel nose? If a centre can be so accurately coned to 50° that work revolving on it as a "dead" centre can be most perfectly turned circular, I think it will be a difficult thing for anyone to prove that the tail end of the same centre cannot be as accurately turned to a cone of 10°, or less taper. Since this is so, the conical hole in the mandrel nose is alone left as the source of error when turning between *live* centres. It is presumed, of course, that the work is properly coned out to fit the 50° male centre. Now, can such a hole be made perfectly true with the axis of revolution of the mandrel? I should be surprised to hear that this was an impossibility, and I do not think Mr. Hines would feel inclined to admit he could not accomplish such a task, and I think if he failed to produce such a hole true to within a fraction of the thousandth part of an inch, he would have to admit that his shop "was not on a level with modern improvements in steel work"; but if the mandrel is true, its conical hole with the centre properly fitted therein also running true, and the work properly coned to fit the 50° male centre, there can be no error. Is such truth impossible? If so, we may at once throw the cone system overboard; if not, we can rely to produce with such a fitting as accurate work with a "live" as with a "dead" centre—theoretically, at any rate. Then why can we not equally accurately centre and true chucks, &c., by similar means? Is not a centre, dead or alive, a chuck? And, again I ask, why is the cylinder and face system, which does not afford adjustment for wear, considered better than the cone system which does, and, as sketched in Figs. 1 to 4, gives 6·29 sq. in. of surface to withstand wear, as against 2·3562 sq. in. for the face, and ·6283 sq. in. for the cylinder-fit of Dr. E.'s mandrel? If the conicity were sufficiently obtuse, no doubt the bite of the mandrel-face would interfere with its corrective action; but in Figs. 1 to 4 I have shown that an acute cone may be employed, in which the "north" end of the mandrel does not project beyond its supporting steel collar to a greater extent than in the "standard mandrel" of Dr. Edmunds—viz., 1½in., and here I beg to say that the accompanying drawings are not to be considered as arbitrarily fixing the dimensions, degree of conicity, or precise mode in which the cone system is to be, or can be, adopted; but simply as illustrating the three systems brought forward, and as showing that an acute cone does not necessarily entail a very long mandrel nose.

I hardly think the term "stop-surface" is well chosen for the short cylinder of Dr. E. I think its action is more that of a preventive. On the other hand, the face answers as a corrective should the crank approach it angularly untrue, but directly the chucks are rendered true the corrective action ceases and the stop-action at once comes into play; and if the chuck happens to be a large and heavy one, and the nose thread moderately fine, unless care is exercised, the momentum of the chuck will cause it to be fixed very firmly indeed. The friction on the face and south sides of the screw will then assert itself, and be very manifest when the chuck is removed. Therefore, as this effect closely resembles that in a fly-press, the question of the pitch of the thread might be with advantage entered into. In the fly-press the pitch of the screw is made so quick or great, that on the die coming down the friction is not sufficient to jam the screw tight; but, on the contrary, the handle can be drawn back with but little effort, and yet the pitch of the screw is not so great that the momentum stored up in the mass of metal at the end of the arm tends to shear off the screw-threads rather than cause the die to descend. Cannot a like happy medium be found for mandrel noses? If so, it must, I think, be found possible to do the same for a cone-fitting mandrel nose, provided the angle of such mandrel cone is not so acute that work can be fitted thereto, by a slight blow, so tight that the friction alone is sufficient to hold there, as illustrated by centres so fitted to their mandrels, the taper plug of scroll chuck, &c. That the pressure on the cone fitting is more than on the face fitting, I do not deny; but, as pointed out before, the surface is increased in the former, and I think that if the pressure on the cone was double that on the face fitting of Dr. E., and the surface of the cone also doubled, the pressure on any given area of cone surface would be found to equal that on the face; but this question cannot be gone into until the dimensions of the cone and its angle are given; but if we take an angle of 90° as an instance, and the force with which the chuck is applied to it, as represented by the hypothenuse of a right-angled triangle, the pressure on its mandrel's conical surface will, I think, be found to equal the sum of the other two sides, or, roughly speaking, about $\frac{3}{10}$ more pressure on the sides of the cone than on the flat surface, and the more acute the cone the greater the pressure; still, I am hardly inclined to think this pressure would be so excessive as to prove appreciably detrimental to either mandrel or chuck; but to guard against the possibility of such being the case, there would be no objection to slightly oiling the coned mandrel nose and means of attachment, and then the oil would act as a buffer and lubricant, allowing the surfaces only gradually to come into contract, and then by its greasy nature facilitating the removal of the chuck and prolonging truth of the coned surfaces. With the Editor's kind permission, my illustrations will appear next week.

E. J. S.

## LENS SHUTTERS—ERRATA.

[23976.]—I have not had an opportunity of writing before, or I should have pointed out sooner several very noticeable errors in my letter on "Lens Shutters" (23876, Feb. 27), which I think ought to be corrected, as they would be very misleading to anyone looking through back numbers.

In 5th paragraph, line 3, portion in italics was omitted: "I placed myself *in the scene*, fifty or sixty feet away," &c,

9th paragraph, line 6, should have read: "J aperture. K, thin slip of wood for handle"; and on line 10, "S, piece of string fixed to H and K, measures the distance the slide must be drawn down when exposing."

The letter K on lens-sleeve was not shown at all.

C. R. King.

## OPTICAL ODDS AND ENDS.

[23977.]—I should be glad of any accurate determinations of the amount of light reflected at a perpendicular incidence by glass of various kinds. Professor Tyndall, in his "Notes on Lights," says 1-40th. Another work says 4·25 per cent. Obviously both may be correct, since different kinds of glass may be referred to. A reference to experiments will be acceptable, for I find no account of the means used to measure the percentage.

Secondly, will the loss at second surface be accurately the same percentage as at the first. There is a difference perceptible enough to me in the brilliancy of the reflections from the first and second surfaces, but I do not feel sure this is not wholly accounted for from the necessary loss the second reflection sustains at the first surface and in the substance of the glass. Evidently a less brilliant beam falls on the second surface and again suffers on emergence.

My reason for asking is a wish to work out the loss of light in telescopes. Taking the larger estimate of loss, it follows that in a refracting telescope of two lenses in o g., and two in e.p., and allowing 4 per cent. in each for absorption, only 64 per cent. of incident light reaches the eye.

And now a question as to an eyepiece. In last number of *Observatory* one is mentioned in which, while the power of eyepiece is 327, the power of eye-lens alone is 641. This requires the proportional foci of eye and field lens to be as 1 to 7. Is not this a very unusual proportion for a Huyghenian eyepiece, and is there any advantage in such proportion?

It is generally said that a prism gives more light than a flat in a reflecting telescope; but if the loss of light at the surfaces of a prism is rather over 4 per cent. at each, and then a further loss by absorption in the substance, there can be no gain over a newly-silvered flat, since that returns at least 90 per cent. of incident light. Is it proved that any gain results in light from using a prism? Evidently there is great risk of loss of definition. Those who have used both can tell us whether any faint objects come into view with the prism that are invisible with flat.

Edwin Holmes.

## OPTICS WITH THE LANTERN.

[23978.]—I have observed one or two queries respecting the arrangments for projecting spectra.

I find, after many trials, that it is by far the most convenient plan to place the prism close in front of the objective, the slit being fitted in a frame like that of an ordinary lantern-slide, and placed in the stage.

I fix the prism (of dense flint glass) on a light swinging bracket attached to the hood of the lens, so that it may be readily thrown out of the way when an ordinary slide is to be shown, and replaced at once in its proper position, resting against a stop.

If the prism is of fair size, each face 4cm. or 5cm. square, and if the condenser is properly adjusted, there is little or no loss of light.

Perhaps I may mention a contrivance which I do not happen to have seen on any other lantern—viz., a "double nose-piece," consisting of a strip of wood sliding up and down close in front of the condenser (like an instantaneous shutter), with two circular openings in it, on which are screwed short nozzles, with bayonet joints, for attaching either the ordinary lantern-front, or a polariscope, or a microscope, or a "vertical attachment," or an open platform for fluorescence, and other experiments.

This slider has a spring catch, which arrests it when either of the openings is concentric with the condenser, and I find it a great convenience to be able to use any two of the above accessories without the trouble and risk of unscrewing and changing in the dark, the simple movement of the slider placing either of the two at once in a position for use.

A bi-unial lantern is better, of course; but for scientific purposes the double nose-piece is nearly as good.

E. R. P.

## SOME ARREARS OF REJOINDERS.

[23979.]—Will our able contributor signing himself as "Os" permit me to tell him that I should greatly regret saying anything that might smack of vituperation.

I do not think that any good will result from any further discussion on the gas-engine question, because from facts which should have been discussed dispassionately personalities have crept in. Therefore I, for one, shall at the present say nothing on the subject. I have stated what I honestly believe to be the truth. Others, no doubt, have done the same, and as we cannot agree it is best for us to agree to differ. And, in a spirit *very far* from that apparently actuating one other writer at least, I would say that "R. A." is certainly in error (no doubt unknowingly) when he states what he does on one or two points on page 12.

One is that the cast-iron motor he quotes as Davey's, of Leeds, has nothing at all to do with the one I referred to, so that he has not allowed for the operations of other inventors. As the patent will show, the invention *is not mine*; therefore I speak dispassionately. I think this is at least the second time I have stated I am not the inventor. Yet "R. A." will persist in showering on me honours I do not deserve, or perhaps even desire. I trust this repudiation will at last satisfy him he is endeavouring to clothe me in another man's garments.

"R. A.'s" last two paragraphs are *not* certainly dictated by gentlemanly or professional feeling, and I can only use words similar to those used in a reply I recently had from a very well-known engineer in reference to statements made by apparently interested parties in these pages—viz., that "they were far beneath notice"; and that the attacks of writers from behind the cover of a *nom de plume* simply merited the supreme contempt of silence.

Point No. 2 is that *I am using day by day* gas from the apparatus in question; and that, compared with coal-gas, it does not cost me 9d. a 1,000 cubic feet. If the daily use and cost will not warrant my statement, I do not know what will.

Invicta.

## THE STATE OF MAN.

[23980.]—I DARE say "Priam" will be able to answer for himself; but in reply to "O. J. L.," who asks "If Moses gave Israel the Ten Commandments, whence came the fourth, in which the Creation is so distinctly referred to?" I reply; Few doubt but that Moses gave the bare commandments; but the accompanying explanation in which the Creation is mentioned is doubtful, because there are *two sets* of commandments—one in Exodus xx., the other in Deuteronomy v., each containing explanations respecting the fourth commandment, and both *differing radically*. Now both cannot be Mosaic—neither may be; and there seems less reason to suppose the first to be Mosaic than the second, for the first says the Sabbath was established because God rested on the seventh day—a matter beyond any man's experience; while the second states that it is to be kept because of the deliverance of Israel from Egypt—a thing well in Moses's memory. This point is also dwelt on in Exodous xxv.; while, I think, the six days of Creation are not mentioned elsewhere except in the first chapter of Genesis.

With due deference to Mr. Hampden's authority as a philosopher (letter 23925), I must remark that many persons do dispute, and, in fact, utterly deny, the Mosaic origin of the story of Adam and Eve, though he asserts they cannot do so. Will he kindly give his authority for the statement that good authorities 6,000 years old back up his opinion? Moses lived but 3,459 years ago, and, as I know of no older person claimed to be a writer on these subjects, I am curious to hear who Mr. Hampden refers to.

Why the Mosaic origin of the Pentateuch is doubted may thus be briefly stated:—

1. Because the language used in it is the very same as that used in books known to be later in date; yet the Israelites numbered but 70 souls when they entered Egypt, and can hardly have had a settled language of their own. They were 500 or 250 years, there and left it numbering 3,000,000, having had hard times in working for harsh Egyptian taskmasters—and led by Moses, who was brought up as an Egyptian—yet the language supposed to be used by Moses is found to be the same as that in use long afterwards by cultivated kings and scribes.

Remembering the difference between the English of Chaucer and that of to-day, I fail to see how Moses can have written in the style of David or Ezra.

2. Genesis is clearly made up of several books, written by different people, and joined together by an Editor who clearly lived at a late date. The same editor mentions the death and burial of Moses in Deuteronomy xxxiv., and says, "There arose not a prophet since in Israel like unto Moses." The stories of the Creation and the Flood are told twice, and by different writers, all the parts in which the words "the Lord" occur being written by the Jehovist, and the parts where the words "Almighty God" occur being written by the Elohist.

That these were not the same person is clearly shown by chap. vi. Exodus, where it is stated that God's name of Jehovah was not known to Abraham, Isaac, and Jacob, whereas we find these persons using that name according to the other writer—see Genesis xxvi. 22. Eve uses it when saying, "I have gotten a man from Jehovah," as the word "Lord" ought to be translated.

That the Editor lived long after Moses, one passage alone will show: see Genesis xxxvi. 31, where we read, "These are the Kings that reigned in the land of Edom before there reigned any King over the Children of Israel." That could not be written before the time of the Kings of Israel.

I could give many more texts to prove my assertions; but consider I have stated enough to show that we are not bound to consider that Moses wrote all the Pentateuch, and that he may not have written the stories in question. **Memnon.**

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[23981.]—IN reply to the very courteous request of "O. J. L." (No. 23923) and others, the authority of the faith that Moses wrote the first five books of the Bible is generally conceded to Archbishop Usher. He was not the first to promulgate this, but he gave his full sanction to it, and the Church accepted the same. Usher also fixed the dates of every event from the Creation to Christ, and for fully two hundred years a gregarious succession of generations, blindly followed the lead of the good prelate, until the modern days of geology, ancient tablets, Darwin, and growing inquiry, compelled the Bible printers to discontinue its chronology.

The strongest proof of the multiple authorship of the Pentateuch, to me, is its own internal evidence, and I suppose even John Hampden would consider as a reasonable doubt the fact that Moses wrote details of his own death. Much interesting light has been cast upon various portions of the Book of Genesis by the labours of Colenso, Dean Stanley, and many of their admirers, in both England and America.

We are taught that man fell, from a state of perfect purity and intellectual supremacy, into the depths of sin and death. We also learn that in his primæval fall he carried down with him the entire unborn human race, not only in its consequences, throughout all time, but on into an endless eternity, and these consequences are so terrible that they are beyond all language to even approach. Now if this momentous fact, the greatest that can occupy the human mind, was familiar to the Israelites, in common with the other writings of Moses, as a truth of eternal import, it is surely fair to expect that some of their prophets would have touched upon a theme so vital. But, no; the incident is never even named, directly or indirectly, between Genesis and Paul. Of course a negative unsupported is not a proof; but J. Donnelly, in his work "Ragnarok," shows that the history of Eden is from the Arabic, and probably even earlier; that the garden was in Ceylon; that the story was very familiar as a legend or ballad, or both, to the founders of Nineveh, as well as to the very early races of the Hindoos, and hence, I assume, it was first taught to the Jews during the Captivity.

Anyone quietly reading the first chapter of Genesis must be struck with the dramatic power, the variety of language, and the true poetry of the author—more in accord with the rapt imagery of the second Isaiah—the prophet who wrote at the time of Cyrus (see Matthew Arnold)—than the crude language of a nomadic race.

At the close of service, if any twenty people were asked why they believed that Moses wrote the Pentateuch, they would probably give an answer about as logical as that of John Hampden in the "E. M." last week: "Of course Moses wrote it." But as Moses himself never laid claim to this honour, nor did any of his immediate friends for him, I claim equal liberty to doubt whether Moses ever troubled himself to write at all. The materials for this occupation in a wilderness are not handy; he had a busy life; he had daily to control, and discipline, and direct, a most turbulent and heterogeneous mass of liberated slaves; and he is much more likely to have himself given the needful laws orally, for others to write out and circulate, than to have devoted much leisure to penning such a massive work as the Pentateuch. The law of the land throughout the Jewish nationality was termed "the law of Moses," and it was often altered and enlarged through the centuries of an advancing civilisation, and was practically lost during the Seventy Years' Captivity. After this a new collation of the sacred writings was made by Ezra the Scribe, for the guidance of the returning and much better educated captives, and this is practically our present version of the Old Testament. All honour to the good, brave man, who, for the service of his God, and the need of his nation, thus patiently built up the most glorious monument the world possesses. Yet in this new dress it is easy to believe that new matter might appear which was unknown to their fathers. The Creation, the Fall, Noah, the true story of whom, or, at any rate, the tablets from which the Jews first read it, are now, thanks to the late Mr. Smith, in our British Museum; Cain and Abel, Babel, and many scraps of ballad poetry of the Tubal Cain age, all appear to have a Post-Captivity, rather than a Mosaic, origin.

It is not easy to explain the addenda to the Fourth Commandment; but it is noticeable that this is the only one in the Ten in which the "motive," without any after-consequences, appears, and it rather suggests a marginal note incorporated. The only chance of proof on this point, that I am aware of, is buried in the archives of Samaria, wherein are preserved many old MS. copies of the Law, some of them claiming to have been written during the reign of David, but which are most jealously guarded from inspection, by the few remaining descendants of the tribe of Reuben.

**Priam.**

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[23982.]—I DIFFER from "Otter" (23926) in stating that the pages of the "E. M." are unsuited to discussion on subjects similar to the present. Why? Why may not the hardworking English mechanic, such as myself, try to prove that his scientific research and knowledge is in strict harmony with the Scriptures, and also with the higher laws of his being? Surely he ought to be able to hammer out the principles that govern the spiritual part of his nature as well as the scientific and mechanical contrivances, &c., we are interested in. I am sure, from past experience, that our kind Editor will not close the columns of "Ours" from any proper discussion if carried on in courteous language, and if writers will only put arguments and facts, remembering that mere assertion is not argument, nor descending to such remarks as "Priam" indulged in in letter 23902. In desiring to arrive at correct conclusions as to the state of man in his early history, we must understand the meaning and value of "religious truth" and "scientific truth." When these are understood fully we shall find that instead of, as "O. J. L." says, "Scripture chronology being utterly and hopelessly at fault," it is most remarkably and clearly opened out and illustrated by scientific discovery past and present. I would ask "O. J. L." not to assume anything, but to try to prove by proper induction and close examination, because we English mechanics do, of all things, like to have some better data than mere suppositions or assumptions, whether we deal with spiritual or temporal affairs. As you say Scripture chronology is hopelessly at fault, and thus deny the truth of Scripture, I must, to explain my premises, ask "What is religion?" Religion properly defined, is piety towards God. This implies two things, first: a correct knowledge of God, and secondly, the exercise of proper affections in view of that knowledge. The first is theoretic, and is investigated by the understanding. The latter is the practical part of religion, and depends upon the will and moral powers of man. All truth which illustrates the divine character and government is properly denominated religious truth. Now scientific truth is but another name for the laws of nature, and you will find a law of nature is merely the uniform mode in which the Deity works and operates in the created universe. It naturally follows that science is only a history of the divine operations in matter and mind.

I throw aside as worthless the assertion of "Priam," about the Israelites bringing the writings of Moses back from the land of their captivity, merely saying that if they did so it was because they *took* the writings with them to Babylon. I like one of the remarks of "J. H.," "Place God at the helm." Yes, then all will come right eventually, and scientific discovery will ever bear out the ideas of scripture. Scientific method requires, in the language of Joseph Cook, that "when we run up our list of causes, chemical, electrical, physical, mental, spiritual, we should also put on at the top, to reach the infinite, another class, the *unknown*. For even in the 19th century there are more things in heaven and earth than we ever dreamed of in our philosophy." This being conceded, we return for a moment to your idea of Scripture chronology. Now in fixing historical events, several methods have been employed of ascertaining the dates of events. I name four: 1. Observations on generations of men or successions of kings. 2. Celestial appearances and changes, such as (*a*) eclipses; (*b*) precession of equinoxes. 3. Coins, medals, monuments, and inscriptions. 4. The testimony of historians who state the distance between the events or between the event and the epoch. Chronology itself consists of two parts, the first measuring time and adjusting the various divisions, the second fixing the dates of historical events and arranging them in order. Now we come to your remark as to the Mosaic account. That this was written by Moses is capable of undoubted proof. Moses wrote five out of the thirty-nine books of the Old Testament, containing an account of the Creation, origin of primitive nations, of patriarchal history, of the Exodus, the establishment of the Hebrew ecclesiastical economy and their especial history down to the time of his death. These five books contain assertions that he wrote them, and the Jewish nation fully believed in their verity. If, indeed, the Pentateuch was not written by Moses, when could the Hebrews have been persuaded to have received it? The dates given by different writers of the creation of the world are very varied, the generally accepted date being that given by Ussher, which is 4004 B.C. Josephus makes it 4658. There are about 140 different dates assigned to it, some being as low as 3616 B.C., while Dr. Hales gives it as 5411. I must for the present draw my remarks to a close, or I shall exhaust the patience of our Editor, and will only say in conclusion with regard to the early state of man after the fall, that after the sin of our first parents the next transgression recorded as having taken place is that which is generally regarded as of the highest turpitude—murder, and *that* the murder of a *brother!* How clearly this shows that mankind were *not schooled into crime* through successive ages of deterioration! On the contrary, human nature had no sooner become alienated from God by wicked works than it was prepared to plunge into the deepest abyss of moral impurity. As we read on we find this spirit continued to be evidenced with the progressive increase of population until the whole earth was filled with its crimes, the cup brimming full to the period when Divine vengeance was roused, and the Flood was sent to sweep away such a dire epoch. **Arvonia.**

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[23983.]—YOUR correspondent "J. H.," letter 23927, surely never read the first chapter of Genesis; if he will kindly read it he must see that the light created on the first "day" was daylight. v. 5, "God called the light day, and the darkness He called night: and the evening and the morning were the first day." Now, to the simple unsophisticated mind there is no other explanation than that the first day, i.e., the day defined as the time between morning and evening, the rising and the setting of the sun, were thus created. No amount of sophistry will ever explain what this account of Genesis tells us; that there was evening and morning, day and night, light and alternating darkness, three days "before the sun was created," which, as far as "man" is concerned, produces this very light and darkness, day and night, morning and evening.

The infantile, mythical character of the whole narrative is clearly shown in verse 16, when the sun is made to rule the "day," and the moon to rule the night. The sun "produces" both day and night by its appearance and absence; the moon is as often apparent in the day as in the night, and for a great part of the month invisible altogether; how then can she be said to rule the night, except in poetical fancy? **F. W. H.**

## THE STATE OF MAN.

[23984.]—I AM sure our friend, "A Fellow of the Royal Astronomical Society," would not allow himself to make a misstatement if he knew it; therefore, without allowing any religious considerations or discussion (which I consider totally unsuited to our pages) to enter into my remarks, permit me to concisely analyse the dates of the chronology in Genesis v. and vii. alluded to in his letter 23918.

| | | | |
|---|---|---|---|
| Adam | | | |
| to birth of Seth ...... | 130 | | Adam lived 800 years, and ho was, when Methuselah was born, 687 years old; therefore, Methuselah was 113 years old when Adam died. |
| „ Enos ...... | 105 | | |
| „ Cainan .... | 90 | | |
| „ Mahalaleel. | 70 | | |
| „ Jared .... | 65 | | |
| „ Enoch .... | 162 | | |
| „ Methuselah | 65 | –687 | |
| „ Lamech .. | 187 | | Methuselah, it states, was 969 years, and he died. Therefore, he died in the same year that the flood is stated to have occurred. |
| „ Noah .... | 182 | | |
| „ Shem .... | 500 | | |
| „ The Flood.. | 100 | –969 | |
| | 1656 | | |

Therefore, if we are to suppose the history of the world from the time of Adam to the Flood was traditional, Methuselah could have taken the history from Adam, as they were both alive for a period of 113 years.

The "mythical character" of the early history is therefore consistent in itself, and does not show, as "F.R.A.S." states, "that Methuselah must have survived the Flood." **J. S. B.**

[23985.]—IN letter 23927, page 31, the old theory of a vast interval of time existing between ver. i. and ver. ii. of the first chapter of Genesis, during which period everything shown by geology occurred is revived. Against this idea, which never entered the mind of any student of Genesis until geology forced it there, many arguments may be adduced. The division into verses, it must be remembered, is modern; no such breaks exist in the old Hebrew rolls, and ver. ii. really is quite continuous with ver. i., with which, moreover, it is directly connected by the word *and*, clearly implying immediate succession in point of time. To interpolate countless ages between the two verses is against all rules of interpretation, and is also in direct disaccord with Exodus xx. 2. The phrases used clearly show that the writer of Genesis had no such idea in view. Further, according to ver. xix., the sun was not made until the fourth day; that is, not until after the period to which "J. H." assigns geological time, but plants could not grow nor animals live without the sun. In no merely figurative or poetical sense, but in strict scientific accuracy, every animal or plant owes its life to solar energy. How then could either animal or vegetal life exist on the earth during this interpolated period before the creation of the sun, and how was the earth kept in its orbit during the said period? "J. H." tries to meet the first part of this objection by asserting the existence of light independently of the sun. I am not aware of any such source of light, except such as are contrived by men, and there were no men during this period, and therefore no light, not even starlight, for the stars were made on the same day as the sun. Thus we are asked to believe that all the geological plants and animals lived in darkness, which is absurd. The crowning argument against the theory is, of course, that derived from the work of Darwin, which shows that, instead of having been created perfect, man has really been evolved from the lower animals, being but the highest link in the great chain of organised creatures. **Wm. John Grey, F.C.S.**

Newcastle-on-Tyne.

[23986.]—I SHOULD like to state, purely in the great interests of science, that the British Chronological and Astronomical Association has succeeded beyond the possibility of question in enumerating all the chief total eclipses of the sun and moon, and also in tabulating the transits of Mercury and Venus, thus forming three astronomical lines of time reversed from the present period to year 0. The association also has formed the solar cycle of simple lunar years, which are precisely the motions of the moon and the axial revolutions of the earth. Upon this solar-luni cycle the two astronomical lines of years have been extended, and the result is a correct line of time. It is proved by the fact that an eclipse repeats its date after 651 years, called the great astronomical year, and as the solar cycle shows, occurs on the same day of the week, thus:—

| | | | |
|---|---|---|---|
| Year | 1 | 1st of fourth month, | Friday-Saturday. |
| | 651 | | |
| Year | 652 | do. | do. |
| | 651 | | |
| Year | 1303 | do. | do. |
| | 651 | | |
| Year | 1954 | do. | do. |
| | 651 | | |
| Year | 2605 | do. | do. |
| | 651 | | |
| Year | 3256 | do. | do. |
| | 651 | | |
| Year | 3907 | do. | do. |
| | 651 | | |
| Year | 4558 | do. | do. |
| | 651 | | |
| Year | 5209 | do. | do. |
| | 651 | | |
| Year | 5860 | our 1861, Jan. 11-12th, | Friday-Saturday. |

A natural luni-solar cycle of seven years will produce the days of the week and dates of the month by giving 30 and 29 days alternately to the months.

The point of interest is—and it is a great one—the years and dates of ancient history show that there has always existed, since year 1, a number of men who have kept correct years. The dates of lunar years take care of themselves.

**J. B. Dimbleby.**

The Shrubbery, Chatham-place, Hackney, E.

[23987.]—IT is curious to notice how here and there we find in the world of thought "fossil" ideas and arguments, which, by some strange process of protection, have survived the fate of their brethren. Such a fossil is the old and exploded argument soberly advanced by your correspondent "J. H."

There is not a particle of evidence for his theory that during, or before, or after the Glacial period the world became desolate and *dead*, or that "the present world is a *re-creation* from the past." Such statements would find more fit expressions in the pages of the *Christian Million*, from which he quotes.

The overwhelming weight of geological evidence points conclusively to the fact that the development of the world, physically and biologically, has gone on slowly and surely through a period of time so enormous that the ordinary measurement of years is inadequate to express it, and at no time was this process stayed or its results destroyed universally by the Glacial or any other period.

By this process of development we are inseparably linked with the first speck of organised protoplasm, and we have no evidence of any supernatural creation from then till now. If "J. H." is acquainted with glacial phenomena, he must be aware that its effects are *local*, and can be determined geographically by well-defined boundaries. That whilst the North of England and the whole of Ireland and the North of Europe was shrouded in a vast sheet of ice, the land south of the Severn and the Thames, and the South of Europe generally, was perfectly free from glacial conditions; and he will not find any evidence of glaciation in these districts; yet it is with these districts, particularly the South of Europe and Asia Minor, we have to deal when considering the question of the origin of man. And we have every evidence to believe that whilst glacial conditions prevailed in their greatest intensity in one district, other regions were free, and supported vegetable, animal, and human life.

It is very instructive to be told "simply" "the reason why geological times are not mentioned in the Scriptures." May we ask "J. H." by what process of "clairvoyancy" he became acquainted with the "reason why" the writer of the Pentateuch stated some things and omitted others?

In considering the Genesis of theology and the Genesis of science in their relation to each other, we have first to ask on what basis of fact are they both founded, and I hope, in our mutual interest, that "Priam" will either substantiate or withdraw his interesting statement as to the authorship of Genesis I., and from whence did it come. It is interesting to note in the face of this discussion that the temple of Denderah, in Egypt, contains frescoes representing the various acts of creation as described in Genesis I., and as Moses was "learned in all the learning" of the Egyptians, he may have heard it in the colleges of Heliopolis.

John Hampden must remember that "the highest authorities of the last 6,000 years" have often been wrong. The highest authority of "the highest authorities of 6,000 years" could not repress the genius of Tycho Brahe, of Galileo, of Copernicus, and of a host of others, and the "highest authorities" have, in the long run, to reconstruct their theories, and that repeatedly. "Antiquated authority" often means *antiquated error*. He also states that "of course the story of Adam and Eve is Mosaic." This may be; but *why* "of course"? What proof can he offer?

I am looking forward hopefully to this discussion that we may obtain some clear and well-supported account of the origin of Genesis I., and of the authority it bears. When this is determined we shall have all the materials before us for an impartial consideration of the question of the "Origin of Man."

**A Fellow of the Geological Society.**

[23988.]—ACTING on "A Fellow of the Royal Astronomical Society's" excellent advice to your correspondent "O. J. L.," I have looked up the "simple illustration" in Genesis v.

| | | |
|---|---|---|
| Verse 25 says: | | |
| Age of Methuselah at birth of Lamech.. | 187 | years. |
| Verse 28: | | |
| Age of Lamech at birth of Noah........ | 182 | „ |
| Chapter vii. verse 6: | | |
| Age of Noah at time of the Deluge ..... | 600 | „ |
| Total.... | 969 | „ |

Chapter v. verse 27;—*All* the days of Methuselah were 969 years, *and he died*.

Am I to suppose Methuselah was resuscitated, as "F.R.A.S." says he survived the Flood; whereas Genesis distinctly states the year of that event to have been the year of his death?

I am rather disposed to think "F.R.A.S." has given more "attention" to the "Short History of the English People" than to the book he quotes.

**Chas. J. B. Findon.**

[23989.]—WILL "A Fellow of the Royal Astronomical Society" kindly say how he infers from Genesis v. that Methuselah must have survived the Flood?

May I suggest to Mr. Hampden that "Priam's" opinion may be none the less true because anonymous, and also that everyone now is at perfect liberty to accept or dispute any dogma. Coercion in religion is happily a thing of the past. Mr. H.'s "highest authorities" are probably the same who taught that the earth is a flat box-like parallelogram, that the firmament is supported by immense walls, that above the firmament is heaven, where the angels live, whose business it is to push and pull the sun and planets to and fro, &c., with very much more of equal truth and value.

I would recommend all interested in this discussion to procure Dr. Zerffi's lectures on "Pre-Adamites: or, Prejudice and Science," and "Long and Short Chronologists: or, Egypt from a Religious, Social, and Historical Point of View."

**E. C. C.**

[23990.]—GEN. i. 1, 2, expressly says that before the seven days there had been a creation that had been thrown into confusion. The exact words are: "The earth was *tohu ve bohu*," which is very like our "topsy-turvy."

After the Fall there were two sorts of men on the earth, "the Sons of God," and "the sons (or children) of men" (vi. 2); that is, there were descendants of Adam and Eve who still retained the perfection which the latter had forfeited, and there were a race of men that were "of Adam's own image," which no longer was completely after the image of God, and through the union of these two races, all mankind became inheritors of the curse pronounced on Adam.

That Adam and Eve had children whilst in Paradise is as good as declared in the *command* that was given them at their first interview, to be fruitful and multiply, and, as your readers will remember, Milton introduces a scene that *ought* to have led him on to a statement to the same effect. If Adam and Eve were long in Paradise—and they may have been there at least a hundred years (iv. 25, v. 3)—there would have been many of the better and wiser race in existence at the time that Cain "builded a city," and he may have learnt how to do so from them.

Has not "F.R.A.S." made a mistake about Methuselah? Gen. v. 25, says that he was 187 years old when Lamech was born; v. 28, that Lamech was 182 years at Noah's birth, and vii. 11, that Noah was 600 years old when the Flood came, which would make the year of the Flood coincide with that of Methuselah's death, which occurred in the 969th year of his age. If

"begat" is taken literally, he would have died a year and a half before the flood, which would then have to be reckoned as occurring in the 971st year.
**K.**

### BORT.

[23991.]—"Z Y. X." gives us further interesting particulars. I cannot find the account of Dr. Robinson's use of his daughter's diamond for the purpose of turning up the hard steel pivots of his telescope. The letter signed "B. P. A." appears in the English Mechanic for Jan. 15, 1869. Perhaps some reader can give the reference to Dr. Robinson's use of the diamond, and I will look it up and write again. There is no doubt that a diamond tool can be used to cut hard steel. The question is, Can it be used practically with any such advantage as to supersede the use of the revolving emery wheel? I say not. But on that question many readers will be glad of further data.

Upon the Dessau nickel diamondiferous tools, I see, under the microscope, that the surface is armed with clear transparent diamond crystals of minute size, but not giving much clue to the system to which the crystals belong. Probably "bort" is one of the substances which does not escape adulteration. If any reader will kindly send me a minute portion of powdered bort, or powdered carbonado, or other of these materials which he is using, I will examine it under the microscope, and report it in "E.M." **James Edmunds.**

Grafton-street, Bond-street.

[23992.]—"S. E. S.," letter 23932, speaks of a black diamond. Does he not mean carbonado, or carbonate, which is not crystallised, but amorphous.

Many years ago the carbonado was used for dressing millstones, and I know it has been used since for cutting stones.

What I want to protest against is that the stuff should be called diamond, unless in a popular sense, such as when coal is called a black diamond, because diamond, carbonado, and coal have all a common origin—viz , carbon. **Z. Y. X.**

### NEW MIDLAND ENGINES.—TO "FIREMAN."

[23993.]—"Locomotive" (letter 23943, p. 35) has so covered the ground in his letter that practically he answers all the points raised by "Fireman." "Expansive working" has changed these engines, which were called "big failures," into "big successes," and all in a few days, and without *any* alteration in the engines themselves. I know well that if the engines had had larger boilers they would have done better, but I can't stand by and see fine engines run down and called "big failures," just for want of "expansive working." Where I blame the company is not for making the engines, but for not informing the drivers that they wanted working differently and more expansively; if all this had been told at first, there would not have been all this bother, and the fine engines would not have got a bad name; anyhow, all's well that ends well, and now the 1667 class are doing as fine work as the 60 or 800 classes, so I have only got to say in conclusion that I am now more than ever in favour of

**More Expansion.**

P.S.—"Fireman" gives a set of conditions that the big engines do not get into—they are "linked" well up, worked more expansively, and, instead of losing time and taking pilots, they are taking their trains to time, don't want a pilot, burn less coal, and have lots of steam. What a change in ten days!

### BRAKES ON THE G. and S.W.Ry.

[23994.]—Mr. W. B. Thompson (letter 23941, p. 34) has evidently come to a hurried conclusion that the G. and S.W. Co. is going to change its brake. Nothing of the kind; it is going on fitting the Westinghouse as fast as possible. The company has got one vacuum train fitted just as an experiment; and it has some carriages with both Westinghouse and vacuum, which used to run over the Midland to Bristol, and over the Lanc. and Yorks. Ry. The lines that interchange at Carlisle are G. and S.W., Caledonian, North British, North-Eastern, Midland, North Western, W.C.J.S., and M.S.J.S.; and as they all run Westinghouse fitted stock to Carlisle there is no trouble in exchanging at that place. **Loco.**

### NEW BRAKES.

[23995.]—I think that certain misstatements made by "Driver" (in 23907) in your issue for March 6 ought to be corrected; these refer to the London, Tilbury, and Southend Railway.

This company never fitted any new stock with the chain brake, the only stock fitted being some which originally belonged to the North London Railway, and was handed over to the Tilbury line in that condition, and they have at present no intention of taking it off.

The Westinghouse automatic is thus the only brake adopted, and this has been done after mature consideration. **Loco. Draughtsman.**

### DYNAMO.

[23996.]—I can assure Mr. Eaves that I do not intend to go on with the making of the dynamo after the instructions at present to hand, as they are not so clear as I think would justify me in laying out a largish sum of money. I, however, have no right to complain. I beg to point out to Mr. Eaves that I stated very distinctly on Jan. 2, in letter 23704, that I wanted to light 16 glow lamps of 20 c.p. each; and on Feb. 6, in query 55839, I asked for information as to shunt winding, for obvious reasons. If Mr. Eaves would give me that information, I should certainly feel much obliged to him. I like this kind of work very much, and have every facility for carrying it out. I should prefer the construction given in No. 1007; but would not adhere rigidly to that shape if another and better is proposed.

March 14. **Anglo-Dane.**

### ETERNITY OF MATTER.

[23997.]—How do those who believe in the eternity of matter get over the following difficulty?

The material universe has been cooling as long as it has existed, so the further we trace it back the hotter we find it; it could never be more than infinitely hot, but it can be shown that it would not take an infinite length of time for the universe to cool down from an infinitely hot state to its present state. For suppose it to have been infinitely hot at one time, then in a moment it would have cooled down to a finite heat, and it can only have taken a finite period to cool down from any finite heat to its present heat, no matter how slow the cooling; therefore, the present course of events called Nature has not always existed. **A. W.**

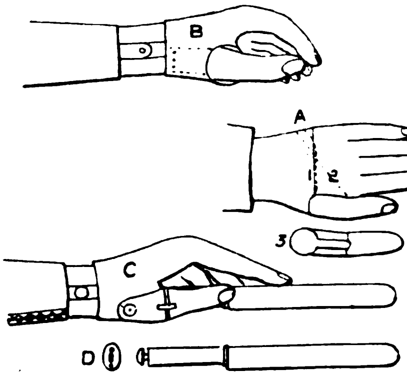
## REPLIES TO QUERIES.

⁂ *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[54745.]—**Rising Logarithms.**—There is often a table thus headed in Epitomes of Navigation by which to find the hour angle from the meridian. It contains the logs. of the square of the sine of half the arc, thus: rising log. of 28° or 1h. 52m. is 18·767350, which, divided by two, gives 9·383675 the log. sine of 14°. The above does not correspond with the logs. quoted by Mr. Ruppel in 54994, but it may afford him some clue to what he wants.—Alfred Dobson, Blenheim, N.Z.

[55323.]—**Musical Scale.**—I must apologise for the error in my letter on page 564, which was written hurriedly. I could not refer to tables while writing, but discovered the mistake in calculation just after, and sent a correction to our esteemed Editor. It must either have arrived too late or not have been clear enough, as my letter appeared in its original form. It is true that the two "semitone intervals" (I don't like this term) are of equal magnitude in the division of the diatonic scale as proposed by Mr. Walter Hardie—viz., as 243 is to 246; but my objection to this division is that such a ratio between two sounds of the musical scale is too complicated to be naturally correct, and it can be correct in no other way. The very essence of music is simplicity of ratio between the vibrations of the notes used, and complexity is unintelligible to the musical ear. There is far more simplicity in the ratio 15 to 16 than there is in that of 243 to 246, which is a comma ($\frac{80}{81}$) smaller; and this simpler ratio for the note sensible is secured by introducing one small tone ($\frac{9}{10}$) in each of the two tetrachords into which the scale is sometimes divided. There are also other complex ratios entailed by Mr. Hardie's division, as, for instance, the major third is in the ratio of 64 to 81 with the keynote, instead of being as 4 to 5; the major sixth as 48 to 81, instead of as 3 to 5; and the major seventh as 128 to 243, instead of as 8 to 15, all being a comma too high, and the minor thirds between E and G and between A and C are necessarily each a comma too small, being in the ratio of 27 to 32, instead of 5 to 6. In melody, as well as in harmony, the endeavour of musicians is to produce pure intervals—that is, to produce intervals with simple proportions; and although it has been noticed that there is a preference for taking the great tone when choice is offered, yet the ear is ever comparing with the key-note, and makes this adjustment of a comma wherever necessary. The natural scale does not contain two intervals of a like magnitude side by side, neither is any greater interval made up of two similar smaller intervals. I am glad to see this question to the fore again, and in view of the forthcoming Exhibition of Inventions, a little acquaintance with the subject will enable those interested in pure intonation, as applied to keyed instruments, in some measure to understand the aim and intention of any exhibits of this character that may be found there. I am hoping that this branch of art will be well represented, and receive a strong impetus.—S. E. Hunt.

[55316.]—**Artificial Hand.**—Like "D. P.," I have a friend who met with the loss of his hand, rather nearer the wrist than shown on "D. P.'s" drawing. He tried the best makers of artificial hands on this side of the Atlantic, and all, without exception, proved useless as far as doing any real work was concerned. We then set to work to make a hand which would enable him to handle a knife or a pen. Our first attempt was similar to B. Noticing that he had considerable movement in the remaining portion of the bone above the thumb, it struck me that he could utilise that motion if something were clasped around it similar to the manner of holding music with the patent springback holders, so we made a hand with rigid fingers and a thumb, as shown at A3, which was attached to the inside of B by leather to give it flexibility. This worked well, and very natural for light work, but his hand being amputated so far back as A1, the spring grip had not the hold which I hope "D. P.'s" friend, at dotted line Fig. 2 would have. The style he now uses is shown at C—fingers rigid; thumb works on a joint purposely exposed to show working; A is opened or closed by a neat thumb-screw, to hold a knife; A is first inserted into D, and given a quarter turn, and then the thumb-screw binds A between thumb and index finger, as shown in the drawing. The hands are fastened on the usual way, with a joint at the wrist and laced leather band above. Hope some of these will prove of use to "D. P.'s" friend.—Andrew Leitch, Hamilton, Canada.



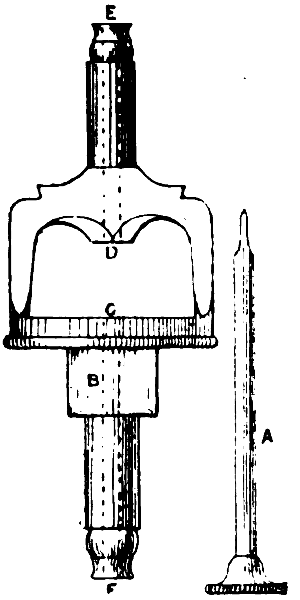
[55384.]—**American Organ.**—To "H. M. I. R."—Thanks for reply; the plan you have adopted is no doubt the best when the instrument will admit of it; but in most cases there would be a difficulty in finding room for the windways for the added set. As regards Munro reeds, I believe they are about the shortest in the market, and I think are all made to one scale. Should consider them very suitable for organette; in fact, I have seen them so used in an organette of American make.—J. E. Floyd.

[55571.]—**Turbines.**—In answer to "E. F.," the arrangement proposed will work, provided the draft tube is not too long, and everything is tight. If, however, any leakage takes place, the draft tube, unless perpendicular or nearly so, will require refilling with the valve closed. Is the saving in excavating, partially balanced as it is by the cost of the valve, worth the risk of leaky packing, &c.? A vertical draft tube is better than a horizontal one, because it is shorter, and need not be so large in diameter; hence the velocity of the effluent water is greater, and will carry off any small quantity of air which may leak in. If the velocity is not sufficient for this purpose, difficulties may be expected.—Chas. Louis Hett.

[55723.]—**Gramme Dynamo.**—To Mr. S. Bottone.—The frame I have made for above dynamo is the usual upright Gramme pattern—11in. high, 10in. long, and weighs ¼cwt.; the field magnets are cast with the pole-ends on; the arms of field magnets are each 3¼in. long by 1¼in. diameter; the pole ends are 1⅛in. wide and semicircular; the ring (Pacinotti form, with 12 cogs) is 3in. inside measure and 4¼in. outside diameter (including cogs). I have Nos. 16 and 18 D.C C. wires, and require machine for incandescent lighting and experiments.—Gramme.

[55813.]—**Land Drainage.**—Practical experience in land drainage might be obtained in many counties; but our friend "Paddy" should not omit Lincoln or Cambridge. One of these and Yorkshire could, I should think, give him all the experience he would need. He should, first of all, read up such books as Scott's "Draining and Embanking," published by Lockwood and Co.—Nun. Dor.

[55702.]—**Watch Pivot Holes (U.Q.).**—I send the following sketch to "Josefus." A is a steel rod accurately turned and finely pointed, which fits in the long hole indicated by dotted lines. There are sometimes three or four of these steel rods. The uprighting tool is made of brass or gun-metal, and its beauty and worth consist simply in its accuracy. B is just a square for the purpose of holding it in the vice. Now, supposing we had to plug up the top centre wheel hole in a Swiss watch, we simply put one of these steel rods into the hole with its point coming out at C, on which point you could rest the bottom plate-pin, insert another runner from the top, and where the point touches is the place to drill the hole.—ANNIE.



[55827.]—**Gravity and Dead Escapements.**—The "Country Parson" now asks me to point out something or other to him from my book. I shall do nothing of the kind. I am always ready to answer *bonâ-fide* inquiries about clocks, if I can, without too much trouble, for persons who show that they have really attended to what I have written and seem capable of understanding more. But I shall not answer a *malâ-fide* question from a man who first gratuitously and anonymously published that my book is "distinctly wrong" in saying what it never has said in any one of the editions; and then, when he is made to see that, does not apologise in the smallest degree, but takes refuge in saying that the sentence he quoted wrongly at first "without doubt conveys a wrong impression." Very likely it does to those who do not choose to attend to my words, which Mr. Brock tells me, again, are perfectly correct, except as to one gravity regulator in which a customer wanted some expensive additions of his own for electrical connections and other things. I have already given the numbers of the pinions in all those clocks that I have had, and all other necessary information, as to what they require, and in what respects I have found them superior to dead and single-beat escapements, and in what respects not superior. I shall not repeat them for a man who only wants to find a pretext for some more contradiction in order to cover his own carelessness and rudeness.—EDM. BECKETT.

[55834.]—**Punching Machine.**—Machines of the kind can be seen at any boiler factory, and illustrations in the lists of makers of machine tools. —T. P.

[55849.]—**Brazing Steel.**—File the surfaces clean; cover with powdered borax and spelter, and pinch the parts between brazing tongs—that is, tongs with broad and heavy beaks, which are made nearly white hot. You can also braze with the blowpipe.—ESSAR.

[55850.]—**Cover for Flywheel.**—What kind of advice is wanted in this case? "Soho" has simply to rivet up some sheet iron into the half of a circle —say, 16ft. 6in. by 8ft. 4in.; repeat, and join the two by riveting a strip, say, 2ft. 2in. wide, having a flange of about 1in. at each side.—T. P.

[55853.]—**Printing Press**—I do not know of any test experiments to ascertain the pressure per square inch on the table and plates of an ordinary press; but it must be something considerable. The querist will have no difficulty in procuring a press to do the work he requires, which is really a very small job.—A PRACTICAL PRINTER.

[55858.]—**Volt and Am. Meter.**—This querist will find an am. meter on p. 62, and a voltmeter described on p. 568, Vol. XXXIX. I have no doubt there are many others described in back numbers, but it is advisable to purchase instruments if accuracy is required in the tests.—NUN. DOR.

[55860.]—**Length of Metal for Cambered Springs.**—I don't think there is a rule. We cut the thing out in hoop iron; bend to exact shape required, mark off the length, straighten out, and there is the gauge.—ESSAR.

[55866.]—**Chemical Stamping.**—It might be possible to do something of the kind with chloride of cobalt; but it is scarcely probable, as such a device would be utilised in many ways, and would certainly be patented.—F. I. C.

[55867.]—**Feed Pump.**—Cannot this querist drive his pump by connecting it with a small shaft driven by a large pulley to reduce the speed. The dimensions, number of strokes, &c., must be calculated according to the rules and plan adopted; but the rules can be found in "Molesworth's Pocket Book."—ESSAR.

[55870.]—**Optics with the Lantern.**—To "EXCELSIOR."—I for one shall be very glad of the drawings you mention. Will you also tell me which form of lime you consider best, the cylinder fixed on a pin, or the pieces wedged into a circular brass ring?—GRAPHO.

[55870.]—**Optics with the Lantern.**—By a printer's error I am made to say "I get a parallel beam when the principal tube jet is ⅛in. from condenser." This should read "I get a parallel beam when the knuckle of jet is ⅛in. from condenser."—W. H. SHRUBSOLE.

[55870.]—**Optics with the Lantern.**—To L. WRIGHT.—Many thanks for your answers. I am still puzzled at my failure, as I am sure that I use prism at proper angle. I shall take your advice and use the mixed gases. Will you help me in another experiment? I cannot get reversed sodium line satisfactorily; I use in front on lantern a large square biscuit-tin cut in two, and sliding camera fashion—one half fits front of lantern, and the other has a large slit cut in it. I also have adjustable slit on lantern front. How far do you actually place the sodium flame from lantern front in the experiment, as described in your book? I hope I am not troubling you too much; but your book has much interested me, and I do not like to be beaten. Many thanks to "Excelsior." If the Editor will permit, I shall much like description he offers. Mr. Shrubsole will perceive that I have Mr. Wright's book; in fact, my original query was on an experiment described in it. Perhaps Mr. Shrubsole, having worked through the book, can give me a hint which will help me with respect to reversed sodium line.—S.

[55876.]—**Improving Light in Coal-Gas.**—Many thanks to "Arvonia" for design and information about carburetter; but before proceeding to manufacture, will he kindly state whether the size given is not too large for ten flat flames, not Argand flames? Also how long the cotton wool will remain saturated with benzoline, especially the upper layer, seeing that each layer is cut off from the reservoir of benzoline, and there is no means of using capillary attraction for re-moistening after once becoming dry. Supposing your design will suffice for, say, ten flat flames, how long will one charging with benzoline last? Because if it is necessary to daily moisten the cotton wool in the trays by refilling from the top, it has occurred to me that a slight improvement to meet this end might be arranged by passing a large cotton wick from each tray down to the reservoir of benzoline. Will not cotton wool after a time, by its own weight, become too solid or dense?—WOOLWICH GAS.

[55896.]—**Heating Room with Steam.**—It is difficult to give "Novice" the information he seeks with accuracy upon the details furnished. He will, however, require about thirty-eight 17ft. lengths of 2in. pipe, which, with the bends, will give about 680ft. run. Steam at as low a pressure as 10lb. may be used, but if he can obtain 40lb. or 50lb. so much the better. The pipes should be placed under the floor, and about one quarter the area of it at a point furthest from the cold air inlet should be perforated, so that the heated air may ascend. After passing through the room, the moistened air should be drawn off by being connected to a flue, a proper feather being introduced in the usual way. If my explanation is not clear, I will supply a sketch. See my reply to 56049.—F. C. S.

[55905.]—**Cores.**—I notice some errors on page 116 regarding the above—viz., at line 18, read "lay in the core bar"; at line 20, leave out the semicolon; and at lines 21 and 22, read "adjust screwed chaplet and socket in top part," and leave out the comma after chaplet.—ASTERISK.

[55935.]—**Electro-Chemical.**—I have no wish to hurry Mr. P. Ward as to the publication of his researches; but I am curious to know how he measured the E.M.F. of "several million volts," and how he contrived to cause a current of 30 h.p. in the primary to yield a current of 1,000 h.p. in the secondary. It would be very convenient to have a means of making 30 h.p. do the work of 1,000 h.p. —WM. JOHN GREY, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

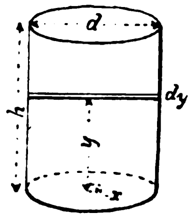
[55947.]—**Pressure of Water in Pipes.**—In glancing through the reply of G. Worlands to this query, I find that he has, in the second part of it, reproduced an error (the result, probably, of a misprint) from, I think, the "Colliery Manager's Calculator," in the formula for finding the number of gallons of water delivered from a borehole. The number of cubic feet discharged per minute is $= v \times \cdot 7854\ d^2$; and as there are 6·25 gallons in a cubic foot, the discharge in gallons is manifestly equal to $6 \cdot 25\ v. \times \cdot 7854\ d^2$. This indicates the evil of replying to questions without an adequate knowledge of the subjects to which they refer; or of placing such implicit reliance on what is contained in books as to take for granted, without question (as in the present instance), a formula containing an error of the most palpable kind, which should have been detected at once even by the merest tyro in hydraulics.—LYONS.

[55969.]—**Problem.**—I am afraid that in his answer to the above in your last issue "Weiv Revir" has fallen into error, and has worked out (correctly) the answer to a different though somewhat similar question—viz, the time required for the discharge of a vol. of water = the contents of the vessel when the head remains constant. In this latter case we have, as he states in the formula:—$Q = M S V T$ — the letters having the same signification as given,

$$\therefore T = \frac{Q}{M S V} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1).$$

But in the problem the vessel receives no additional supply, and the head consequently varies. Now, suppose the contents of the vessel to be divided into an indefinitely large number of layers, the indef. small interval of time occupied by one of such layers in descending through a height equal its own thickness—i e., for the discharge of one of such layers—is obtained by equation (1), since in such a case we may assume the head to remain constant, the distance $dy$ being inappreciable. In Fig. 1, let $dy$ represent such a layer, situated at a height $y$ above c.gr. of opening; the other dimensions being as given in question:

FIG 1.



$$\text{Vol. of layer} = \frac{\pi}{4} . d^2 . dy \text{ cub.-ft.}$$

$$\text{Sect. area of opening} = \frac{\pi}{4} \cdot \frac{x^2}{144} \text{ sq.ft.}$$

$$\left.\begin{array}{l}\text{Veloc. of descent}\\ \text{of layer in question}\end{array}\right\} = \sqrt{2 g . y} = 8 \cdot 074 \sqrt{y} \text{ft. per sec.}$$

$$\text{Constant} = \cdot 67 \text{ as assumed.}$$

$$\therefore\ dt = \frac{\frac{8}{4} \times d^2 . dy}{\cdot 62 \times 8 \cdot 074 \times \frac{8}{4}\ \frac{x^2}{144} \times \sqrt{y}}$$

If we integrate the above expression we obtain the whole time $t$ required for the vessel to empty itself—i.e.,

$$t = \frac{144}{4\ 975} \times \frac{d^2}{x^2} \int_0^h \frac{dy}{\sqrt{y}}$$

$$= \frac{144}{4 \cdot 975} \cdot \frac{d^2}{x^2} \times h\sqrt{b}$$

$$\text{or } t = 57 \cdot 88 . h^{\frac{1}{2}} . \frac{d^2}{x^2} \text{ seconds.}$$

The above result is just double that obtained by "Weiv Revir," and proves what was pointed out by "M.I.C.E." in his solution.—C. Mc +.

[56025.]—**Trueing Grindstone.**—Has not "Fair Dealing in Monopoly," who says he is a patentee, allowed his feelings to get the better of his judgment? If he knew so much as he now discloses, why did he ask for the information in our columns? Now, I suggest a common—very common—rough slide-rest, carrying a piece of carbonado at the end of an iron tool. This will true up any grindstone of any kind, whether Newcastle, Welsh, or even emery!—Z. Y. X.

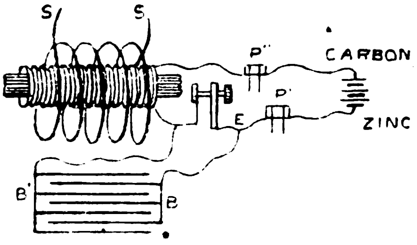
[56026.]—**Trueing Grindstone — Patent Law.**—Having been accused (p. 255, Vol.

XXXIX.), of being in the interest of the telephone companies (I do not know whether there is one or two), I hope I shall not be misunderstood if I venture to demur to the phrase, the "socialistic tendency of the times," which your correspondent "Z. Y. X." introduces (p. 40) in a reply under this head. I do not admit the existence of any "socialistic" tendency (whatever that may mean) that has not existed at any time since monopolies were first granted. There is no more tendency in "ours" to "get at trade secrets and the mode of getting round a patent" than has existed at any time within the memory of "Z. Y. X." and myself. I yield to no one in a just recognition of the rights of a patentee; but knowing what I do of patents and patentees, I confess to some degree of smiling when a would-be monopolist finds that his "invention," as he is pleased to consider it, is as "old as the hills." In this very connection—a machine for trueing a grindstone—I am confident there can be nothing better than the old plan pursued for generations by our forbears; and if some one has devised a means of putting the bit of iron into a rest or guide, I can only say that he may be entitled to claim the exact way he has done it, but he cannot prevent any one else doing the same thing in a different manner, because there is really no "invention" about it. The thing has been done hundreds of times, and "all honour to 'Marcus'" means no honour at all, unless it can be shown that the machine or apparatus in question is a real invention. As to the telephone business, no one regrets more heartily than I do that the battle was so easily ended, for I look upon Reis as the real inventor, and consider Bell as the merely successful adapter, just as Watt was with the steam-engine, though I suspect Watt expended more brain-tissue than ever Bell did. When we are all dead and gone, the impartial historian will wonder how it was that no one apprehended the importance of the facts Reis communicated to a well-known English electrician until Bell unearthed them, and, in a race with Edison, Gray, and others, managed to get the first patent. I have not the slightest commercial interest in telephones; but I suspect that I regret more than those who are so anxious to make use of the outcome of other men's brains, the result of the trials in this country, for they have given Bell, or his representatives, a practical monopoly of the telephone, and put a stopper on its development for 14 years from 1876. It is not these cantankerous quibblers—these miserable copiers of other men's work—the public have to consider; but those who really help in the march of progress by improving upon the ideas of others, and the latter have been stopped because the decision of a judge has given the monopoly of the principle to Bell, whereas, as it seems to me, he was entitled only to claim his method of carrying out Reis's idea. Money, as a matter of course, now carries the day; and who is prepared to fight the monopolists who have bought up every device which threatened to rob them of their monopoly? That is no fault of the patent law; but is due rather to that greatest and worst of trade-unions—the lawyers—which makes it impossible for the impecunious to fight against those who have money, even though all the equity is on their side. Having thus relieved myself, I would say that "Z. Y. X.," in quoting the actual words of the prohibition clause, goes too far, for it has been held that one may make a patented invention for the purposes of experiment, but must not use it in the sense of beneficial user. That is, to take the telephone, one may make a telephone, and even exhibit its capabilities to friends; but he must not, for example, lay it on to his stables to call his coachman, as that would be a beneficial user. The law, on this point, is very clear, and there are numerous cases to exemplify it. You may make any patented invention you like for the purposes of experiment; but you must not use it in the ordinary sense of the term. It seems to me that the law here is very definite and satisfactory, for the sole object of granting a patent is to promote invention, and that would be almost impossible if one could not make and use a patented device by way of experiment.—NUN. DOR.

[56033.] — **Regulating Shocking Coil.** — "S. D." might regulate the strength of the shock obtainable from his coil by having the zinc plate more or less immersed in the dilute sulphuric acid in the outer cell of his battery; it would also be better if he were to actuate the contact-breaker with a small electro-magnet, separate from that in the coil, as the introduction or withdrawal of that magnet from the coil greatly varies the strength of the secondary current (therefore, of the shock obtained), it being weakest when the magnet is withdrawn.—J. KEAN.

[56033.]—**Shocking Coil.**—Make one glass cylinder 10in. long, ½in. inside diameter, cement a brass cap to each end, make a hole through one end for a brass rod to slide in, which must be a little longer than the tube, so that it can be brought in contact with the bottom plate, then fill with water and stand up; join wire from coil to one plate and wire from handle to the other, start with rod right up and slide down gently. Water, being an imperfect conductor, offers a greater resistance to the current, as the electrodes are separated.—C. H. CARTER.

[56037.]—**Induction Coil.**—It is almost impossible to explain to W. G. Glasgow the precise cause of his inability to obtain strong shocks from his coil. I should think it very probable that there must be a connection between two, or perhaps more, layers of his secondary wire, so that the current, instead of going *through* each layer, passes from one to the other, thus shortening its should-be journey; and this is very important, as the circulating of the secondary current round itself in the separate layers of wire greatly intensifies it; or, perhaps, this thin wire has had a sharp twist or bend together; either of which will sometimes materially decrease the strength of a current on account of the increased amount of resistance offered to it; or, again, is W. G. G. sure that his batteries, contact-breaker, and primary coil are all right? Now, with regard to the condenser, the annexed diagram will, I hope, help to explain it.



Let P′ P″ be the terminals of the primary coil, M the soft iron core, and S S′ the terminals of the secondary coil; the primary terminal P′ is connected to a series of sheets of tinfoil B, connected together along one edge, but separated by sheets of paraffined paper from a similarly connected series of tinfoil sheets B′, which are connected to E; this arrangement and connection of tinfoil sheets constitute the condenser, which is, I might say, always placed in the wooden base of the coil; the base being made hollow to receive it.—J. KEAN.

[56037.]—**Induction Coil.**—It is impossible to tell the reason why the induction coil will not give good results. Possibly the wire of your secondary is too thick; examine connections and contact breaker. A condenser for an induction coil is made thus: Take many sheets of tinfoil and paraffined paper, arrange in alternate layers, connect together the 1st, 3rd, 5th, &c., of the tinfoil sheets, and also connect together the 2nd, 4th, 6th, &c.; then connect each of these series to the ends of the primary coil. You will get good contact by screwing a piece of wood firmly across the edges of the tinfoil. —J. RANCE.

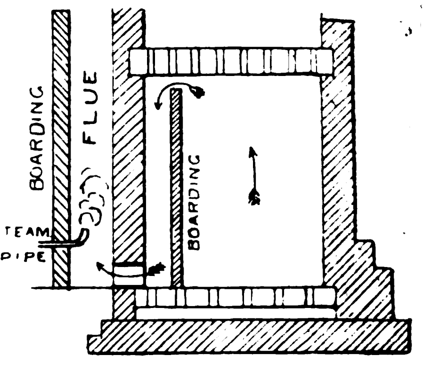
[56040.]—**Knocking in Gas-engine.**—When we first started our ½ h.p. Otto we experienced the same annoyance until our old millwright turned his attention to the key of the flywheel. On this being driven tight home, the thumping noise ceased. See that bearing at crank end of connecting-rod is not too loose, and, if necessary, slightly tighten set screw at the other end. Don't be afraid to drive key well home. Our engine has run splendidly ever since, with no trouble. — AUBERT, Guernsey.

[56041.]—**Gun Metal.**—Is "Nun. Dor." poking fun at us when he suggests that gun-metal is sometimes made of a mixture of copper, tin, zinc, and iron? Is it really the fact that these four metals can be melted together? I thought that in making gun-metal the difficulty was to prevent the zinc being dissipated by the heat required to melt the copper; but will not this difficulty be insuperably increased if iron is to form one of the ingredients? Is it a fact or a slip?—Z. Y. X.

[56046.]—**Turning Spindle.**—The apprentice's difficulty may arise from one of many causes: 1. It may arise from his lathe centres not being true to each other. 2. It may be from careless punching of the holes at each end. 3. It may be that the centres on mandrel and poppet are not of the same angle; but probably he will find that 4 is the true solution—viz., that he did not drill the holes at each end deeper than the centres, so that the centres bottomed the hole. This is the cause of much bad work. The point of a centre ought never to touch the metal which is being turned.—Z. Y. X.

[56048.]—**Burning Bricks on Wet Ground.** —The heat draws the damp from the ground. Pave the bottom of the kilns with hard burnt bricks. In "setting," put a course or two of burnt bricks at the bottom, and let the green bricks be well dry. Set them so as to have plenty of bottom draught. Fire slowly and carefully at first, and try well for steam before getting the fires away, so that the bricks will not be "boiled" before they start to bake.—BURNER.

[56049.] — **Laundry Man.** — The moist air should be tapped off from the top of room by means of a flue.



Plain deal boarding will suffice if no chimney exists, a small jet of steam being turned in to create a draught; exhaust steam from engine will do.—F. C. S.

[56057.]—**Ornamental Bricks.**—Various kinds of ornamental bricks can be made direct by brick-machines, such as Bevels, Plinths, Bull-noses, and Moulded bricks, Dog-tooth, Nail-head, &c., and Floriated bricks; and Floriated, Martini, Gillebone, and Indian tiles must be pressed, and require special boxes, plates, and blocks, varying according to the size and pattern of the goods required. The blocks and plates are best made of cast iron, wood will do, but soon gets worn. I shall be glad to give "Brickmaker" further information if required, either through the "E. M." or privately, if he will advertise his address.—BURNER.

[56058.]—**Tires.**—The work of a steel tire is represented by the distance run. An eminent maker has deduced this formula $W$ = weight in pounds, $M$ or mileage $= \frac{W \times 248{\cdot}55}{2{\cdot}2048}$, which gives for all practical purposes 115 miles for every pound weight of the tire.—R. B. HANSELL.

[56063.]—**Brazing Bicycle Fork.**—File the surfaces of broken parts flat, clean well from foreign bodies, such as grease, oil, or dirt, bind on (with binding wire) two strong pieces of iron wire so that the joint will be held firmly together. The filed faces must touch each other in all parts, else you can't braze. Get borax and mix with clean water so as to form a thick paste; smear the parts to be mended with this solution; get two or three small pieces of (soft brass) is best, lay them on the joint, put into furnace or strong fire, and as soon as brass has melted the joint will be complete.—ANNIE.

[56064.]—**Troublesome Battery.**—If Mr. J. Parsons were to remove the zincs from his cells, take out the binding-screws if they will come, then clean off the white fibre and afterwards coat the top of the rods and about ½in. down with Brunswick black, I think he would find the nuisance effectually prevented. I tried this on a Leclanché battery which I made early last year, and on reading Mr. Parsons' letter I went and had a look at it to see if I could find the same thing, but there it is as good as when I put it up. I have done nothing to it since September last. I may say that it does only bell-work. Mr. Parsons gives no reason for wanting to use old charge in new pots; if the old charge was working all right where it was, it may, of course, be effectually used again.—J. KEAN.

[56081.]—**Baffled.**—I fear that "Baffled" will not be able to work a reliable contact with suspended astatic system as shown. If the needles are pivoted at both ends, a firmer contact can be obtained; but the needle is very apt to rebound, and, on the other hand, owing to the very small contact surface, it has a tendency to stick to the contact pin, even when a very small current is used. Some years back I made a series of experiments, using a great variety of metallic substances. In every case I found the needle stick, and closer examination showed that fusion had taken place between the metals used. I then tried platinum and carbon, reasoning that since the oxide of carbon was gaseous, I should get over the difficulty. I found this answer perfectly, and patented the use of this form of contact with the instrument concerned. As, however, the patent has expired "Baffled" is free to use it, and I believe he will find it answer well.—A. S. T. E.

[56085.]—**Scroll Chuck.**—Mark jaws and chuck so as to be able to return to right slots. Unscrew till jaws are set free, noticing order in which they come out. The last to be set free is the first to be taken up by screw in replacing. Clean with paraffin oil, dry, and apply a little olive oil before replacing jaws.—GEO. A. WALTON.

[56089.]—**Fasting and the Jews.**—Jewish fasting always implies the strictest abstinence from all food or drink. The Mosaic law appointed one day only in the year for fasting, which was ordained "for the chastening of the Nephesh" (soul). This fast was on the Day of Atonement, and it not only implied abstinence from food and drink, but also from washing, anointing, and the putting on of sandals. In process of time five more fasts were added; but these were not long held, and few entire fasting days are now observed by an orthodox Jew. With the exception of the fast on the Day of Atonement, and the anniversary of the Destruction of the Temple (both of which begin at sunset), a Jewish fast lasts from the break of the day till the appearance of the first three stars. Passover cake is another name for the unleavened bread which is eaten at the feast of the Passover. It used to be eaten in a standing position, as the Israelites had eaten hastily on the night of the Passover, with the loins girt and shoes upon the feet. It is not now eaten standing, except by the Samaritans, who eat it in this way at the summit of Gerizim, and there to this day they will hand to the stranger an olive-shaped cake of unleavened bread inclosing a green fragment of some bitter herb, which may perhaps resemble the sop that Judas received from our Saviour. The healthiness and long life of the Jews are proverbial. It would be difficult to determine whether it is owing to the fasting or not, as any benefit to be had from fasting depends on many things—such as climate, habit, general health, &c. Their temperance, I have no doubt, has much to do with it. Physiologically considered, there is no benefit from fasting for any period of time when the body is in health; but when one has bile, a good "starving" often restores the natural balance.—Bobadil.

[56091.]—**Water Capacity of Boiler.**—Your boiler will require 95 cubic feet of water before appearing in the glass gauge. The answer is easily got by plain figures and a reference to nearly any textbook on mensuration.—Yama.

[56095.]—**Gramme Machine.**—The resistance of the armature depends upon what purpose the machine is intended to be used for. If for an experimental machine or shunt-wound machine for lighting incandescent lamps in parallel, the resistance is abnormally high; it should be less than ¼ ohm; for a series-wound machine it is also high, and should be considerably less if you wish to get good results from the machine. In the latter case the resistance might be ¼ ohm.—J. Rance.

[56096.]—**Amalgamating Zinc.** — You can amalgamate them by moistening them with one part sul. acid to two parts water, then rubbing the mercury on till it appears bright all over. Do this about once every month.—C. H. Carter.

[56096.] —**Amalgamating Zinc.** — This has been answered over and over again in back numbers. Pour the mercury into a dish, and, having cleaned the zinc by washing it in dilute sulphuric acid, rub the mercury upon it with a rag moistened with the dilute acid. The mercury will stick to the zinc and form a bright mirror-like coating on its surface. Or, if you like, you can use this: Dissolve 1oz. of mercury in 1¼oz. of nitric acid and 3¼oz. of hydrochloric acid; pour the solution on to the zinc in a dish, and rub the zinc with a piece of flannel till it is coated with mercury. If your mercury is bright and clean, its age does not much signify.—R. A. R. Bennett, Oxford.

[56096.] —**Amalgamating Zinc.**—Wash the zinc in dilute sulphuric acid, one of acid to eight or ten of water; then pour mercury over it, rubbing with rag dipped in the acid. The mercury will adhere at once wherever the zinc is clean; but give it a good coat, as you can't put on too much. The fumes in the process are unhealthy, so have good ventilation.—Bobadil.

[56098.] — **Grinding V-Tools.**—"Junior" should look at Churchill's catalogue for "Centre Gauge" and for "Watch Charms." Under each head he will find what he requires. The little gauges are cheap and true, and full instructions are given in catalogue and with article when sold.—Geo. A. Walton.

[56100.]—**Oxyhydrogen Lantern.**—To "Invicta."—On p. 15 you will find a description of smith's bellows. The gas bags in question are very similar, with the exception that mackintosh cloth is used instead of leather, and that no valves are used. I am exceedingly out of sorts with an attack of rheumatism, or would go into the matter further; but must try next week to do so.—Invicta.

[56104.]—**Gasoline Gas Engine.**—For the reason stated in reply 56100, I am quite unable to deal with the matter at the moment; but will, if possible, send on sketches in time for next issue.—Invicta.

[56108.]—**Microscopical Staining.**—I know of one place where anything required for this purpose can be obtained—Martindale, chemist. I think the address is Cavendish-street, Cavendish-square, London; but look it up in directory.—Geo. A. Walton.

[56108.]—**Microscopical Staining.**—I believe aniline dyes may be obtained of Messrs. Becker and Co., 34, Maiden-lane, Covent-garden, London. —G. L. M.

~~[56109.]—**Photo. Lenses.**—"Gwent's" len should be quicker than he can expose by hand on good plates. I should recommend him to get the *British Journal Almanac* for 1885, price 1s. At page 250 he will find a diagram of the standard stops recommended by the Photo. Society, and if he starts his largest at No. 14, about 2⅛in. diam., the exact size to produce proportional apertures are given.—A. Pumphrey.~~

~~[56112.]—**Chemical.**—To test wall paper for As, scrape off some of the suspected pigment with a penknife, introduce it into a test tube, and cover it with a layer of charcoal (powdered). Heat the tube where the pigment lies over a spirit lamp. If As is present, a dark ring will be seen to form in the cooler part of the tube, while, higher up still, in the coolest part, some crystals of the oxide of arsenic may be seen.—G. L. M.~~

[56112.]—**Chemical.**—Digest the paper in hydrochloric acid, and boil the resulting liquid with a piece of bright copper foil. A dark stain shows the presence of arsenic; and on heating the stained foil in a test tube, the arsenic is oxidised to arsenious oxide, which sublimes, and may be further examined.—Wm. John Grey, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[56118.]—**American Gas Bag.**—See my reply to 56100. Will give you and "Oxygen" all particulars you desire.—Invicta.

[56119.]—**Magnitude of Small Stars.**—There cannot be any reliable formula for ascertaining the magnitude of the smallest star visible, because there is no difference between the last star of the first magnitude, and the first star of the second magnitude, and the more minutely you examine the succeeding magnitudes in the same light, the more difficult it becomes to detect any perceptible difference between them.—Star-gazer.

[56120.]—**University.**—This query (?) does not contain a single question.—Wm. John Grey, F.C.S., Newcastle-on-Tyne.

[56122.]—**Small Brace.**—Do you want a hand brace or drill, or do you want it to fix on bench, and must simplicity of construction be a leading feature? I will, then, do my best to help you with pleasure.—Invicta.

[56126.]—**Chemical Examination, London University.** — The maxim, "Never prophesy unless you know," applies with especial force to examinations. The querist should wait until he has time to study the subject properly. Gill's book does not contain very much.—Wm. John Grey, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[56126.]—**Chemical Exam. Lond. Univ.**—"Londoniensis" evidently wishes to "cram." Let him procure the syllabus and the questions for the last half-dozen years, and he will see at once what to get up.—Geo. A. Walton.

[56132.]—**Cutting Pipes.**—The length BE is same as BF. By Euclid I. 47. $(CF)^2 = (CB)^2 + (BF)^2$ Hence $BE = \sqrt{[(25)^2 - (6)^2]} = 13{\cdot}7477217$. With regard to cutting out in paper when large diameters are required, I may suggest cutting on a diminished scale, say 1in. to the ft.—Geo. A. Walton.

## UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

Since our last, "Annie" has replied to 55702.

55558. Fancy Gas Lamp, p. 417.
55565. Cone Pedals, 417.
55568. Title and Author Wanted, 417.
55575. Leather Dressing, 417.
55577. Centres of Driving Wheels, 417.
55578. Model Farm, 417.
55580. Logarithms, 417.
55591. Slide-rest, 417.
55613. Dynamo, 417.

55819. Microscope Fine Adjustment, p. 506.
55828. Swedish Gymnastics, 506.
55829. Chime Barrel, 506.
55831. Drying Room for Starch Factory, 506.
55833. Legal, 506.
55335. Workmen's Time Check, 506.
55836. Repairing Gun, 506.
55842. Stampings, 506.
55846. Circular Saw for Wood, 507.
55854. Centring Glass, 507.
55855. Measuring Height of Solar Prominences, 507
55856. Brass Castings, 507.
55857. Pressure for Stamping, 507.

## QUERIES.

[56137.]—**Tracing Paper.**—Can any correspondent kindly give me a receipt for making a better tracing paper than that made with Canada balsam and turpentine? It is wished to have the paper moderately transparent, but it is still more desirable that it be free from brittleness, and, most desirable of all, that it be perfectly free from all approach to anything like stickiness? To secure the two latter points, I am willing to sacrifice a good percentage of the transparency, if unavoidable.—Jod.

[56138.]—**Plaster and Pipeclay.**—1. What is the composition of which such toys as Father Christmas, Little Red Riding Hood, &c., are made, and how used? 2. What is mixed with pipe clay in the making of common clay pipes that makes it so hard and white?—W. Bennett.

[56139.]— **Boot - Cleaning Machine.** — In our household, as in many others, the number of feet to be kept tidy, is largely in excess of the hands able to keep them so; even these few hands are often enfeebled by very poor health, and by oppressive demands made on their activities in other directions. Any apparatus, then, likely to save labour would be gladly welcomed by us; but we cannot afford to waste any money on costly catchpennies. If any correspondent who has had experience of a boot-cleaning machine, would kindly say whether, or not, he thought it likely to be serviceable in a case like ours, we shall be deeply grateful. A capital washing machine has already done us yeoman's service. Would a boot-cleaning machine be similarly hopeful? — Hopeful.

[56140.]—**Ozone Bleach.**—Can any one tell me where to get, or how to make, Holmes' Ozone Bleach? I find it is a very good thing for washing prints, in the proportion of one part of bleach and ten parts of water.—A. J. B.

[56141.]—**Lobster - Back Cowl.**—Will some kind reader inform me how a lobster-back cowl is put together, so that the front and rim of the head are both the same size? I cannot make one without making the front the largest, through lapping the pieces all one way, from the rim upwards. Is there any means of remedying this? If so, I shall be extremely obliged, as I am a plate-worker, but have not had much experience in the above line.—Plate Worker.

[56142.]—**Wheatstone Bridge.**—The construction of a Wheatstone bridge, is fully described in Vol. XIX., page 56, but it seems to be only suitable to possessors of long pockets, needing in fact three sets of equivalent known resistances, to determine an unknown one. Is this construction capable of modification, so as to use with the known resistance, against that to be determined? Please avoid algebraical formula.—J. O. M.

[56143.]—**Hermit Crabs.**—What do they feed on? All that I collect, refuse animal food, *i e.*, mussels, sandworms, &c., and soon creep out of their shells and die.—Yesallaw.

[56144.]—**Sea Anemones.**—In May last year I obtained 22 anemones, digging them out of damp sand, in which they were firmly planted, only shewing their corona (which is about 1½in. across) just above the ground. They were mostly securely anchored to small stones or pieces of shell, at a depth of from 3in. to 4in., and very local; also I never found any, if there were any, castings of sandworms in the immediate vicinity. Colour: grey, with sometimes a dash of pale pink, yellow, or purple. What is their name, as I cannot trace them at all in any of my books? They are very hardy, and live in quite foul water, in fact being the only inhabitants of a small aquarium, they remained from May to February in the same water, without any attention, and only two of them died; their bodies were not removed, yet did not seem to affect the health of the remainder.—Yesallaw.

[56145.]—**Wimshurst Machine.**—Some time ago I constructed a Wimshurst electrical machine, from descriptions given in the papers, and with insulated bridges or connections of the opposite electrified sectors on the plate. I always found great difficulty in starting the machine: it was always uncertain, and would never charge itself as stated. I sometimes set it going by charging one conductor, and sometimes some of the sectors. Since then, for the reason that these bridges were not securely fixed, I fastened them in such a way that they were not insulated. This, I was given to understand, was not a material point in the construction. Now I cannot get the machine to act at all. Could you explain the reason of the failure, and tell me how the machine should be started, and whether the conductors should be first electrically connected or not?—E. A. K.

[56146.]—**Spiral Springs.**—Would some obliging reader help me? I need some springs, but find that the steel wire (No. 18) I buy at the ironmonger's, loses its elasticity on compression? I have tried to temper them by heating openly in a fire, and quenching in oil; but they either break, or have no more elasticity than before. Is there any special wire made for springs, or any particular way of tempering them?—David.

[56147.]—**Speeds.**—What is the best system of compensation for maintaining regular speed in winding material from one roller to another, when, for instance, there is 9in. thickness on one roller, and is required to be wound on another, at the same time keeping regular speed in the moving of the material.—Subscriber.

[56148.]—**The Thermal Unit in Relation to Time.**—Is there any method by which the temperature (supposing it to be constant or at its highest point) may be determined from the number of thermal units it parts with in a given time. Is the temperature proportional, both to the heat and to the rate of combination? If so is there any fixed rate of combination for the various elements?—Equivolt.

[56149.]—**Calorimeter.**—What is the best form of calorimeter for measuring the heat of chemical combinations. Practical directions for making such, and if possible, an illustration would greatly oblige. What would be the best and cheapest substitute for mercury in Favre's calorimeter as described in "Ganot's Physics."—Equivolt.

[56150.]—**Time Required.**—I have a vertical water receiver entire length 18ft. diameter 4ft.; it requires 18 minutes to fill the same with a 4in. supply pipe let into the side of receiver 4ft. from the top. How much time is required (out of the 18 minutes) to fill the top 4ft., when the water is above the orifice of supply pipe.—J. B.

[56151.]—**Boring Lathe Heads.**—To "INVICTA."—In No. 1,036, Vol. XL., page 479, Query 55590, you promised to show me through these columns the best way to bore a pair of 2¼in. centre lathe heads (for centres and back-gear spindle) in a 2¼in. centre, single-speed lathe with an ordinary small slide-rest. I have patiently looked for the fulfilment of your promise in this paper since the issue of the above number; but my search has not yet been rewarded. Will you please reply to the above query at your earliest convenience, and oblige?—UNCAS.

[56152.]—**Tempering Steel.**—I have been trying to harden some small tools, but cannot succeed to get them above the blue temper; I heated them in a bright coke fire and quenched in water. I also tried salt-and-water, but with the same result.—UNCAS.

[56153.]—**Test for Oils.**—Can any of our contributors give me a method, or refer me to some reliable work, whereby I can tell when I get pure oils, say of sperm, olive, gallipoli, malaga, southwhale, lard, neatsfoot, animal, mineral, linseed, and cottonseed oils. I do not mind going to some expense to be able to find when the oil is genuine. The s.g. and price paid does not always prove that there has been no doctoring in the oils we buy. I find many users of oil uncertain about the oils they use, and will be glad to see an answer to the above.—W. E. P.

[56154.]—**Working Strain.**—Imagine a piece of annealed ¼in. round shear steel resting on two supports, three inches apart: what weight would it safely bear suspended from the middle? What would be the breaking strain?—F. SEARCH.

[56155.]—**Dry Rot.**—Most of my furniture is ruthlessly attacked by a small insect that bores deep circular holes into nearly all descriptions of wood. Should be thankful for a cure; have tried paraffin; but it seems only effective for a short time. What is the name and the habit of the pests?—F. SEARCH.

[56156.]—**Chemical Action in the Bichromate Battery.**—I shall be glad if any of your scientific contributors will explain as far as possible the chemical actions that take place in a bichromate battery during work, stating what are the salts formed, why the solution becomes black, and if any practical use can be made of refuse liquor.—J. T. S.

[56157.]—**Edison's Electric Pen.**—Would any of your numerous readers inform me as to whether or not T. A. Edison renewed his patent for his electric pen, after that taken out in 1875? I have heard through imperfect sources that Edison was refused a renewal in a law case in which a patent for a telephone was mixed up with it.—R. E. G.

[56158.]—**Injector.**—I have got an injector to fit on a boiler; but I may say that the injector is Vaughan and Stubb's patent. It has only one inlet and one outlet, and has the appearance of a common stop valve; and I can't see how the water can be thrown into the boiler with it. Perhaps some reader that has seen them at work will assist me.—REX.

[56159.]—**Model Engine (Boiler and Boat).**—To "INVICTA."—I have a pair of engines 1⅜in. bore, 2in. stroke. Would you be kind enough to tell me what size the boiler ought to be, and how best to make it? Also, dimensions of boat, and whether I should cut it out of the solid or build it; the engines from bedplate to cylinder covers are 11in. high.—REX.

[56160.]—**Planing Machine.**—I have a hand planing machine with bed 20in. long and 10in. wide. Can I have a quick return made so that I need only to turn the crank handle in one direction? The machine has three spindles, the 1st spindle has a pinion about 1½in. diam., with 15 teeth, which gears into a wheel 7in. with 70 teeth; on 2nd spindle, pinion and wheel are outside the bed, in centre of 2nd spindle is a pinion 2½in. diam., with 24 teeth, gearing with another of same diameter and number of teeth on 3rd spindle, which gears with rack; 3rd spindle is only for the purpose of reaching up to rack. The bearings are conical as in a lathe, and adjusted by lock nuts.—F. SHAKESPEAR, Dresden.

[56161.]—**Telescope.**—What number and kind of lenses are required for an astronomical telescope, magnifying 125, object lens 3½in., focus 4ft. or 4ft. 6in.; and is there any great difficulty in making such a telescope?—F. SHAKESPEAR, Dresden.

[56162.]—**Model Footplates.**—How are the diamond shaped patterns made on the footplates for models of marine and locomotive engines? I have tried casting the plates; but it does not answer, as the plates must bend. Have also tried corroding them with acids to no purpose.—F. SHAKESPEAR, Dresden.

[56163.]—**Mandrel.**—I have bent the nose of my mandrel; can it be set right—if so, how?—F. SHAKESPEAR, Dresden.

[56164.]—**Applegarth Battery.**—Could some practical friend write by post and tell me how to recharge an Applegarth battery for electric bell?—JOHN COLLEY, Salop House, Queen's-road, Aberystwith, Wales.

[56165.]—**Weevils.**—I should like to hear of some remedy for staying the ravages of these. I have them in a bedstead, and have taken it down and soaked the parts with paraffin and afterwards stopped the holes with red lead, but to no purpose. I have them also in some naves which I purpose using for wheels.—SEYMOUR.

[56166.]—**Damp Worskhop.**—Out of a back yard I made a very spacious workshop by putting a flat roof, which rests on four walls. It was made flat for the purpose of storing crates, &c., on the top; but although it has been twice covered with a solution of tar and steel filings, then asphalted, and twice had a ⅞in. coating of Portland cement—it lets through the rain and spoils the tools in the shop. Size of it is 14ft. by 25ft. and the wood used in its construction is planks 14ft. long by 7in. by 3in. covered with ⅞in. floorboards. Would a coating of boiled pitch cure it, if we covered it with planks to prevent sun melting it and walking on it cracking it? Have spent over £4 on it, and now want to cure it in the cheapest way possible, as it is only a temporary erection. It has a fall of 4in. with rain channel on the long side.—TRICYCLE MAKER.

[56167.]—**Developer.**—As the photographic season is now rapidly advancing, can I get any assistance? I have been using Wratten and Wainwright's developer (as per last almanack)—two grains pyro, and three drops each diluted ammonia and bromide. Is it a very slow developer?—as I find after the image is out, and the detail, &c., fairly discernible, the negative appears weak and covered by a greyish mist after fixing, although sharp. I do not think they are over exposed, as they are rather long in coming up. How long should a C.D.V. take to develop by the formulæ? I forgot to say I use Fry's plates.—JAY PEA.

[55168.]—**Electro-Plating.**—I do a little electro-silver plating, but am much bothered by the silver anode becoming discoloured, sometimes with a brownish film, and at other times with a thick, bluish-white coating, and I find that when either of these takes place, that the deposit ceases; it seems only by a fluke that the anode will occasionally work with a clean surface, and when it does, the deposit is all right. I have tried different battery-powers, and have varied the strength of solution (cyanide of silver), and sizes of anodes and cathodes. I have done a lot of electro-gilding, and have very little difficulty with that. Will some of "ours" put me right?—ARGENT.

[56169.]—**Spectacle Lenses.**—Can any one tell me the meaning of the formula, prescribed by the oculist? For instance, I have a pair of convex glasses, formula + 1 D; another of my family has − 4 D, and − 1·5 D. Do these figures relate to absolute measurements, or to some artificial scale? One would like to be able to select the proper glasses for oneself. Also is there any real advantage, and if so, what, in having pebbles (so called) instead of glass lenses?—BAL-NA-CILLE.

[56170.]—**Municipal.**—I should be glad if some one would give me his opinion, whether for general examining work, and also delicate work, a binocular, or single microscope would be preferable. Also please recommend me a good work on practical microscopy for beginners.—H. T. BARNETT.

[56171.]—**Gas-Engine.**—To "INVICTA," FROM "GASSY."—Thanks very much for your replies to my two queries. I quite understand the rule for air compression. As regards the gas-engine, I want it to replace a single cylinder, 4½in. bore by 6in. stroke, working at 60lb. Would you recommend a vertical trunk engine, single acting—if so, what dimensions?—or the ordinary inverted single cylinder, like Clerk's; if so, what size? I have no idea of what size the air-pump should be, the gas pressure, or what valve arrangement, and firing gear is to be used. Can you kindly help?—GASSY.

[56172.]—**Locomotive Mechanics.**—Supposing that a loco. engine's eccentric rod had not been properly adjusted, and as a consequence she had a lop-sided sort of a beat, and supposing that the forward gear-rod wanted shortening to put it right, would it be necessary to lengthen the back-gear rod?—YOUNG HAND

[56173.]—**New Battery.**—Can any reader tell me how to make the new cell, invented by Dr. Pabst (Germany)? I believe it is an iron cell, with wrought-iron and carbon dipping in a solution of ferric chloride.—F. Q.

[56174.]—**Dioscope.**—How are these made? They are to enable a person to see what is going on (at an entertainment, &c.) from a distance, by means of an objective lens and electricity.—A.

[56175.]—**Books on Herbal Medicine.**—Can any one give me information as to the most recent and best works on herbal medicine? Not mere family guides, but works that will enable one to thoroughly study and master the subject.—W. M.

[56176.]—**Patent Annealed Iron.**—Has any reader of the "E.M." had any experience with the new process of annealing chill and other iron castings, and how they make their chill, and what kind of castings they make?—MELBOURNE.

[56177.]—**Earthenware.**—Mr. S. Arlidge, in the "E.M." of Feb. 6th, referred to my query on the above subject, but he does not say what ingredients are used in giving the white colour to earthenware, before putting on the lead for glazing. In making black ware, we use black manganese, but I want to make white ware as well. Any information that Mr. Arlidge, or any others can give on this subject, will be highly appreciated by—J. HAYDOCK, Mon.

[56178.]—**Gum Juniper.**—Will any of your readers kindly inform me how to dissolve gum juniper—I have tried several ways but failed, and oblige?—KOILA.

[56179.]—**Bort.**—Will "Z. Y. X." be so kind as to state if bort, carbonado or carbonate, can be manufactured, or is it a natural production?—CARBON.

[56180.]—**Martini-Henry Rifle.**—Will "Armourer" be so good as to explain the proper way to take the breech action of a Martini-Henry rifle to pieces and replace same, and what is the lubricant used. it appears to be some thicker substance than oil.—ANOTHER RIFLEMAN.

[56181.]—**Cheap Achromatic Condenser.**—To MR. NELSON.—I should be glad to make a condenser, as described by you, if you will kindly inform me what focus the two lenses should be, as I presume they should bear some proportion to each other. The hole in the stage of my old upright microscope is ⅝in. in diameter, and there is only 1¼in. space between the top edge of the mirror (when inclined) and the upper surface of the stage. I have tried single lenses as condensers, but without advantage.—NOVICE.

[56182.]—**Sweet Making.**—Will some kind reader give me information how to make sweets (brown sugar goods) quantity of water per pound of sugar, and how long to boil, or can any book be got on the subject?—NOVICE.

[56183.]—**Force and Motion.**—What is the answer to the following question?—Given a rope with a horse at each end. The horses are started in opposite directions Is the pull on the rope that of two horses, or of one? Similarly in a steam-engine, is the strain on the cylinder cover, the same as that on the piston, or more?—T. P. L.

[56184.]—**Transfer Fluid for Engravings.**—Would any correspondent tell me if there is any chemical that would produce an impression or copy from engravings?—T. P.

[56185.]—**Astro. O.G.'s.**—Would anyone give me particulars respecting the making of fluid lenses, and how the old astronomers did without achromatic lenses?—Cassini and others of his time.—T, P.

[56186.]—**Gum for Micro. Slides.**—I should feel obliged if one of our kind readers would give me a recipe for making gum for attaching labels to microscope slides—such as is used on postage and other adhesive stamps?—A. B.

[56187.]—**To Mr. Bottone.**—Would you kindly help me with the following?—I have made a motor with one of Jones' laminated armatures, 1½in. diameter and 4in. long. I first wound it with 4oz. of No. 22 s.c. copper wire on armature, and 1½lb. of No. 16 c.c. on magnets; but, with the idea of improving it, I rewound it with 6oz. of No. 22 s.c., and 2lb. 9oz. of No. 18 c.c.; but on trying it with two quart Bunsens I got less power than I did at first with the same cells. Would you kindly say if the wire I have on just now will be right with more battery power? If so, how many quart bichromates shall I use, and what power may I expect?—LOANHEAD.

[56188.]—**Pump.**—Would some kind reader conversant with brickworks kindly give short description, with small sketch, of a simple pump or other means for lifting—about 5ft. or 6ft. of a lift—water out of brick clay holes?—something that would lift a considerable quantity at a time for manual power.—T. PLUNKETT.

[56189.]—**Brickmaking Books.**—Wanted, names of a few thoroughly practical works on above, and which would give description, with plans and dimensions, of best sort of up and down draught kilns.—THOMAS PLUNKETT.

[56190.]—**Clark's Gas Lamps.**—Can any reader inform me whether those powerful smoke-consuming gas-lamps, which are fixed at the Langham Hotel, are made on a small scale?—W. C.

[56191.]—**Electrotyping.**—Can any of our readers inform me of the latest method of copying wood blocks, or refer me to work (recent) on above, the cost of necessary plant, and where to be bought?—ELECTRO.

[56192.]—**Mineral.**—Can any reader kindly inform me of the name of the above from the following description?—Glistening white, under microscope like minute transparent sand; heated slightly light brown, intense heat nearly black; insoluble in cold water; from boiling water white opaque gelatinous deposit; soluble in sulphuric acid; carbonate of ammonia turns solution brown; ferrocyanide of potassium blue, with white deposit at bottom.—W. G.

[56193.]—**Eccentric and Oval Cutting Chuck.**—Will some correspondent kindly either furnish us with a working drawing, or say where it is to be met with, as I wish to make one?—H. G. B.

[56194.]—**Lady's Colonial Outfit.**—Can any reader give reliable information as to a useful outfit for a lady going to the country parts of New Zealand? and also what size of packages are more convenient for luggage, and any hints about the voyage? In fact, any useful information on the subject will oblige an—OLD READER.

[56195.]—**Consumption of Coal.**—Would any of our readers kindly inform me approximately the quantity of coal consumed per day of 24 hours upon some of the large Atlantic-going mail steamers, such as the *Alaska*, *Oregon*, *Nevada*, &c.?—J. L.

[56196.]—**Gas Holder.**—I have a job to put some new sheets in an old gas-holder; I have heard some special packing is required for the joints. Will someone say what is the best thing to make them gas-tight when riveted?—OLD SUBSCRIBER.

[56197.]—**Rusty Water.**—Some months ago we laid about 1,000ft. of black iron tube from a high-level well across some fields to a dwelling-house some 30ft. lower. Up to the present moment the water has been so rusty that it is quite unfit for use. Can any of our readers suggest a remedy that will not unfit the passing through pipes for drinking purposes?—F. D. A.

[56198.]—**Speed of Pump.**—What is the quickest speed at which I can drive an ordinary 3in. brass barrel bucket forcing pump 8in. stroke? Would it be possible to drive such at 120 or 180 strokes per minute? What quantity of water would be delivered at each of these speeds, and what power would be required to lift and force a height of 50ft. (suction included) at each of these speeds? Would indiarubber valves be better than leather at such speeds?—J. D. A.

[56199.]—**Nickel.**—Is this much harder than copper, and what is the relative hardness of nickel bronze and copper, and what are the proportions of the alloy called nickel bronze? Can the alloy be made harder or softer at pleasure by using different proportions, and if so what different proportions? If these are secrets of trade, I of course do not expect a reply.—Z. Y. X.

[56200.]—**What is a Diamond Carat?**—Per Mr. Emanuel's book, a carat is 4 grains, therefore a diamond of 2¾ carats ought to weigh 11 grains. I sent one out of a ring to a manufacturing jeweller, asking him to say how many carats and how many grains. His written reply was—2¾ carats, 11 grains; thus he agrees with Emanuel. But, on weighing the diamond in a pair of chemical scales, it is found only to weigh 8.70 grains. My deduction is that a diamond carat is only 3·16 or 3 1-6 grains, and not 4. What is the truth, and what is the explanation? I do not enter in the gold carat, where the term has a different meaning—viz., a something which has so many parts of pure gold out of each 24 of actual weight of the article; thus, 6 silver and 18 gold is 18 carat fine, and absolutely pure gold is 24 carat fine.—Z. Y. X.

[56201.]—**Fixing Battery Plates.**—I am making a double-cell bichromate battery arranged as follows:—The outer cells are square, and are placed in a rack which has two uprights at each end, between which a counterpoised board slides; to this board the plates are fixed by brass clips screwed down to it. This answers well enough for the carbons, but the zincs being heavy slip from between the jaws of the clips. Will any reader kindly inform me of a method of fixing the zincs so that they may be readily removed for amalgamation, &c.? Please do not refer me to back numbers, as I am a new subscriber.—MIKROS.

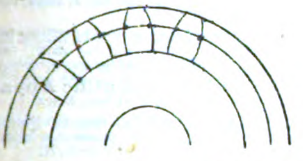
[56202.]—**Clock Gongs.**—Would some correspondent kindly tell, me through the columns of "Ours," how to make clock gongs, the kind of steel they are made of, and how to harden and temper them?—CHIME CLOCK.

[56203.]—**Chemical Affinity.**—Will some chemical reader kindly publish in "Ours" (of course with the Editor's permission) a reliable table of affinity, embracing that of the principal acids for the various bases? Such a table would, I opine, be of the greatest use to beginners in the science.—EQUIVOLT.

[56204.]—**Calorimetry.**—Would it be too presumptuous on my part to ask "Sigma," S. Bottone, or others, to give the chief results of Favre's and Silberman's experiments upon the heat of chemical combustion and combination, such as are given in Mr. Sprague's "Electricity," or can they recommend a cheap book on the subject?—EQUIVOLT.

[56205.]—**Tennis Court.**—Will anyone kindly give instructions for making a cinder court for lawn-tennis; The intended site is part of a grass field; should the turf which is taken up, go to make a bank round the court? How is the ground made truly level? What are the correct measurements for court? Information will much oblige.—CHROMIO.

[56206.]—**Teeth of Wheels.**—Will someone of "ours" kindly give me particulars for striking out teeth



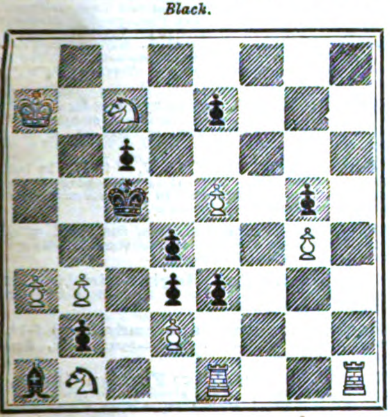
with one sweep, as per sketch. Prof. Willis invented an instrument for the centres and radius for different-sized wheels (I don't mean the odontograph, with two radii)—do any of "ours" know it?—ATHOS.

# CHESS.

**ALL Communications for this department must be addressed to J. PIERCE, Llandwrog, Carnarvon.**

**PROBLEM DCCCCXXXI.**—By H. F. L. MEYER.

*Black.*



*White.* [10+9

White to play and mate in four moves.

SOLUTION TO 929.

| *White.* | *Black.* |
|---|---|
| 1. Q-Q Kt 7 | 1. Anything |
| 2. Q, B or Kt mates. | |

(Seven variations.)

## NOTICES TO CORRESPONDENTS.

CORRECT solutions to 929, from Rev. W. Anderson (Old Romney), H. Culmer, J. E. Piper, C. Meiklejohn.

To 928 by H. Culmer.

C. MEIKLEJOHN.—You have overlooked that in 928, after 2. Q-Q 2 Black can play Kt-Q Kt 3, thus avoiding mate.

GAME received from F. A. Vincent. Tourney Problem from "Chess Struck."

"E. M." Tourney game between W. Nash (White) and J. Clothier (Black).

(King's Bishop Gambit.)

1. P-K 4, P-K 4 / 2. P-K B 4, P takes P / 3. B-B 4, P-K B 4 (*a*) / 4. Q-K 2, Q-R 5 (ch) / 5. K-Q sq, P takes P / 6. Q takes P (ch), K-Q sq (*b*) / 7. Kt-K B 3, Kt-K B 3 / 8. Q-B 5, Q-R 4 / 9. Q takes B P, P-Q 3 / 10. Kt-B 3, Q Kt-Q 2 / 11. P-Q 4 (*c*), Kt-Kt 3 / 12. B-Kt 3, B-Kt 5 / 13. R-K sq, B-K 2 / 14. Kt-K 4 (*d*), K Kt-Q 4 / 15. Q-Kt 3 (*e*), B-R 5 / 16. Q takes B (ch), Q takes Q / 17. B-Kt 5 (ch), Q takes B / 18. Kt takes Q, K-Q 2 / 19. P-Q R 4 (*f*), P-Q R 4 / 20. K-Q 2, B takes Kt (*g*) / 21. P takes B, P-K R 3 / 22. Kt-K 6, P-K Kt 4 / 23. P-Q B 4, Kt-K B 3 / 24. R-K 2, Q R-K sq / 25. Q R-K sq, P-Q B 3 / 26. K-B 3, Kt-Q B sq (*h*) / 27. B-B 2 (*i*), K R-Kt sq / 28. B-B 5, R-Q sq (*k*) / 29. Kt takes P (ch), K-B 2 / 30. Kt-K 6 (ch), K-Kt sq / 31. Kt takes R, R takes Kt / 32. B takes Kt, K takes B / 33. R-K 6, Kt-Kt sq (*l*) / 34. R-K 8, resigns.

(*a*) This defence is now considered superior to P-Q 4. Mr. Bird is fond of Q-R 5 (ch) at once, and with good reason, judging by results.

(*b*) Cook gives B-K 2 as best.

(*c*) We prefer B-K 2 followed by Kt-K Kt 5.

(*d*) B-K 3 and then K-Q 2 to free the Kt, looks more developing.

(*e*) The only move.

(*f*) With the view to gain a piece.

(*g*) P-K R 3 seems better.

(*h*) On account of P-Q B 5.

(*i*) A good move, of which Black fails to see the force. R-K 2 meets it best.

(*k*) Now if 28 $\frac{\qquad}{\text{R-K 2}}$ 29 Kt-B 5 (ch) &c.

(*l*) This saves Kt and P, but game was already lost.

# ANSWERS TO CORRESPONDENTS

⁂ *All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

## HINTS TO CORRESPONDENTS.

**1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put** titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

**⁂ Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.**

## A NEW VOLUME.

NUMBER 1041 was the first of Vol. XLI. Readers willing to oblige us by recommending "Ours" to new subscribers should do so now, when a new volume has just commenced. The index to Vol. XL. is published this week, and cases and bound volumes will be on sale shortly. Readers desirous of making up their sets for binding the past volume are recommended to do so at once, as the back numbers soon run out of print.

The following are the initials, &c., of letters to hand up to Wednesday evening, March 18, and unacknowledged elsewhere:—

PALL MALL ELECTRIC ASSOCIATION.—R. E. Quinn.—W. Matthew.—F. L. Moore.—Otto Co.—J. Manford.—R. Hannen.—C. H.—The Optical Bricklayer.—C J. K., Ventnor.—Samuel Shaw.—Millwright.—E. H. J.—C. L. Tweedale.—B.Sc., Plymouth.—E. M.—Wade.—Jack.—A Many Years' Subscriber.—J. Gayler.—T. R. Allinson.—M.I.C.E.—A Fellow of the Royal Astronomical Society.—E. J. S.—J. H.

G. O. W. (Can only afford so much space and so many engravings to replies, not to questions asking whether proportions, &c., are good. Besides we have had a great deal about dynamos lately.)—STERO. (What is it you mean by "French bronze"? Look through the index issued with this number, and see if there is not some reference to it. "Where to get materials" is answered by "At any dealer's." Such a question is against the rules.)—F. S. S. A. (Gum arabic dissolved in water. See the indices, or Richmond's "Grammar of Lithography," published by Wyman and Sons. Transfer paper is prepared by coating any good paper with gelatine, starch, or gum, or mixtures of the three, the object being to interpose a soluble film between the writing ink and the surface of the paper. It is always best to purchase the inks and papers required when working on a small scale.)—VULCANITE. (The ink is dissolved in soft water or alcohol according to its nature, and glycerine or treacle added—sometimes both. For aniline violet, dissolve 90 grains in 1oz. of rain or distilled water, and add a little glycerine. Several recipes in back volumes.)—W. W. (Bellows camera in No. 894, or p. 380, No. 953.)—A COLLIERY SMITH. (We do not know of any useful liquid for welding steel. Borax is generally sufficient in the hands of expert smiths; but some fuse 10 parts of borax with one of sal-ammoniac until all spume has disappeared, and then pour out, and when cold pound into powder.)—INK. (Grind up any suitable pigment with gum tragacanth in solution, and mould under high pressure, or treat the same as pigments for making cakes of water colours. That is, grind up with isinglass size and thin gum water; but the pressure is indispensable.)—J. M. B. (Free ventilation is the best way of removing the smell of fresh paint; but some use a handful of hay in a pail of water, and others close up all air-holes, and put in a vessel containing lighted charcoal, on which they throw a handful or two of juniper berries.)—AMATEUR. (Yes, they are tuned to equal temperament. The best plan is to get a set and tune others to it. The scale in G is just the same as in C, except that it has F sharp instead of F natural. In factories they have a tuning bellows, on the exhaust plan generally, and fixing the standard reed over one hole tune the others to it. They require very little afterwards when placed in instrument.)—WARMINSTER. (We have no time for problem solving, and we are afraid there are not many of our readers who could tell you "at what velocity must a turbine run to generate electricity sufficient for a town of 6,000 inhabitants at a distance of three miles." Do you know of a turbine which generates electricity. 2. We do not know, but the makers can tell you. 3. As to the cost of wire, see the lists, wherein you will find the prices per mile for the different sizes. You have forgotten the latter item.)—PENWITH. (You will find a very good pocket battery described on p. 119, No. 1019; but see the indices.)—ECONOMY. (We do not understand how any one is to tell you how to make the battery or accumulator, the only description of which is that it is in an ebonite case 4in. by 5in., and ¾in. thick. See previous answer. It is probably a chloride of silver cell.)—C. H. (Given in all works on navigation; in the *Nautical Almanac*, and in back volumes. 2. What "astronomical clock" do you mean?)—T. B. (You will find an improved baking powder on p. 229, Vol. XXX., and several recipes in Nos. 739, 740. A good recipe is 1lb. bicarbonate of soda, ½lb. of tartaric acid, and ¾lb. of ground rice.)—NIX. (There is no book of the kind; but you can obtain suitable apparatus of any dentist's furnisher. See the articles on the indiarubber and guttapercha industries in Vols. XXXI. and XXXII. These were also published in a cheap form by the Society of Arts. You can ascertain whether still in stock by applying to Messrs. Bell and Sons, York-street, Covent-garden, W.C.)—A SUBSCRIBER, F.G. (See the indices for medical coils, shocking coils. Look in last week's number, for instance.)—CONSTRUCTION. (Look on p. 475, No. 1,036. Oxide of copper, zinc, and a solution of caustic soda.)—D. D. (Let them read up the subject of Flight in back volumes. How would they store the electricity which is to supplement the man's motive power? Do they think they can put it into a balloon like so much gas?)—MUSICIAN. (It is something loose; from what you say some part of the swell action—very likely the wire spring. When you hear the "jarring," try touching all likely loose parts.)—IN THE DARK. (If the connections are all right, possibly it is the zincs which are at fault, especially as they appear eaten into holes; they should be amalgamated after each time of working—that is, if you use the light for any considerable time. See pp. 110, 174, 193, 217, Vol. XXXIX., for some useful information.)—J. O. M. (It would occupy too much space to explain fully; for that you must see the textbooks. But the effect of a fault is to decrease the resistance of the circuit and to weaken the current received at the distant station. Calculations will indicate the whereabouts. A broken line is found by asking each station in turn to put the line to earth, until one is unable to deflect the needle of a galvanometer: the break is between that and the previous station. The distance is found by the aid of the "bridge.")—ZENO. (You can obtain all particulars about the Whitworth Scholarships from the secretary of the Science and Art Department, South Kensington. The guide is 6d., we think; but there is a book of the kind you mention, published, we believe, by John or Abel Heywood, Manchester, which gives much useful information.)—HEALTH. (We believe Macmillan and Co., Bedford-street, W.C., publish such a work.)—B. B. (Both. The pores of the charcoal contain oxygen which burns up the organic matter. That is why it is necessary to clean the charcoal occasionally, and leave it dry at frequent intervals.)—E. F. J. H., Manchester. (You are just about the right age to enter any branch of the engineering profession. The usual thing is to be articled for a term, unless you wish to go through the shops and become proficient as a mechanical engineer. Then it is usual to enter as a gentleman apprentice. We do not know which branch has most openings, and cannot advise in such a matter.)—J. G. BRISTOL. (We have given full particulars of the New Patents Act on pp. 25, 376, Vol. XXXVIII. It is not necessary to employ an agent, but it is advisable. The difference in the charges is an indication of the value the agent puts upon his services. The stamp payable on an application is £1.)—J. E. (Two methods of making dark slides in No. 979. For shutters see indices.)—W. FREEMAN. (See the index published with this number, and back volumes for all sorts of methods for making enlargements.)—TRICYCLE. (Put yourself into communication with Mr. Shipton, Secretary of the Cyclists' Touring Club, 139, Fleet-street, E.C. 2. If there is only one bookseller, surely there is a bookstall at the railway-station, and you can get any paper there almost as soon as it is published.)—TRICYCLE FRONT WHEEL. (The rubber is too large; but why not bind it on?)—RAGOSINE OIL. (It is a petroleum, and is composed of hydrogen and carbon.)—ENQUIRER. (You should not go unless you have money to start in business, or can afford to wait until you make a connection. Work of the kind is highly paid, but then there is so little of it to do.)—READER OF "E.M." (Why not have mentioned the page? It is Part II. of Miller's "Chemistry" that is meant, price 21s. The apparatus is simply an ordinary sheet-iron furnace with a chimney and legs. An iron tube passes through the centre horizontally, and so through the middle of the fire. This tube is filled with iron borings or turnings, which, when red-hot, decompose steam, absorb oxygen, and leave the hydrogen free. The usual apparatus is illustrated in many textbooks.)—TRUKH-SUNKER. (Surely it would depend on the length of the holes or tunnels; but at any rate, such a query is of no interest to our readers. We do not know of a work giving such information.)—P. WARD. (A reply by post sent as asked has been returned through the Dead Letter Office marked "insufficient address.")—XEMA. (It is a question for a jury; on your own statement you are undoubtedly "A.'s" agent, and entitled to a commission: but then some people have such a remarkable facility of becoming agents to people who have never authorised and do not want their services.)

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*FRIDAY, MARCH* 27, 1885.

## BOILER EXPLOSIONS IN 1884 AND THE BECKENHAM DISASTER.

IT is satisfactory to find that the records of boiler explosions during the past year compare favourably with those of any previous twelvemonth; for although the number of explosions is not quite so small as in 1879, it is less than in 1883, though the mortality is slightly greater. How much of the improvement is due to the Boiler Insurance and Inspection Companies, how much to the action of the Board of Trade, and how much to the exercise of greater care by steam-users, it is impossible to say; but it cannot be doubted that the system of inspection by disinterested experts has done a great deal in reducing the frequency of disasters of the kind, while the very existence of such associations has compelled, as it were, steam-users to be more careful. The number of explosions in 1884 was 32, causing the death of 22 persons, and injuring 48 others—figures which compare very favourably with those for 1874, when there were 76 explosions, killing 77 persons and injuring 198. The numbers fluctuate from year to year to a small extent; but since 1878 we may say that they are only half what they were in such years as 1874; and looking over the details of the explosions of 1884, there seems no reason why boiler explosions should not become sensations by their rarity. We will not go so far as to say that none of the 32 explosions of 1884 could be fairly set down as accidents, but it is incontestable that the great majority of them would have been prevented by timely inspection and adequate repairs or alterations. As usual in the list of purposes for which the boilers were used ironworks figure highly, about one-third of the total number being credited to them, while wood-working shops and farms are each responsible for four. It is easy to understand that boilers used for agricultural purposes do not receive so much skilled attention as those employed in factories; but where there is one boiler used on a farm there are hundreds used on railways, and yet only two of the explosions of 1884 occurred in connection with locomotives, because as a rule they are well looked after and frequently inspected. Of the 32 explosions in 1884, 18 were due to corrosion, 10 to faults which ought to have been detected by the attendants, such as shortness of water and over-pressure, and four to defects of construction or materials. Corrosion is, as usual, the principal cause, simply from the fact that it is most difficult to detect it unless the boiler is submitted to expert inspection at intervals, for although external corrosion offers sufficient signs to lead any careful person to suspect the real extent of the damage, it is only those familiar with the "diseases" of steam-boilers who know where to look for internal corrosion, the most insidious and dangerous of all boiler defects. The internal corrosion which produces "furrows" in the line of strain is the cause of many explosions which appear to the owners and tenders mysterious until the wasted metal is shown to them, and it is the cause which should bring home to the mind of all steam-users the absolute necessity of having a thorough inspection at least once a year. To take some of the instances of 1884, a vertical boiler with plates three-eighths of an inch thick, and not more than seven years old, ruptured at the flanged base of the uptake, where internal corrosion had reduced the metal to the thickness of a well-worn shilling. The "furrow" was produced by the expansion and contraction of the parts, and corrosion once started in such a place proceeds rapidly until the boiler gives way even at a moderate pressure, as in this case at 40lb. In another case a locomotive boiler used at an ironworks had $\frac{3}{8}$in. plates, was 12 years old, and was worked with 120lb. pressure. That gave way at a groove produced by internal corrosion through the continued bending of a plate backwards and forwards as the boiler was alternately heated and cooled down. In another locomotive boiler, this time in use on a railway, a longitudinal seam at the top of the barrel gave way behind the dome, the groove being so deep that only a skin was left. This is one of the few cases which might be fairly termed an accident, for the defect was in such a position that it could not be seen even by expert inspection, though its existence would have been detected if the hydraulic test had been applied. External corrosion is, of course, most dangerous when it occurs in parts hidden by brickwork, or other setting, though even in that case the existence of any serious wasting would scarcely escape the expert, and might be suspected by anyone blessed with a little common sense. Yet we find that a portable multitubular used at a farm was so corroded from the leaking of a feed pump, that at the point of rupture the original $\frac{1}{4}$in. plate had been reduced to about the thickness of tin plate. Here there was external corrosion without brickwork to hide it; but we must assume that no one detected what would have been at once apparent to an expert. A Cornish boiler used at a brickworks, and said to be ten years old, was so much corroded where it rested on brickwork, that it gave way along nearly the whole length of the shell while working at 45lb., although the plates were originally $\frac{3}{8}$in. thick. Such corrosion ought not to have escaped the attention of any boiler attendant when clearing the flues, but that such cases occur shows the necessity for skilled inspection. What, however, shall we say of another case, where a vertical, twelve years old, exploded because the plates round the bottom were corroded externally to such an extent that they were reduced to the thickness of a piece of stout paper! In the solitary instance of a printing-office boiler which exploded during 1884, the firebox was so reduced by external corrosion, that it was unable to bear the pressure. This case will be remembered from the extraordinary evidence of the manager of the works, who gave personal testimony of the incompetence of those under whose charge boilers are too often placed. One of the explosions last year occurred with a semi-waggon shaped boiler used to supply a chaff-cutting engine, and tended by a coachman, who was killed. The pressure might have been anything up to 100lb., as the spring balance was screwed down and could even be made fast. In another case, a "contractor's" boiler, which had no safety-valve, killed one person and injured three, because the pressure was allowed to accumulate until the firebox was forced inwards. We have said enough, however, to show that nearly every explosion could have been prevented or foreseen by inspection—foreseen, because even after inspection some owners will not do what is recommended, and will pooh-pooh warnings. The annual reports issued by the Steam-Users' Association and Boiler Insurance Companies demonstrate the fact that boiler explosions might be still further reduced in number, and those who are unacquainted with the subject may be referred to the illustrated reports which Mr. E. B. Martin, the chief engineer of the Midland Steam Boiler Inspection and Assurance Company, has issued for several years past. The explosion which occurred last month at Beckenham is another instance of the necessity for periodical inspection. The boiler in this case was of the Cornish type; but it had two furnaces, which led into one flue tube, the connecting piece being made up of no fewer than fourteen plates. The shell was over 15ft. long, with an internal diameter of 5ft. 7in. As to the pressure, it was stated at the inquest that it was usually 45lb. to 55lb.; but at least one witness said that he had seen the gauge standing at 63lb., while another stated that he had seen the safety-valves blowing off at 60lb. It seems probable, however, that the boiler had often been worked at higher pressures, for calculations show that the valves could be weighted to 76lb. and 84lb. respectively. These details have, however, only a subsidiary interest; the main fact is that the boiler exploded in consequence of the weakening caused by external corrosion from damp in the setting, and to the question of the coroner, "Was the dangerous state of the boiler known to those responsible for its being in proper condition?"—the jury returned an answer in the negative. To a further question whether the boiler was adequately examined for defects likely to arise in the course of time, the jury answered "No"; and to another question, whether there was any wilful, criminal, or gross culpable negligence shown by any person responsible for the working of the boiler, the jury again answered "No"; and when the further question was put, "Were the latent defects undetected through ignorance, or through an error of judgment?" the jury replied, "Through an error of judgment. It is not easy always to draw the line between simple negligence, and that gross, culpable negligence which comes within the grasp of the criminal law; but here we have a boiler which exploded because it was in a perfectly unfit state to be trusted at all—a fact which ought to have been at least suspected by everyone acquainted with it. Eleven years ago, it appears, the boiler was lying in the yard of a second-hand dealer, and was then tested by the hydraulic method up to 110lb. The company to whom it was sold never used it more than two or three times, and in the end of 1877 it was put into position at the brickworks, was examined by a firm of boiler makers, and tested with the water-pump to 110lb. So far there seems no reason to suppose that the boiler was not capable of doing its work; but where it was erected at the brickworks it appears that water in a pond at the back of the boiler was at a higher level than the stokehole, and water came through the ground to such an extent that the first man who had charge put in a drain to lead it off. Other witnesses gave evidence which proved conclusively that the dampness of the seating of the boiler was well known, and an examination of the plates proved that the cause of the rupture was the severe external corrosion, which in parts had reduced the plates to a thickness of less than the sixteenth of an inch, and at some points probably the metal was corroded quite through. It is incontestable that this corrosion would have been detected by expert inspection, and it is impossible to believe that any boiler attendant possessed of a little common sense would have failed to discover the serious weakening of the plates if he had ever used his hammer when making a perfunctory examination. The engine driver who had charge of the boiler up to the spring of 1883 thought it all right when he left it, and would have trusted it another seven years with 70lb. of steam; but it is almost certain that if the boiler had been examined by one of the inspecting companies at the time it was first put into the brickworks, the limit of pressure would have been fixed at 45lb. or less, while the dangerous character of the seating would have been pointed out.

In the reports which have been issued annually for many years, clear and unmistakable warnings have been given over and over again of the risk run through external corrosion from damp seatings; but the jury in the Beckenham case acquit those responsible for the careful working of the boiler, declare that there was no culpable negligence, and that the defects were undetected "through an error of judgment." Compulsory legislation in matters of this kind is very naturally disliked by everyone; but if there are many more boiler explosions like that at Beckenham, it will be absolutely necessary to insist upon periodical inspections and all sorts of repairs and alterations. It will be better for boiler owners to take warning in time, and render legislation unnecessary by doing all they can to prevent explosions.

## NOTES ON CASSEGRAINS.—II.

By Dr. Royston-Pigott, F.R.S.

### Construction.

ANYONE attempting to design a Cassegrain must first of all dismiss the ridiculous notion that the instrument, when in working order, must be so arranged that the focus of the small convex (always behind it) must coincide with the focus of the large parabolic. If we call the point F the sidereal focus of the big mirror, and *f* the point where the focus of the convex oscillates, there is a space F*f*—

A B F

and (*f*) lies beyond F by a space F*f*. And the magnifying power of the whole system for the same eyepiece varies inversely as the distance between these foci, and, as it is a variable, it will be well represented by the quantity $x$. It is next to impossible, when the foci are even perfectly known, to decide upon the position of the small convex (*f*) unless its distance ($x$) from F be calculated beforehand, and for this purpose I know no better formula than the following approximation, carefully determined, on the supposition that convex focus is one-fifth of the concave focus.

$$x_5 = 0{\cdot}038\ \mathrm{F} \text{ or } = \frac{38}{1000} \text{ of F.}$$

If the convex has a focus only ¼ of F,

$$x_4 = 0{\cdot}059\ \mathrm{F} \text{ or } = \frac{59}{1000} \text{ of F.}$$

This algebraic formula is approximately true—

$$\mathrm{F}x + x^2 = f^2$$

$$\text{Whence} \quad x = \sqrt{\frac{\mathrm{F}^2}{4} + f^2} - \frac{\mathrm{F}}{2}$$

And if F = 5*f*, taking positive sign—

$$x = \sqrt{\frac{\mathrm{F}^2}{4} + \frac{\mathrm{F}^2}{25}} - \frac{\mathrm{F}}{2} = \sqrt{\frac{29\,\mathrm{F}^2}{100}} - \frac{\mathrm{F}}{2} = 0{\cdot}038\mathrm{F}$$

### Magnifying Powers.

The moment we can get the value of $x$—i.e., the distance of the convex focus from the great focus—viz., F*f*, the magnifying power (M) for a given eyepiece with focus E is known—

$$\mathrm{M} = \frac{\mathrm{F}}{\mathrm{E}} \times \frac{f}{x}$$

Example. In my Cassegrain the lowest power with 4¼in. eyepiece and 28½in. convex, and great focus 129in.

$$\mathrm{M} = \frac{129}{4\frac{1}{4}} \times \frac{28\frac{1}{2}}{4{\cdot}9}{}^{*}$$

$$= 30{\cdot}3 \times 5{\cdot}82 = 175 \text{ nearly.}$$

It will be observed the magnifying power changes not in proportion to the focus of the convex, but as the ratio of this to its distance from the great focus.

It is important for anyone about to construct a Cassegrain to know how to place a given convex in position at once by actual measurement. Of course, if a vertical rod be suspended above, the length from the hinge or ball and socket measured to the surface should be exactly half of the proposed focal length (*f*).

Take the Melbourne Cassegrain focus F = 30½ft. = 366in.; focus of convex = 74·71in. Find the position for the convex surface. The dist. of it from the great focus is $x$ in the equation (approximately).

$$\mathrm{F}x + x^2 = f^2$$

Solving the equation, by adding to complete the square—

$$x^2 + \mathrm{F}x = f^2$$

$$\frac{\mathrm{F}^2}{4} = \frac{\mathrm{F}^2}{4}$$

$$x^2 + \mathrm{F}x + \frac{\mathrm{F}^2}{4} = f^2 + \frac{\mathrm{F}^2}{4}$$

Square rooting—

$$x + \frac{\mathrm{F}}{2} = \pm\sqrt{f^2 + \frac{\mathrm{F}^2}{4}}$$

(The *plus* sign only is required), so transposing—

$$x = \sqrt{f^2 + \frac{\mathrm{F}^2}{4}} - \frac{\mathrm{F}}{2}$$

Now, in the monster Melbourne Cassegrain—

$$f = 74{\cdot}71\text{in.}, \ \mathrm{F} = 366\text{in.}$$

Then—

$$x = \sqrt{(74{\cdot}71)^2 + \frac{(366)^2}{4}} - \frac{366}{2}$$

$$= \sqrt{5582 + 33489} - 183$$

$$= \sqrt{39071} - 183 = 197{\cdot}5 - 183$$

$$= 14{\cdot}5, \text{ the approximate position.}$$

This is correct for the monster telescope at Melbourne within about ¾in.

The Melbourne telescope's concave mirror A is 366in., and small convex 71·74in. focus; while dist. of its surface from great focus is 61in., and from its own focus 71·74, leaving the difference $x$ = 13·71, and focus of eyepiece E = 8·05 (I believe it is really 8in.).

*f* F 61 B A.

Then, the magnifying power as before—

$$\frac{\mathrm{F}}{\mathrm{E}} \cdot \frac{f}{x}$$

$$\mathrm{M} = \frac{366 \times 71{\cdot}74}{8{\cdot}05 \times 13{\cdot}71}$$

Taking the logarithms—

$$\log. \mathrm{M} = \log. 366 + \log. 71{\cdot}74 - \log. 8{\cdot}05 - \log. 13{\cdot}71$$

$$\begin{array}{rr} = 2{\cdot}5634811 & -\,0{\cdot}9057959 \\ 1{\cdot}8557614 & -\,0{\cdot}1370375 \\ \hline 4{\cdot}4192425 & -\,1{\cdot}0428334 \\ -\,1{\cdot}0428334 & \\ \hline 3{\cdot}3764091 & \end{array}$$

And, therefore, M = 237·9, which is 1 per cent. less than the value assigned at Melbourne 240. That the formula—

$$\mathrm{M} = \frac{\mathrm{F} \times f}{\mathrm{E} \times x}$$

is sufficiently near is quite evident.

For my Cassegrain, A being centre of concave and B of (*f*), in this diagram, A F = 129in., B*f* = ⅕ 129 = 25·8in. F*f* = $x$ = 4·96; and B F (as F is a fixed point) = B*f* − F*f* = 25·8 − 4·9 = 20·9, so that the surface of the convex must be placed at B where B F = 20·9in.

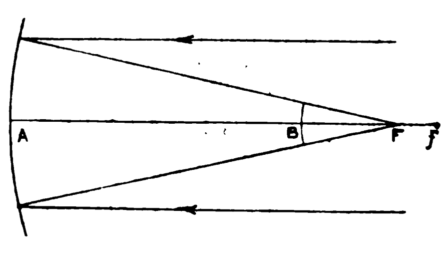
$$\text{The magnifying power} = \frac{\mathrm{F}}{\mathrm{E}} \cdot \frac{f}{x}$$

$$(\text{If } 3\tfrac{1}{2} = \mathrm{E}) \qquad = \frac{129}{3\frac{1}{2}} \times \frac{25{\cdot}8}{4{\cdot}96}$$

$$= 191{\cdot}5 \text{ nearly.}$$

The proportion of foci—the large concave to have five times the focal length of the small convex, is as good as possible.

In viewing the convex in position through the aperture in concave, the reflected image should just embrace the whole of the convex. If the convex be too large, a black margin will be seen all round the convex, which causes a larger black spot in the eyepiece than necessary; besides obstructing light and darkening the field of view.



The small convex being 20·9in. outside or beyond the convex, a cone of light converging thither will almost exactly fill the convex with light coming from an 18in. mirror; with the condition that the convex is 3 1-16in. in diameter. A very important point is to keep down the size of the black spot on the eyepiece. In the case just given the diameter of this

$$\delta = \frac{3}{190} \text{ nearly} = \frac{1}{63}\text{rd of an inch.}$$

Whilst the final pencil has a diameter of $\frac{18}{190}$ $= \frac{1}{10{\cdot}5}$ nearly, which darkens about $\frac{1}{27}$th of the whole pencil.

It may be remarked here that an eyepiece of 7in. focus would give a power of 95 with great brilliancy, with the convex of 28½in.

The field of view for power 190 would be—

$$\theta = \frac{\text{co-tangent 1 minute}}{\text{magnifying power}}$$

$$= \frac{3438}{190} = 18 \text{ minutes.}$$

This would embrace rather more than half the moon's disc. The great difficulty in this form of telescope is to keep down the final diameter of the moon's image. It is only by lengthening the focus *f*, or shortening F, this can be done. At the same time it should be stated that no other form of telescope can display so large a lunar image. In the case now discussed, the size of the image presented at the aperture of the concave mirror is just about 5¼ larger than would be produced by a Newtonian of the same parabolic focus F, equivalent, indeed, to that produced by an achromatic or Newtonian of 56ft.

There are some special advantages belonging to this virtual focus. The moon is so enormously magnified at first hand that a very low eye-lens—especially short-focus photo-lenses—can be employed, producing remarkable precision of definition, whilst the light being spread over so large a surface, is pleasantly subdued to a pearly brilliance.

(*To be continued.*)

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* ($x$ = 0·038 F = 0·038 × 129 = 4·902in.; say 4·9.)

Then for a convex of one-fourth the focus of F = ¼ 129 = 32¼ $x$ = ·059 F = 7·63.

$$\mathrm{M} = \frac{\mathrm{F}}{4\frac{1}{4}} \cdot \frac{f}{x} = \frac{129}{4\frac{1}{4}} \times \frac{32\frac{1}{4}}{7{\cdot}63} = 30{\cdot}3 \times 4{\cdot}22 = 128$$

## SOLID v. LAMINATED ARMATURES.

By Selimo R. Bottone.

CONTRADICTORY statements have appeared in several publications devoted to electrical matters as to the relative efficiency of solid and laminated armatures. In manufacture, a laminated armature is certainly more expensive: hence it must present some decided advantage over the solid form to insure its adoption.

In order to decide the point by actual experiment, the writer fitted up a small dynamo (one of those described in his book) with 7lb. of No. 16 c.c. copper wire on the fields. Two armatures, each 1½in. in diameter, 3¾in. in length, with a channel ⅞in. wide, and a web ¼in. in thickness—one (*a*) solid, weighing 13oz., the other (*b*) laminated, weighing 11oz.—were each wound with 6oz. of No. 20 silk-covered wire, and then soaked in melted paraffin to insure good insulation. These were both mounted on spindles of the same size, fitted with similar commutators, and, in point of fact, rendered as identical as it was possible for them to be except in the point of lamination.

When the solid armature (*a*) was fitted to the dynamo, worked as a series machine, it was possible, by driving at a speed of about 3,000 revolutions per minute, to light fairly well four five-candle Swan lamps, arranged in parallel arc, having each a resistance of 8 ohms. At this speed the electromotive force was about 10 volts at the terminals.

The laminated armature (*b*) was now substituted, and on trial it was found that the five-candle Swan lamps could be kept brilliantly lighted by a speed of 2,000 revolutions per minute. On adding lamps, and increasing the speed, it was found that six and even seven fives could be lighted up, and at 3,000 revs. the effect with six was as good as the solid armature gave with four. The electromotive force of this machine at this speed was found on careful measurement to be about 20 volts; and, in point of fact, it was possible to light well three ten-candle Swans in parallel arc each of 20 ohms resistance. With regard to heating, (*a*) rose from a temperature of

45° Fahr. to 120° after a twenty minutes run; (*b*) after running twenty minutes had only increased 5°.

In order to render the experiments more conclusive, two exactly similar motors were fitted up, alike at all points except in the armatures. The armatures (*a*) and (*b*) were fitted to these motors, but so as to be interchangeable at will. No material difference was, however, detected in the field-magnets. These two motors were connected up in series, but back to front, so as to get the driving-wheels to run in opposite directions. The two driving-wheels were then joined together by an endless band, and the motors joined to one and the same battery (so that the same current circulated round both at the same time).

The result was that the motor fitted with the laminated (*b*) armature began to revolve, dragging with it armature (*a*), which was thus obliged to rotate in a direction opposite to that in which it was impelled by its own field-magnets.

To what may this superiority be attributed? Probably three causes are at work simultaneously.

1. The sheet iron from which the laminated armature was made is softer, more free from carbon, and purer than it is possible for cast iron to be; hence more rapid and more perfect magnetisation and demagnetisation.

2. The lamination, and consequent separation of the portions of the armature, prevents the formation of the Foucault currents; therefore, the iron cone does not get heated.

3. The interstices between the laminations, by allowing the passage of air, help to keep the armature cool; and the coolness of the armature favours the conductivity of the wire, and consequently the efficiency of the machine.

## ASTRONOMICAL NOTES FOR APRIL, 1885.

### The Sun.

| Day of Month. | Souths. | At Greenwich Mean Noon. | | |
|---|---|---|---|---|
| | | Right Ascension. | Declination North. | Sidereal Time. |
| | h. m. s. p.m. | h. m. s. | ° ′ ″ | h. m. s. |
| 1 | 0 3 49·69 ,, | 0 43 52 | 4 43 4 | 0 40 2·20 |
| 6 | 0 2 20·77 ,, | 1 2 6 | 6 37 23 | 0 59 44·96 |
| 11 | 0 0 57·46 ,, | 1 20 25 | 8 28 53 | 1 19 27·73 |
| 16 | 11 59 41·79 A.M. | 1 38 52 | 10 16 53 | 1 39 10·49 |
| 21 | 11 58 35·35 ,, | 1 57 29 | 12 0 39 | 1 58 53·25 |
| 26 | 11 57 39·44 ,, | 2 16 15 | 13 39 27 | 2 18 36·02 |

The method of finding the Local Sidereal Time at Mean Noon at any other Station will be found on p. 355 of Vol. XL.

Although the sunspot maximum has now passed, interesting groups of spots, faculæ, &c., continue to reward the assiduous observer.

The Zodiacal light may still be seen during the first part of the month.

### The Moon

Enters her Last Quarter at 2h. 42·6m. in the afternoon of the 7th, and is New at 5h. 51·4m. a.m. on the 15th. She will enter her First Quarter at 11h. 20·2m. at night on the 21st, and be Full at 6h. 14·3m. in the morning of the 29th.

| Day of Month. | Moon's Age at Noon. | Souths. |
|---|---|---|
| | Days. | h. m. |
| 1 | 15·8 | 1 8·1 a.m. |
| 6 | 20·8 | 5 6·8 ,, |
| 11 | 25·8 | 9 0·0 ,, |
| 16 | 1·3 | 1 10·5 p.m. |
| 21 | 6·3 | 6 0·0 ,, |
| 26 | 11·3 | 10 14·2 ,, |

The Moon will be in conjunction with Mars at 6 a.m. on the 14th; with Venus at 8 p.m. on the same day; with Mercury at 7 a.m. on the 16th; with Saturn at 1 a.m. on the 19th; and with Jupiter at 7 p.m. on the 23rd.

### Occultations of (and a near approach to) Fixed Stars by the Moon.

| Day of Month. | Name of Star. | Mag. | Disappearance. | Moon's Limb. | Angle from N. Point. | Angle from Vertex. | Reappearance. | Moon's Limb. | Angle from N. Point. | Angle from Vertex |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | h. m. | | ° | ° | h. m. | | ° | ° |
| 9 | 14 Capricorni | 5 | †3 48 a.m. | S. by E. | 9 | 339 | | | | |
| 20 | λ Geminorum | 3½ | 10 59 p.m. | Dark | 147 | 187 | 11 20 p.m. | Bright | 192 | 232 |
| 22 | B.A.C. 3122 | 6½ | 9 4 ,, | Dark | 100 | 127 | 10 4 ,, | Bright | 221 | 255 |
| 23 | π Leonis | 5 | 6 46 ,, | Dark | 28 | 14 | 7 42 ,, | Bright | 291 | 290 |
| 24 | *d* Leonis | 5 | 11 7 ,, | Dark | 109 | 135 | 11 58 ,, | Bright | 206 | 238 |
| 26 | B.A.C. 4256 | 6½ | 8 28 ,, | Dark | 85 | 66 | 9 39 ,, | Bright | 225 | 219 |
| 30 | ο¹ Libræ | 6 | 3 46 a.m. | Bright | 65 | 92 | 4 55 a.m. | Dark | 276 | 310 |

† A near approach.

### Jupiter's Satellites.

| Day of Month. | Satellite. | Phenomenon. | H. | M. | S. | Day of Month. | Satellite. | Phenomenon. | H. | M. | S. | Day of Month. | Satellite. | Phenomenon. | H. | M. | S. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *II* | *Oc D* | 7 | 11 | P.M. | 12 | I | Oc D | 2 | 1 | A.M. | 21 | I | Sh I | 8 | 49 | P.M. |
| 1 | II | Ec R | 11 | 53 | 11,, | 12 | I | Tr I | 11 | 22 | P.M. | 21 | I | Tr E | 9 | 59 | ,, |
| 2 | IV | Tr I | 2 | 59 | A.M. | 12 | I | Sh I | 12 | 25 | ,, | 21 | I | Sh E | 11 | 8 | ,, |
| 4 | I | Tr I | 3 | 5 | ,, | 13 | I | Tr E | 1 | 41 | A.M. | 22 | *III* | *Oc D* | 2 | 24 | A.M. |
| 4 | *I* | *Sh I* | 4 | 2 | ,, | 13 | I | Sh E | 2 | 45 | ,, | 22 | I | Ec R | 8 | 14 | 0 P.M. |
| 4 | I | Oc D | 12 | 13 | P.M. | 13 | I | Oc D | 8 | 29 | P.M. | 23 | *II* | *Oc D* | 2 | 28 | A.M. |
| 5 | *I* | *Ec R* | 3 | 26 | 56 A.M. | 13 | I | Ec R | 11 | 50 | 22,, | 24 | II | Tr I | 8 | 34 | P.M. |
| 5 | I | Tr I | 9 | 32 | P.M. | 14 | *I* | *Sh I* | 6 | 54 | ,, | 24 | II | Sh I | 10 | 57 | ,, |
| 5 | I | Sh I | 10 | 31 | ,, | 14 | I | Tr E | 8 | 9 | ,, | 24 | II | Tr E | 11 | 30 | ,, |
| 5 | I | Tr E | 11 | 52 | ,, | 14 | I | Sh E | 9 | 13 | ,, | 25 | II | Sh E | 1 | 52 | A.M. |
| 5 | I | Sh E | 12 | 50 | ,, | 14 | III | Oc D | 10 | 43 | ,, | 25 | *III* | *Tr E* | 7 | 55 | P.M. |
| 6 | *I* | *Oc D* | 6 | 40 | ,, | 15 | III | Oc R | 2 | 22 | A.M. | 25 | III | Sh I | 9 | 6 | ,, |
| 6 | I | Ec R | 9 | 55 | 35,, | 15 | *III* | *Ec D* | 3 | 13 | 18,, | 25 | III | Sh E | 12 | 41 | ,, |
| 7 | II | Tr I | 2 | 28 | A.M. | 15 | II | Oc D | 12 | 0 | P.M. | 26 | II | Ec R | 8 | 59 | 32,, |
| 7 | *III* | *Oc D* | 7 | 7 | P.M. | 17 | II | Sh I | 8 | 21 | ,, | 27 | IV | Ec R | 8 | 35 | 43,, |
| 7 | *I* | *Sh E* | 7 | 19 | ,, | 17 | II | Tr E | 9 | 2 | ,, | 27 | I | Oc D | 12 | 11 | ,, |
| 7 | III | Oc R | 10 | 45 | ,, | 17 | II | Sh E | 11 | 16 | ,, | 28 | I | Tr I | 9 | 31 | ,, |
| 7 | III | Ec D | 11 | 13 | 55,, | 18 | III | Sh E | 8 | 43 | ,, | 28 | I | Sh I | 10 | 44 | ,, |
| 8 | III | Ec R | 2 | 40 | 51 A.M. | 18 | IV | Tr E | 11 | 36 | ,, | 28 | I | Tr E | 11 | 51 | ,, |
| 8 | II | Oc D | 9 | 34 | P.M. | 20 | I | Tr I | 1 | 12 | A.M. | 29 | I | Sh E | 1 | 3 | A.M. |
| 9 | II | Ec R | 2 | 29 | 22 A.M. | 20 | I | Sh I | 2 | 20 | ,, | 29 | I | Ec R | 10 | 8 | 58 P.M. |
| 10 | II | Sh E | 8 | 40 | P.M. | 20 | I | Oc D | 10 | 19 | P.M. | 30 | *I* | *Sh E* | 7 | 32 | ,, |
| 10 | IV | Ec D | 10 | 13 | 51,, | 21 | I | Ec R | 1 | 45 | 15 A.M. | | | | | | |
| 11 | IV | Ec R | 2 | 37 | 10 A.M. | 21 | *I* | *Tr I* | 7 | 39 | P.M. | | | | | | |

Ec Eclipse; Oc Occultation; Tr Transit of Satellite; Sh Transit of Shadow; D Disappearance; R Reappearance; I Ingress; E Egress. The printing of a phenomenon in *italics* indicates that its visibility is rendered doubtful, either by the brightness of the twilight or by Jupiter's proximity to the horizon.

### Mercury

Is an Evening Star up to the 27th. At 3 a.m. on the 28th he comes into inferior conjunction with the Sun, and, of course, afterwards travels to the West of him, and becomes a Morning Star. He attains his greatest elongation East (19° 15′) at 2 a.m. on the 8th, and is, during the first ten days of April, excellently situated for the observer, who, on clear evenings, may pick the planet up above the Western horison with the naked eye.

| Day of Month. | Right Ascension. | Declination North. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 1 46·2 | 12 47·9 | 1 6·0 p.m. |
| 6 | 2 11·4 | 15 54·1 | 1 11·4 ,, |
| 11 | 2 28·2 | 17 46·8 | 1 8·5 ,, |
| 16 | 2 35·4 | 18 20·3 | 0 56·1 ,, |
| 21 | 2 33·5 | 17 35·2 | 0 34·5 ,, |
| 26 | 2 24·9 | 15 45·9 | 0 6·2 ,, |

The path indicated by the above Ephemeris commences where Cetus, Pisces, and Aries are conterminous, and extends into the last-named constellation. On the same day that he comes into inferior conjunction with the Sun, he will, at 7 p.m., be in conjunction with Venus—it is needless to say invisibly.

### Venus

Is a Morning Star, and is at once an object devoid of all interest, and in a most indifferent position for the observer. She is immersed in the glare of sunlight, and the diameter of her practically circular disc dwindles from 9·8″ at the beginning of April to 9·6″ by the end of it.

### Venus.

| Day of Month. | Right Ascension. | Declination. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 0 14·3 | 0 1·4 S. | 11 34 3 a.m. |
| 6 | 0 37·0 | 2 27·9 N. | 11 37·3 ,, |
| 11 | 0 59·8 | 4 56·1 ,, | 11 40·4 ,, |
| 16 | 1 22·7 | 7 21·8 ,, | 11 43·5 ,, |
| 21 | 1 45·8 | 9 43·5 ,, | 11 46·9 ,, |
| 26 | 2 9·2 | 11 59·6 ,, | 11 50·6 ,, |

Hence, starting from Pisces, Venus travels across the North-West course of Cetus into Aries.

### Mars

Is invisible. To those who care to look at the Minor Planets,

### Ceres

Comes into Opposition to the Sun on April 2nd, and is hence well situated for observation. Our Ephemeris is, as usual in these cases, for ten-day intervals only. The planet shines as a 7th magnitude star.

| Day of Month. | Right Ascension. | Declination North. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 13 14·2 | 9 19·3 | 12 32·2 p.m. |
| 11 | 13 5·6 | 9 49·4 | 11 44·2 ,, |
| 21 | 12 57·4 | 10 0·0 | 10 56·7 ,, |

Ceres will thus retrograde through a short arc in a very barren part of Virgo. On the night of the 22nd she will be a very little more than 1½° South of ε in that constellation.

### Pallas

Was, as stated on p. 553 of our last volume, in opposition on March 17, so that she may still be well seen during the earlier part of the night. She presents the appearance of a bright 7th mag. star, of a yellowish tint.

| Day of Month. | Right Ascension. | Declination North. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 11 51·1 | 11 55·2 | 11 9·3 p.m. |
| 11 | 11 46·0 | 14 51·9 | 10 24·9 ,, |
| 21 | 11 43·2 | 17 5·3 | 9 42·7 ,, |

Starting from the confines of Virgo, Pallas will travel into Leo. She will be almost exactly 1½° North of β Leonis on the 18th.

### Juno

Will be in opposition to the Sun on April 15th. Her light is of an orange cast, and she looks like an eighth-magnitude star.

| Day of Month. | Right Ascension. | Declination. | Souths. |
|---|---|---|---|
| | h. m. | ° ″ | h. m. |
| 1 | 14 3·8 | 1 35·3 S. | 1 25·5 a.m. |
| 11 | 13 55·6 | 0 11·9 ,, | 12 34.1 p.m. |
| 21 | 13 47·7 | 0 57·4 N. | 11 46·9 ,, |

Juno is in Virgo, too, in a blank part of the sky. On the nights of the 10th and 11th she may be fished for a little more than 2° South of τ Virginis—a wide and unequal double Star.

### Jupiter

Is approaching the West, but is still king of the night sky. He should be observed as soon as it is dark enough, in order to be seen to the greatest advantage. His angular diameter slowly decreases from 39·6″ on April 1st to 36·5 on the last day of the month.

| Day of Month. | Right Ascension. | Declination North. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 9 56·5 | 13 52·4 | 9 15·0 p.m. |
| 6 | 9 55·4 | 13 57·3 | 8 54·2 ,, |
| 11 | 9 54·7 | 14 0·7 | 8 33·8 ,, |
| 16 | 9 54·2 | 14 2·4 | 8 13·7 ,, |
| 21 | 9 54·0 | 14 2·5 | 7 53·8 ,, |
| 26 | 9 54·2 | 14 1·1 | 7 34·3 ,, |

As shown by the above Ephemeris, Jupiter will, to the naked eye, remain sensibly stationary in Leo, a little to the West and North of Regulus.

### Saturn

Now souths in bright daylight, sets soon after midnight at the beginning of the month, and, of course, sooner and sooner every night. We last month intimated our intention (Vol. XL., p. 553) of discontinuing our Ephemeris of him; but as he may still be seen for a short time after dark in the West and West-North-West, we subjoin one for the first half of April.

| Day of Month. | Right Ascension. | Declination North. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 5 12·6 | 21 52·9 | 4 31·8 p.m. |
| 6 | 5 14·3 | 21 55·7 | 4 13·9 ,, |
| 11 | 5 16·1 | 21 58·6 | 3 56·0 ,, |

So that Saturn, during the short remaining time of his visibility, will continue at the right-hand extremity of the base of the rudely isosceles triangle which he forms with β and ζ Tauri.

### Uranus

Is still capitally placed for the observer, and is in his best position during the most convenient hours of the night. His angular diameter of 4″ remains unaltered.

| Day of Month. | Right Ascension. | Declination North. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 12 2·7 | 0 33·3 | 11 24·9 p.m. |
| 6 | 12 1·9 | 0 38·2 | 11 0·4 ,, |
| 11 | 12 1·2 | 0 42·8 | 10 40·0 ,, |
| 16 | 12 0 5 | 0 47·3 | 10 19·7 ,, |
| 21 | 11 59·9 | 0 51·4 | 9 59·3 ,, |
| 26 | 11 59·2 | 0 55·2 | 9 39·0 ,, |

Hence it will be seen that Uranus is travelling through a short retrograde arc away from η Virginis, and in the direction of β in that constellation.

### Neptune

Is invisible.

### Shooting Stars

Should be watched for from the 19th to the 21st, and notably on the 20th. A look-out should also be kept from the 26th to the 30th.

### Greenwich Mean Time of Southing of Nine of the Principal Fixed Stars on the Night of April 1st, 1885.

| Star. | Souths. h. | m. | s. | |
|---|---|---|---|---|
| β Cancri .. .. .. | 7 | 29 | 1·96 | p.m. |
| ι Ursæ Majoris .. .. | 8 | 9 | 58·62 | ,, |
| α Hydræ .. .. .. | 8 | 40 | 30·03 | ,, |
| Regulus .. .. .. | 9 | 20 | 42·15 | ,, |
| α Ursæ Majoris .. .. | 10 | 14 | 56·40 | ,, |
| δ Crateris .. .. .. | 10 | 31 | 51·61 | ,, |
| ε Corvi .. .. .. .. | 11 | 22 | 20·74 | ,, |
| α Canum Venaticorum .. | 12 | 8 | 38·85 | ,, |
| Spica Virginis .. .. .. | 12 | 37 | 1·70 | ,, |

The method of finding the Greenwich Mean Time of Southing of either of the Stars in the above list for any other night in April, as also that of determining the local instant of its Transit at any other Station, will be found on p. 356 of Vol. XL.

## COMPOUND EYES AND MULTIPLE IMAGES.[*]

MY microscopical recreations the past summer were directed mainly upon the structure of the compound eyes of insects, not so much for a definite scientific purpose, as with the practical object of discovering what insects have eyes that are the most serviceable for showing multiple images under the microscope. The results thus far obtained are far from exhaustive; yet I have fallen upon some curious features in the structure of these organs, which may possess the interest of novelty to an audience not composed exclusively of entomologists.

These compound eyes, consisting externally of a great number of lenses, sometimes exceeding twenty thousand, set in a framework of convex or, often, hemispherical form, have a range of vision, or "angular aperture," very much larger than could be commanded by a simple eye of the same convexity. For, while the simple eye could form correct images of those objects only which are situated within the range of rays passing through its optical axis, the minute lenses composing the compound eye may, many of them, receive light from a horizon as low down as the base of the entire set, if not lower.

In some species of Neuroptera the head is nearly cylindrical, and is placed with its axis transverse to the axis of the insect's body. As the eyes constituting, of course, the extremities of the cylinder, have a diameter exceeding that of their support, and are, besides, hyperhemispherical, they give to the head the appearance of a dumbbell. Were one of these insects placed at the centre of a hollow sphere, it could, undoubtedly, see at the same moment every point of the sphere's interior surface.

The *Gyrinus*, or water-beetle, which may be seen sporting on the surface of still water in summer, has the unusual number of four compound eyes. Besides the usual pair on the upper and frontal part of the head, set in the under side of head is another pair, looking directly downward and completely submerged — "water-immersion" eyes. The utility of this arrangement is readily seen. Its anatomy I have not myself examined; but I have somewhere heard or read that the two eyes on each side, though separated externally, are, in a measure, connected internally. The *Gyrinus* is the only example of this peculiar structure that has come under my observation.

To those who admire colour, a microscopical observation of the eyes of living insects, especially those of the order Diptera, and of the night-flying Lepidoptera, will be fruitful of delight. For the eyes of these insects display an endless variety of colours which vie in brilliancy with the most lustrous of the "bright jewels of the mine." After the death of the insect, however, the colour soon disappears.

In mounting compound eyes for the purpose of showing multiple images, the first step, after carefully washing the interior of the cornea, is to press the cornea flat, so that all the lenses may lie as nearly as possible in the same plane. But as this operation necessarily occasions either a breaking or folding of the cornea, I cut out, with a small punch made for the purpose, a circular disc not larger than can be pressed flat without disturbing the facets. In punching out these discs, a single cutting gives two circular pieces, showing that the cornea is double; and in the eyes of *Cicada*, a single cutting gives three separate discs showing a triple set of lenses in the cornea. Each set constitutes, without doubt, an achromatic combination.

In some of the Diptera, particularly of the genus *Tabanus*, or horse-fly, the lenses of the upper and anterior part of the eye are much larger than those situated below a median line. A disc cut from one of these eyes in such a way as to include a number of the upper or larger facets, and also some of the lower, shows that the larger facets have at least twice the diameter of the smaller, or four times their superficial area. A still more remarkable feature, however, is the difference in focus between the larger lenses and the smaller. For upon placing this part of the eye upon the stages of the microscope, and adjusting the focus for multiple images, I found that the larger lenses form pictures at a plane considerably above the focal plane of the smaller ones. From this fact it would appear that these insects are furnished with eyes of two varieties, corresponding to our long-sight and short-sight spectacles; in other words, telescopic and microscopical eyes, the telescopic looking upward and forward, and the microscopical downward. The economy of such an optical structure in a parasitic insect which seeks its prey at a distance is so obvious that I need not stop to explain it.

For showing multiple images, the most perfect eyes that I have yet found are those of *Blattia orientalis*, or the cockroach. As the eyes of the insect are quite brittle, only a small part of the cornea can be pressed flat in one piece. Yet a piece large enough to fill the field commanded by a ¼in. objective and a B ocular can be cut out with the punch. The many advantages which it possesses more than counterbalance its lack of superficial extent. For the lenses are very transparent, and comparatively large, and, being set in a moderately-hard framework, do not separate so as to destroy the achromatic combination. Nor do the lenses which make up each combination slip upon one another when subjected to slight pressure, as do the lenses in the eyes of most other insects except the coleoptera. When the lenses do thus slip upon one another, each separate eye shows two or three imperfect images instead of a single good one. The chief advantage, however, which the eyes of the cockroach possess over all others is that they may be mounted in glycerine and thus kept perfectly transparent without losing their properties as lenses.

The usual method of exhibiting the multiple images is to place the mounted cornea of the compound eye upon the stage, and focus the microscope so much above it as to show a clear circle of light in each facet. Then, if any small object be placed between the stage and the mirror, its image will be exhibited by every lens. Also if a small letter, figure, or picture, in black, with a clear, white background, be placed 1in. or 2in. below the stage, and a strong light be condensed upon it, it will be seen with tolerable distinctness. Such objects are, however, much more sharply defined if first cut out, and then pasted upon a thin cover-glass, which may be mounted on the substage. In this situation the object is illumined by light reflected from the mirror. The effect will be still better if a slip of ground glass be interposed between the object and the mirror, so as to shut off the image of the lamp if lamplight be employed, or of distant objects, if daylight be used. The eye of a mosquito will show two or three hundred pictures of a person, in silhouette, with great distinctness, provided you have a window so situated as to allow light from the sky or from a white cloud to pass unobstructed to the mirror. The person must stand at a distance of 5ft. or 6ft. from the microscope, and with the profile of his face in clear relief against the sky. The plane mirror must, of course, be used.

I have recently been much interested in examining the structure of the eye of *Limulus*, or the horse-shoe crab, which, though compound, is quite different, in some particulars, from that of insects.

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[*] By J. D. Hyatt, from the *Journal* of the New York Microscopical Society.

The exterior of this eye is perfectly smooth, and consists of a transparent horny coat of considerable thickness. The concave interior surface is studed with lenses varying in form from plano-convex, near the centre, to conical and paraboloid, toward and at the periphery. These lenses are so placed that their optical axes converge to a common point situated in a plane a little below the base of the whole eye. This point, without doubt, is occupied by the retina, or the extremity of the optic nerve. Good multiple images will be made by this eye if a small disc cut from the central part be used, the eye being flattest at that point and the lenses least conical. From any other part of the eye it would be extremely difficult to cut a disc that would not, in consequence of the oblique position of the lenses, greatly distort the images.

Multiple images may be formed under the microscope in many other ways than by the use of compound eyes. The minute plano-convex bodies of water produced by breathing on a slide, will display good images of any small object supported above the mirror. In like manner, images will be made by other transparent bodies, or by the transparent parts of any structure, which are of lenticular or globular form. Concave lenses, as well as convex, will give images, but with this difference —the images will be found below the plane of the foci of the lenses, and will be inverted; whereas, images produced by convex lenses are formed erect and, as before stated, at a plane above such focus. It follows that air-bubbles in water will yield inverted images, the water immediately surrounding them acting as a biconcave lens. These facts may possibly be of some service in determining the character of minute bodies or structures, such, for example, as human blood corpuscles, all of which show erect images—a proof that they are nucleated or, at least, lenticular at the centre. The head of the pin-shaped sponge-spicule, and the nuclei in certain diatoms, produce inverted images.

## THE DANGERS OF MECHANICAL GENERATORS OF ELECTRICITY.*

THE more and more general use of powerful electro-magnetic generators has caused several accidents, some of them involving the loss of human life. It is, therefore, desired at present to regulate the employment of electricity, and to determine experimentally the tension and the current which are dangerous in practice. The problem thus set forth is not well put, and is not susceptible of any solution, as the object of the present communication is to show. In the first place, it is not, generally, when the electric current is permanently established that accidents take place, but at the moment of the establishment or of the rupture of the electric circuit. Under these circumstances, the body of the experimentalist re-establishes for a longer or shorter time the continuity of the broken circuit. It is easy to show that, at this moment, the danger incurred depends by no means on the tension and the intensity of the primitive current, as is generally believed, but depends on quite a different factor, which cannot be calculated from a mere knowledge of the tension and the intensity of this primitive current. All physiologists know that the energy of an electric excitement depends much less on the intensity of the current than on the rapidity of the fall of the potential and on the frequency of the shocks. This being established, the following propositions become, so to speak, self-evident:—Proposition I.—A battery and a machine producing in a rectilineal circuit two currents having the same current and the same tension do not present the same dangers. In fact, if we break the circuit in any point whatever, holding in each hand an end of the uninsulated wire, we find that the battery gives scarcely a shock, whilst the machine produces a much more considerable excitement of the nervous and muscular systems—an excitement which, in certain cases, may become instantaneously fatal. The reason of this difference is that the battery in a rectilineal circuit does not give an extra current, whilst the machine, by the mere fact of its construction, gives one, the power of which varies with the length and the manner of coiling of its circuit, as well as with the quantity of iron which forms its framework. The danger, therefore, resides simply in the power of the extra current resulting from the self-induction of the generator. From these very simple considerations, the results of experience, we deduce the following propositions:—Proposition II.—Two machines yielding currents of the same intensity and the same tension in a similar circuit may be unequally dangerous, since their coefficients of self-induction, and consequently their extra currents, may be very different. Proposition III.—A current not dangerous in one circuit may be dangerous in another. It is merely necessary to give the circuit a self-induction by any means whatever—*e.g.*, by the interposition of an electro-magnet. I have verified experimentally these theoretical deductions by operating upon Guinea pigs with a Gramme machine (laboratory model) and with accumulators. The tension of the currents employed varied only from 2 to 20 volts, and the current from 1 to 30 ampères. Notwithstanding the feebleness of the currents employed, the Guinea pigs were nevertheless killed. We see, therefore, that, if we wish to suppress all danger in the use of electricity, we arrive at the absurd conclusion that electricity itself must be suppressed. I have sought for a remedy for this state of things. This is the method which has proved efficacious in all cases, and which constitutes a general procedure for the suppression of extra currents. To avoid all danger, what, in short, must be done? Simply prevent the extra current from traversing the body of the experimentalist. We know that the tension of the extra current is infinitely greater than that of the primitive current from which it takes its rise. This being admitted, I place in derivation at the extremities of the electric generator a series of voltameters, with lead plates and acidulated water, in such a number that their electromotive force of polarization may be superior to the maximum electromotive force of the machine. This derivation is absolutely impassable by the direct current, while the extra current traverses it readily. At the moment when the circuit is broken the extra current passes through the voltameters, and the human body is absolutely secure. This is a general and very simple method for the suppression of extra currents. It admits of numerous applications, some of which I have already carried out, but their explanation cannot be given in this brief notice. I take voltameters with leaden plates because they develop practically the greatest electromotive force, and I vary the arrangement according to circumstances. We see that the process which I propose consists in the establishment of a derivation, insurmountable for a direct current, and consequently occasioning no waste of current. This derivation exists only for the extra current. It is analogous to a safety valve, which opens automatically at a given pressure.

## HOME-MADE EMERY WHEELS.

THE solid emery wheels have made possible a wonderful advance in the surfacing and poling of metals in the shop, in truing centres, sharpening tools, and in other processes. Yet in some cases they are not equal to the home-made wheel for one reason—they become smaller by using, like the grindstone; and there are jobs where it is desirable that the emery wheel should retain its original and uniform size. It is well, therefore, to give a few words of this almost forgotten shop lore. The emery wheel should be of soft wood—pine is to be preferred—made of alternate layers of boards planed to make good joints, put together with glue and screws, the grain crossing each alternate layer of boards, which should be not more than ¾in. thick; ½in. boards are better. Make the wheel slightly thicker than it is to be when finished, as it is to be turned and trued on the sides as well as the face. With a band saw or gig saw, shape the glued up and screwed boards to a circle, chuck it in a lathe, and bore and turn a hole and recess at the centre to receive a disk, or gland, of iron that has been bored and faced up, having screw holes in its flange. The hub of the gland should be seated in the wooden wheel. When the gland is in place and secured the wheel is ready to be turned to finish. It is mounted on an arbor for this purpose. Some wheels are to run on a threaded arbor, and the gland is therefore threaded. After turning to size, peg a belt or band of wet belt leather with shoe pegs to cover the rim of the wheel, flesh side of the belt outside. This makes a hard wheel. If one with a yielding surface is desired, peg on layers of Canton (cotton) flannel to the requisite thickness, carrying them over the edges of the face to make a round edge. Cover the whole, not with leather, but with strong denim or bed ticking, pegging or tacking it on the sides of the wheel. This makes a soft or stuffed wheel, which is for polishing—not grinding—and it will do work of a somewhat irregular form. Brush the face of the wheel with hot glue, pass a round bar through the centre and roll the wheel in emery that is spread in a shallow trough or on a clean table. Any particles of iron or steel filings in your emery will make trouble; have the table or cloth very clean. One coating of glue and emery is better than more, for when the outer coating is worn off the glue will glaze. Do not rap off any of the loose particles of emery until the wheel is perfectly dry; the reason is obvious—the undried glue will not hold the particles in place. When the wheel has been worn, the glue and emery are removed by soaking in water, and the facing repeated. If the use of these wheels is insufficient to warrant the trouble, it is well to have a trough of water, in which two iron rolls revolve by power, the faces of the rolls far enough apart to allow an emery wheel to roll and ride between them, the shafts of the rolls to be connected at one end by gear wheels and an intermediate, so that they both turn in the same direction, and the emery wheel standing on its face will be slowly revolved by their combined action, the water in the trough being at a sufficient height to just wet the face of the wheel as it turns. This method prevents the whole wheel from being wet and warped. If this method is not feasible, repeated hand washings of the face must be made to soften the glue.—*Southern Coachmaker.*

## PHOTOGRAPHING INTERIORS.

IN some occasional notes for beginners contributed to the *Photographic Times*, "Flandreau" writes thus about photographing interiors:—

In making negatives of interiors the circumstances are quite different from those under which landscapes are photographed. Not only are the circumstances different, but so also is the resulting negative, especially as regards its characteristics of chiaro-oscuro. However beautiful shadows and violent contrasts may occasionally be in landscapes, in negatives of interiors they are not to be desired. We must here be content with composition alone for artistic beauty, and should not employ lighting as a means to that end. Perfect detail is most desired, and a negative showing well the delicate tracery of carpet and wall paper, and reproducing distinctly the details of furniture, familiar portraits and other objects in the room should always be aimed at. Such a negative can only be made by the employment of a small diaphragm in the lens, and by giving an ample exposure; this latter being of the utmost importance. A beginner is far more likely to under-expose than to give too long a time to his plate. It is comparatively easy to check the development in the case of over-pressure, and to produce an excellent negative, while an undertimed plate is hopeless, for if urging be resorted to by increasing the strength of the developer, fog will be the inevitable result. Let the novice, therefore, be on his guard and give a liberal exposure when photographing interiors.

It is a mistaken idea held by some that to exclude all strong light conduces to the development of detail in the negative. Now, this method has but one effect upon the result—the making of a longer exposure necessary. Admit all the *diffused* light possible, and make the exposure when the subject is best lighted. All *direct* sunlight must, however, be carefully excluded, as this would so unequally affect the film that parts of the resultant negatives would be much too dense, while on others no detail at all could be discovered. A plain white linen curtain, or even white paper placed over the window through which the direct sunlight comes, will successfully diffuse it. It is best, so far as possible, to light an interior from the sides and from behind the camera, and in order to do this, that time of day must be selected for the exposure when the greatest amount of light will come through the side and rear windows.

It is scarcely necessary to add that a wide-angle lens should be used. One with as short a focus as will clearly cover the entire plate will include the maximum amount of the interior. The longer the focus the less will be included in the field of view, but with a relative increase in the size of individual objects.

## USEFUL AND SCIENTIFIC NOTES.

**Coal and Iron.**—The consumption of coal in the iron manufacture of the United Kingdom, relatively to the total production of pig iron, as compiled from the "Mineral Statistics of the United Kingdom" has been reduced in the past few years. The figures, so far as they go, would appear to show that the average quantity of coal consumed per ton of pig made in the United Kingdom as given in the British Iron Trade Report, by Mr. Jeans, was 2·08 tons in 1883, against 2·55 tons in 1874. In the interval, therefore, the quantity of coal used per ton of pig was reduced by very nearly half a ton over the whole—thanks very largely to the more general adoption of the Cowper and Whitwell hot-blast stoves.

**The Cotton Plant.**—A contemporary says Mr. A. A. Luber, of Macon, Georgia, has succeeded in endeavours to hybridise the cotton plant that grows wild in Florida with the common okra. The plant has an average height of 2ft., and each plant ha only one large bloom. Each boll is said to produce about 2lb. of very long-stapled cotton. There are no seeds in the lint, from four to six seeds, resembling those of persimmon, being at the bottom of the boll. If this is true, the new cotton will need no ginning, and the effect must be felt in several parts of the cotton industry if the new plant can be commercially cultivated.

**Shaving a Luxury.**—We do not believe it ourselves under any circumstances, being tender skinned; but are ready to admit that one of Messrs. Heaton and Co.'s hollow-ground razors, which they have sent us, and which they supply post free for 1s. 8d., brings it as near as is practicable. The temper and finish of the razors are very good.

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* By M. A. D'Arsonval, in the *Comptes Rendus.*

# SCIENTIFIC SOCIETIES.

## ROYAL METEOROLOGICAL SOCIETY.

THIS Society opened its sixth annual exhibition of instruments on Wednesday, the 18th inst., at the Institution of Civil Engineers, 25, Great George-street, S.W. This exhibition is devoted to sunshine recorders and solar and terrestrial radiation instruments.

The first attempt at obtaining an instrumental record of the amount of sunshine was made by Mr. J. F. Campbell, of Islay, in the year 1854, when he mounted a hollow glass sphere filled with acidulated water in the centre of a cup of mahogany, so arranged that the sun's rays were focussed on the interior of the cup and burned it. The lines of burning, therefore, indicated the existence of sunshine. Solid glass spheres have been substituted for the hollow ones, and cards in metal frames have replaced the wood; but in its principle the sunshine recorder of 1885 differs little from that erected on Richmond-terrace, Whitehall, thirty years ago. Other modes of recording sunshine are based on the action of the rays of the other end of the spectrum on the actinic instead of the heat rays. Among workers in this direction may be mentioned Marchand, of Fécamp, Sir Henry Roscoe, and others. The most recent improvements in this direction are those by McLeod and by Jordan.

With regard to solar radiation thermometers, the successive stages in the assumed perfecting of these instruments have been as follows:—An ordinary mercurial thermometer acts as a spherical mirror, and reflects the rays which fall upon it. To lessen this, the bulbs were first made with black glass; moreover, originally the degree marks were put upon the supporting slab, then they were put upon the tubes of the thermometers. It was then found that in a position where two thermometers with similarly coated bulbs were exposed to the sun—but one was exposed to more wind than the other—the indicated temperatures varied greatly. To avoid this it was proposed that the thermometer should be inserted in a glass shield exhausted of air. Various forms of mounting have been adopted; but the chief efforts have been expended in determining the influence of the amount of air left in the so-called vacuum. The next stage was that, inasmuch as black glass had a bright-surface, there was still much light reflected, and therefore the surface was dulled with a coat of lampblack, so that all heat falling upon the bulb might be absorbed. Subsequently, owing to the influence of the lower temperature of the unblackened thermometer tube, about 1in. of it was coated like the bulb. As evidence of the degree of exhaustion, a small mercurial pressure gauge was attached to the thermometer; and by other makers platinum wires were soldered through the shield, so that the stratification of the electric are might indicate the amount of air still left.

With regard to terrestrial radiation thermometers the pattern of instrument used has varied very little. The Rutherford minimum has almost always been used, but its sensitiveness has gradually been increased. The spherical bulb was replaced by a cylinder; the cylinder was elongated and bifurcated, and eventually, in order to strengthen the forks, they were united into what is known as a "link." Another plan was to flatten the cylindrical bulb into as thin a plate as possible, this giving a maximum of surface in proportion to the contents. The bulb was also made double, and thus we have the so-called "bottle" pattern, and then the tube was led into the side of the bottle, and both ends of the bottle were left open, and so we have the "open cylinder"—a remarkable specimen of glass blowing. Then there have been two patterns of mercurial thermometers, Casella's and Negretti's. Difficulties have arisen from the degree marks being obliterated by the weather. To guard against this, the tube has been inclosed in what are known as Leach's shields, and many attempts have been made to render the joint at the entrance of the tube watertight. This is not easy, because the thermometer is exposed to a great range of temperature, and the air inside the shield varies so much in volume that it forces its way through almost every joint. The object is, however, effected when the external jacket is sealed on the stem near the bulb.

In addition to specimens illustrating the various patterns of the above instruments, the exhibition also included a number of new instruments and many interesting photographs, sketches, and diagrams. The photographs of clouds and lightning were very good.

At the meeting of the Society the President, Mr. R. H. Scott, F.R.S., read a paper giving a brief account of the various instruments and arrangements to be found in the exhibition for the purposes of recording solar and terrestrial radiation, and the duration of sunshine both in regard of its light and its heat, the last-named being obtained by means of the sunshine recorders, which are now pretty generally used. He exhibited 12 monthly maps showing the percentage proportion of hours of recorded sunshine to the hours the sun was above the horizon in the various districts of the United Kingdom. He stated that the features which strike anyone on examining the maps of sunshine, which are, for the most part, for the last five summers and for the last four winters, excluding January to March, 1885, which has not yet expired, are—First, The broad fact that the extreme south-western and southern stations are the sunniest, as has already frequently been pointed out. Jersey is undoubtedly the most favoured of our stations in this particular. Second, That in the late autumn and winter Ireland is much sunnier than Great Britain, Dublin having absolutely the highest percentage of possible duration of sunshine in November and December, and being only equalled by Jersey in January. The Dublin instrument is not situated in the city, but at the Mountjoy Barracks in the Phœnix Park, beyond the viceregal lodge. The north-east of Scotland is also exceptionally bright, as the station, Aberdeen, lies to leeward of the Grampians. In April the line of 40 per cent. of possible duration takes in Jersey, Cornwall, Pembrokeshire, the Isle of Man, and the whole of Ireland, except Armagh. The absolute maximum of the year occurs in May, and the amount rises to 50 per cent. (nearly to 60 in Jersey) over the district just mentioned as enjoying 40 per cent. in April. In June there is a falling off which is continued into July, and even into August in the Western Highlands. In the South of England, however, a second maximum occurs in August, the figure for Jersey rising to 50 per cent. This is mainly due to the exceptionally bright weather of August, 1884, in the Southern Counties of England. In September Ireland shows a falling off, and the greatest degree of cloudiness is in Lincolnshire. In October the Midland Counties of England are the worst off. In November the line of 40 per cent. incloses two districts, one Dublin, already mentioned, the other the Eastern Counties (Cambridge and Beccles). The absolutely highest monthly percentages in the period under consideration are in the month of May, 1882, in which St. Anne's Head, Milford Haven, had 62 per cent., while Geldeston (Beccles), Douglas (Isle of Man), and Southbourne (Bournemouth) show 61 per cent. The exhibition remained open till the 20th instant.

# DOMESTIC RECIPES.

**Macaroni (Italian Style).**—The *Caterer* gives the following as an approved recipe: Take six ounces of Italian macaroni, and put it into a stewpan with three pints of water, adding salt and pepper, a saltspoonful of each. Place the saucepan over a gentle fire, and, when the contents have simmered for twenty minutes, drain the water off thoroughly, and then add to the macaroni one half-pint of good broth. Replace the saucepan on the fire, and let the contents again simmer until all of the broth has been absorbed. Now have some grated cheese—the Parmesan and Gruyère mixed in equal proportions are best for this purpose—and add two ounces of it to the macaroni: when it melts, add two ounces more, together with one ounce of best butter, giving the pan a circular motion in order to mix the melted cheese thoroughly with the macaroni. Then serve on a hot dish.

**False Rabbit.**—The same authority gives these directions for a favourite German dish: Chop as fine as for croquettes one pound of the lean of beef, and one pound of the lean of fresh pork, and mix them together. Add four raw eggs, a tumblerful of sifted bread-crumbs (better than cracker-crumbs), half a small nutmeg grated, two teaspoonfuls of black pepper, a tablespoonful of salt, a small onion, parboiled, and minced very fine, a little chopped sweet savory, parsley, and thyme, in quantities to suit the tastes. Knead into a loaf, in flat, roundish form. Roll the loaf in egg, then in bread-crumbs, and place it in a dripping-pan, with a small piece of *salt* pork on top of it, sliced like the pork placed on top of baked beans when served. Place the pan in the oven, and with the drippings from the pork occasionally baste the loaf. Its being cooked can easily be tested by prodding it with a carving-fork. When done, it is a good dish served hot. When cold, it is better still—a sort of sublimated sausage, as toothsome as any preparation that ever came from the shop of a *charcutier*, and excellent as a relish for luncheon or tea.

THE total quantity of pig iron produced in the United Kingdom during 1884 was 7,528,966 tons, being a decrease of 961,258 tons, or 11 per cent. on the quantity made in the preceding year. This is the second year during which a decrease of production has occurred since 1879. In 1883 the decrease was 3,063 tons on the make of 1882. In 1879 the make was 290,566 tons below that of 1878. But on comparing the latter year with 1884, it comes out that the increase of make in the interval has been 1,519,532 tons, or 25 per cent.; so that, on the whole, substantial progress has been made.

# SCIENTIFIC NEWS.

THE death is announced of Theodor von Frerichs, the famous Berlin professor, and the foremost exponent of clinical medicine in Germany. He was born at Aurich in 1819, and after studying chemistry and physiology, turned his attention to clinical medicine, in which he became so famous that he attracted students from all parts of the world. A year ago the University of Berlin celebrated the 25th anniversary of his professoriate.

M. Joseph Alfred Serret, professor at the Collége de France, and Member of the Bureau des Longitudes, fell down dead in Paris last week. He was born in 1819, and was admitted a member of the Academy of Sciences in 1860.

The retirement of Mr. Walter White from the post of assistant secretary to the Royal Society will be regretted by the majority of the Fellows. The post is one requiring much tact and unwavering courtesy, and during forty years Mr. White has accomplished his duties in such a manner as to earn the good wishes of all the Fellows.

Dr. Bouchardat, Professor of Hygiene at the Paris Faculty of Medicine, has, after a service of nearly forty years, retired, and his name has been placed on the list of honorary professors.

Herr von Gothard contributes to the *Astronomische Nachrichten* an elaborate paper on the changes observed in the spectrum of Beta Lyræ during the past year. The changes are believed to be periodical, and observers are requested to direct attention to the star. Herr von Gothard made 30 observations between the middle of February and the middle of November, and found the bands $D_3$ to periodically vary from an almost dazzling brightness to total disappearance.

We have received a copy of the Meteorological Observations for 1884 taken at Rousdon Observatory, Devon, near Lyme Regis, Dorset. The observatory is situated 524ft. above the sea-level, and has a good exposure on all sides. Observations, such as these, made at a few well-equipped stations in different parts of the island would, on comparison, soon teach us more than we have learnt hitherto about the weather. The observatory belongs to Mr. Cuthbert E. Peek, M.A., F.R.A.S.

Dr. R. C. Kedzie sends to the *New York Tribune* an explanation of the discrepancy in thermometer readings taken simultaneously at places within the vicinity of one another. He says "We treat of air under the head of pneumatics, whereas it sometimes comes rather under the head of hydraulics, for cold air flows in currents, the same as fluids. In the absence of wind, which mixes up the strata of air of different temperatures, and consequently of different specific gravity, the cold air of the night will flow in streams, and gather in ponds or lakes the same as water. Under such circumstances the temperature will vary with the level." Near Dr. Kedzie's laboratory a ravine runs through the College lawn, and thermometers placed at the laboratory door, and in the ravine 25ft. below, indicated on Feb. 22, 6.45 a.m. — 15° at the laboratory and — 20° at the ravine. This difference of 5° was observed on the following morning, the temperatures being the same, although the lowest reading during the preceding nights at the meteorological station, 40 rods distant and on higher ground than the laboratory, was — 14°. The thermometers were changed about, and gave corresponding readings; but it is not quite clear what is meant by — 15°, whether fifteen degrees below freezing-point or fifteen degrees below zero—presumably the thermometers were graduated on the centigrade scale.

At a recent meeting of the Linnean Society Dr. F. Day read a paper on the rearing, &c., of salmon in fresh water, in which he described the experiments of Sir James Maitland at Howietoun. In December, 1880, salmon eggs and milt were obtained from fish captured in the Teith, and the ova were hatched in March, 1881. In November, 1884, ova were obtained from one of the young salmon, and milted from a Lochleven trout. On Jan. 23, 1885, eighteen of the eggs hatched, and the fry were strong and healthy. Pure salmon eggs have also been hatched, the young being reared to parr, smolts, and grilse, and salmon have been successfully hatched from their ova. It remains to be seen how the fry thrive in fresh water.

The collections belonging to the Science Department at South Kensington Museum are to be reported upon by a committee who are also to consider plans for properly housing them. Sir F. Bramwell is chairman, and Dr. W. Pole secretary.

The Imperial Geographical Society of Vienna have resolved that Dr. Lenz should be sent to explore the watershed between the Nile and the Congo.

At a recent meeting of the Physical Society Mr. C. Cleminshaw described some "Further Experiments on Spectrum Analysis"—viz., methods of obtaining the inversion of the sodium line in the spectrum of the limelight. The first consisted in concentrating the rays from the slit by a lens, just beyond the focus of which is a spoon in which sodium is ignited by a Bunsen flame. In the second method the burner and sodium are introduced between the lime and the slit, and carbonic acid is introduced into the flame. The result in either case is to cause the inversion of the D line. Prof. Guthrie, alluding to the pale blue flame produced by common salt in a coal fire, suggested that there might be more than a mere mechanical action produced by the carbonic acid. Mr. Cleminshaw, however, believed that the action was purely mechanical.

M. B. de la Grye is going to Teneriffe in order to study the laws of gravitation under all the conditions for which the peak offers facilities. His observations are to be reported to the Minister of Instruction.

# LETTERS TO THE EDITOR.

*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

*All Cheques and Post-office Orders to be made payable to* J. PASSMORE EDWARDS.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

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## ENCKE'S DIVISION IN SATURN'S RING—THE PRIMITIVE STATE OF MAN — MAGNITUDES OF SMALL STARS—FULL MOON IN FEBRUARY, 1904—A NEW FORM OF OCCULTATION—MAKING AN ASTRONOMICAL TELESCOPE.

[23998.]—IN connection with letter 23919 (p. 31). I may remark that while drawing Saturn at the telescope during the first week in March, I could not divest myself of the impression that ring A was striped with several concentric fine lines, or divisions, parallel to its edges. I cannot doubt, however, that this was an optical illusion. My supposititious divisions were of hair-like tenuity, and all seemingly alike. I may reiterate here that I have on rare occasions held Encke's division steadily for some seconds at a time with my 4⅛ Dallmeyer achromatic, and of this I have no doubt whatever.

Mr. John Hampden (letter 23925), "Otter" (letter 23926), and "J. H." (letter 23927), all on p. 31, beg the entire question of the authorship of the Pentateuch. As for Mr. Hampden's "testimony of the highest authorities of the last 6,000 years," how can any human being *testify* to what he has never seen? It is to be hoped that the next time Mr. H. finds himself in the witness-box, he will not attempt to offer such "testimony" to the Court, or he will be pulled up very summarily indeed. With reference to "Otter's" quotations from Exodus xx. 11, I can only say (with "O. J. L."), "*If* Moses gave to Israel the Ten Commandments," he was assuredly not consistent in the reasons he alleged for the observance of the seventh day (Cf. Exodus xx. 11 and Deuteronomy v. 15). As for "J. H.," his boldness in attempting to instruct any human being in geology is amazing. He is hopelessly mistaken in his notion that "during geological times climatic changes were produced by *the internal heat of the earth* and *not by the sun*," if, by "geological times," he intends to signify those of which the records are preserved in the rocks. The sun must have shone on the Cambrian trilobites, just as he does now. Did "J. H." ever see a trilobite's eye? There have, moreover, been glacial epochs in all stages of the earth's history (*vide* "Ramsay's Physical Geology and Geography of Great Britain"), and, what is of vital importance to our present argument, *man himself was pre-Glacial.* With regard to the *Christian Million*, I thought that its utter untrustworthiness in anything relating to science was too notorious for anyone to have had the hardihood to quote that; but seemingly "J. H." takes its utterances for gospel, his own knowledge of the rudiments of his subject being too imperfect to enable him to check its assertions. Let me recommend "O. J. L." to obtain and read Joly's "Man before Metals" in the "International Scientific Series," published by Kegan Paul, Trench and Co. He will find the subject of primitive man discussed there upon the sole basis upon which such discussion can take place at all. I mean the scientific one. [Since the above was written, I have seen the various letters on this subject in the ENGLISH MECHANIC of to-day (March 20), with reference to which I would append a few remarks. Imprimis with regard to the letter (23972) of "O. J. L." himself, on p. 60, I may say that "the glaciation which may have wrecked our world" is a mere figment. That all Europe was glaciated in the Pleistocene age, is as certain as that I am writing; but that such glaciation extended, say, to the Sahara is a perfectly unwarranted and unwarrantable assertion. One of the most curious mistakes into which people either ignorant, or possessing merely a smattering, of geology fall, is to assume that the various "formations" surround the globe like the coats of an onion, and that, for example, Oolitic rocks were simultaneously deposited, and an identical fauna existed, in what are now Somersetshire and the Transvaal. The glaciation of the northern and southern hemispheres certainly occurred at vastly different periods. In plain truth, glaciation has happened in every stage of the earth's history of which we possess visible records: even at that almost appallingly remote period when those who are so burningly anxious to prove that the sun never became visible until "the fourth day" assert that the earth was nearly red hot! Turning now to letter 23982 (p. 62) I should like to ask "Arvonia" one question: "If, indeed, the Book of Mormon was not revealed to Joe Smith and copied by him from the plates of gold in the year 1827, when could the hundreds of thousands of 'Latter Day Saints' now existing have been persuaded to receive it?" To "J. S. B." (letter 23984), C. J. B. Findon (letter 23988), "E. C. C." (letter 23989), and "K." (letter 23990), p. 63, I would say that I do seem to have given Methuselah an undue advantage, inasmuch as he appears only to have been contemporary with the Flood—and not necessarily to have survived it. If, however, any proof of "the mythical character" of the entire set of legends were needed, it might well be found in the alleged ages of the subjects of the quoted pedigrees. This superstition of the great age, and the cognate one of the gigantic size of their primitive fathers exists among all races emerging from barbarism. Would Mr. Findon be surprised to hear that my familiarity with the book I quote is, at the very least, equal to his own? I, however, certainly consider Bibliolatry as degrading and enslaving a form of idolatry as can be practised. To "K." I would say that the word "begat" is quite obviously used in the sense of the recording the time of birth of the person to whom it is applied.]

In reply to "H. A." (query 56119, p. 43), there are several formulæ for determining the magnitudes of stars visible with any given aperture in inches. Carrington, adopting 2·75 as his light ratio, $m = 9$ mag., and $a =$ 1in., gave the following one for determining the magnitude of stars *just* steadily visible with no moon in a dark field, with any given aperture.

$$\tfrac{1}{2}\log. R = \frac{\log. A - \log. a}{M - m}.$$

This would give—

| | | | | inch. |
|---|---|---|---|---|
| 6 | mag. | just certainly | visible with | 0·22 |
| 7 | ” | ” | ” | 0·36 |
| 8 | ” | ” | ” | 0·60 |
| 9 | ” | ” | ” | 1·00 |
| 10 | ” | ” | ” | 1·66 |
| 11 | ” | ” | ” | 2·75 |
| 12 | ” | ” | ” | 4·56 |

Pogson's very simple formula is founded on an assumed light ratio of 2·512, and is this: If the observer will determine for himself the smallest of Argelander's magnitudes, just discernible by fits on a fine moonless night, with an aperture of 1in., and call this quantity L (or the limit of vision for 1in.); the limit $l$ for any other aperture is given by the simple formula, $l = L + 5 \times \log.$ aperture. Pogson found, from a large number of experiments, that L was = 9·2 (for his own sight), and if we are content to accept this as our standard, we have only to multiply the logarithm of the aperture of our telescope by 5, and add 9·2 to the product, to obtain the magnitude of the smallest star visible with that aperture. One example must suffice. What is the smallest star visible with an aperture of 0·23in.? The log. of 0·23 is $\overline{1}\cdot361728$, and if we multiply this by 5, we get $\overline{4}\cdot808640$. If to this we add 9·2, we obviously obtain 6·0, so that the 6th mag. is the *minimum visibile* for an aperture of 0·23. With Carrington's light ratio, this, as we have just seen, comes out 0·22. A collation of Argelander's magnitudes with others in use will be found on p. 207 of "Celestial Objects for Common Telescopes."

"Leo" (query 56131, p. 43) may attack his own problem thus: Note that 1900 is *not* a leap year. Hence from March 1st, 1885, to March 1st, 1904 is 15 common years, three leap years, and 61 days, i.e., 15 × 365 days + 3 × 366 days + 61 days = 6,634 days. But a synodical lunar month = 29·5305887 days, so that we have only to divide 6,634 by 29·5305887 days, to ascertain that on March 1st, 1904, the moon will have passed through exactly 224·6485 lunations. Hence there will be a full moon in February in that year. The Metonic Cycle of 19 years is, of course, only an approximate one, which does well enough for the idiotic ecclesiastical Paschal moon, but is inapplicable in a case like this.

An absurd misprint occurs in lines five and six of column three on p. 53, where the President of the Liverpool Astronomical Society is represented as saying that Dr. Copeland of Dunecht had called "his attention to the Occultation of Jupiter's II. satellite by its own shadow on the night of February 19" (!). The American gentleman who lifted himself by the waistband of his own trousers was as nothing to this. What, of course, Dr. Copeland did see was Satellitte II. superposed on its own shadow on the face of the planet.

Mr. F. Shakespear (query 56161, p. 68) must buy a 3½in. object-glass, as he cannot possibly make an achromatic one of that size (or, for the matter of that, of any other) himself; and a non-achromatic one he would find rather worse than useless. If the focal length of his objective is 54in., an eyepiece composed of two plano-convex lenses, the field-lens ·864in. focus, and the eye-lens ·288in. focus mounted ·576in. apart, with their convex sides towards the object-glass, will give him a power of 125. A diaphragm must be inserted at the focus of the eye-lens.

**A Fellow of the Royal Astronomical Society.**

## A POSSIBLE CASE OF PROPER MOTION IN A NEBULA.

[23999.]—CASES of proper motion in nebulæ are of such rarity and interest that it may not be out of place to call attention here to what seems to be a fairly well attested instance of motion in a small nebula. The object in question is the triple nebulous star No. 2529 of Sir John Herschel's fifth Catalogue of Double Stars, No. 705 of the Catalogue of Nebulæ published in the "Phil. Trans." for 1833, and No. 2091 of the General Catalogue. It will be most convenient to give the principal observations at length in chronological order.

The object in question is entered in the fifth catalogue thus (I have added the letters A, *a*, B, and C for convenience sake), the distances being estimated only.

[A − *a*] 95·3° : 1½″ : 11, 12,

"A most curious, delicate, and interesting object. The nucleus of a very faint nebula, examined with 320; proves to be distinctly a 1st class double star." (Sweep 243).

[A − B] 10·8° : 7″ : 11, 14,

[A − *a*] 95·4° : 1″ : 11, 12,

"A nebula strongly suspected about the close double star, and a fourth star also suspected." (Sweep 242.)

[A − B] 8·0° : 7″ : 10·11, 13,

[A − C] 330° ± : 6″ : 10·11, 14·15.

[A − B] 7·0° : 18″ : : 10, 11,

"A double star in a very faint nebula. (A hurried observation.) The dist. seems to have been greatly overrated." (Sweep 338.)

[Sweeps 242 and 243 were made on the 23rd and 24th of March, 1830; Sweep 338 on April 6th, 1831.]

A little further on Sir J. Herschel writes of this object:—"Hardly less interesting, though much less conspicuous (being, in fact, one of the most difficult objects in the heavens) is *h* 2529, where a minute and very close double star forms the nucleus of a small round nebula. One or two other small stars in the immediate vicinity seem unconnected with it; but the exactly central position of the double star strongly points to a physical relation between them."

It will be observed that there is a great difference between the estimates of the distance of A − B in 1830 and 1831. Sir John thought the estimate in the latter year in error; but the estimates in sweeps 242 and 243 are really in fault. The mirror was very badly tarnished in March, 1830, and we see from Sir John's estimates of *h* 166, 128 (222 Cancri), 199, Σ. 1556, Σ. 1792, &c., on these two evenings in March, 1830, that, owing to the state of the mirror or some other reason, the distances were all largely underestimated. Judging from his observation of *h* 2616, the mirror was either out of adjustment or the definition very bad during sweep 243.

The angle of A-C should evidently be 230°±, not 330°±; a similar misprint has occurred in position angle of $\alpha^2$ Cancri in this very sweep, where 224·3° is evidently misprinted for 324·3°.

The next observation in point of time is one made at Parsonstown, on March 3rd, 1851, where the entry stands, "Double star with nebula north." In the recent publication of the nebula observations in the "Scientific Transactions of the Royal Dublin Society" the words—or rather the abbreviations of the words—"small, elongated, brighter in the middle," are added.

The late Professor d'Arrest observed this nebula with the 11·lin. refractor at Copenhagen in 1864 and the following year. He writes, *April* 8, 1864: "A double (?) star of the 10·11 magnitude, to which a short and shining tail is affixed. The nebula is prolonged towards the north; a very delicate nucleus at times shines through. The place is that of the fixed star; for the seeing at this time had become very indistinct, and so the components were not clearly divided. *February 4th*, 1865.—A double nebulous star. The stars are of magnitudes 10, 11, and 14. With a brilliant moon I see the nebula distinctly enough. A nucleus seemingly composed of many little stars seems an evidence of resolution; but I am not altogether certain of this. *March 16th*, 1865.—A triple nebulous star, arranged in this fashion. An 11-magnitude star south preceding [A]; this itself is composed of two, having a 15-magnitude *comes s.p.* [C]; a 13-magnitude star *n.f.* at 12″ distance [B]. This latter is situated in the centre of a small and faint nebula, so that the brighter star just spoken of [A] adheres to its edge. This star only appeared double in Lord Rosse's telescope in 1851. Herschel II. saw it at once triple."

Two recent observations at Parsonstown are given in the "Scientific Transactions" of the Royal Society of Dublin:—

"1872. April 2nd.—9 mag. star to nebula 13·0° : 19·7″. [A to nebula]. [angle — 180°].

"1872. April 2nd.—9 mag. star to 12 mag. star, 234·3° : 8·8.″ [A-C.]

"1876. March 22nd.—Double star [A--*a*]; star 10·11 magnitude, south [C]; and star 15·16 magnitude north, position 5·0°, distance 21″ [B], with very faint nebulosity around it, elongated suddenly towards the north."

Mr. Burnham gives his measures of the relations between A and the nebula on page 270 of Volume XLVII. of the "Memoirs" of the R.A.S. These are:

8·3° : 18·96″ : 10 (12) : 1879·225
7·5° : 18·96″ : 10 (12) : 1882·195

He quotes the first observation of Herschel (sweep 243), and says: "This note would seem to indicate the closer pair was the nucleus of the nebula, and not the 14 mag. companion. However this may be, the nebula is now 19″ from the principal star [A]. As this angle agrees substantially with H., and his distance is only estimated, there is no reason for suspecting change. I could not see any signs of duplicity in the 10 mag. star [A]; but the conditions were not particularly favourable. There is an excessively faint star [C] about 8″ from A in the direction of 230°, noted in my first observation. On the second occasion the seeing was too poor to show it. This may be the star suspected by H., although the direction is different. I am not prepared to say that the principal star is not double; but, if so, it must be closer than 1½″...... I have estimated the nebula as equivalent to a star of 12 mag., and it should, therefore, be apparent as a nebula with a comparatively small aperture." Mr. Burnham has accidentally overlooked the fact that this nebula is included in the catalogue of 1833 and the "G.C."

We see that in 1830 and in 1831 the close pair A was *exactly in the centre* of a small round nebula; in 1851 and 1865 it was *not in the centre, but on the s.p. margin* of the nebula, and the nebula had had moved so that a star B at. 21″ distance from A was then in the centre; from 1872 to 1882 the nebula was 19″ *distant* from the close pair A. Motion seems certain; but of what character is hard to determine. The star C is evidently variable. A very faint object in H's. reflector in 1830, D'Arrest rates it 11mag. of Herschel's scale in February, and 15 mag. in March 1865. It is called 12 magnitude at Parsonstown in April, 1872, and 10½ in March, 1876; is "excessively faint" in the 18½in. at Chicago in March, 1879, and invisible in 1882. The place of this nebula, brought up from the "G.C.," is for 1885·0, Xh.17m.35s.+13° 8·1′. It will be easily found by setting the telescope 36½′ to the north of Regulus, and then sweeping 15 minutes 20 seconds of time to the east. I trust that some of the readers of the English Mechanic who possess telescopes of sufficient size will examine and report on the present state of this curious object. Observations of such phenomena, carefully made, would be infinitely more valuable than merely looking to see whether the faint stars of the Trapezium of Orion, the Satellites of Uranus, or cognate objects, were or were not visible in the observer's telescope on some particular evening.

March 19th. **H. Sadler.**

P.S.—This nebula is shown on Peters's star maps to the north of A, but the scale is too small to show any detail. It does not appear to have been observed by Schönfeld, Schultz, Vogel, or by anyone except Sir John Herschel, the Parsonstown observers, D'Arrest, and Burnham.

## MIRA CETI—DOUBLE STARS.

[24000.]—The star near Mira Ceti, referred to by Mr. Ruthven (letter 23892, page 10), is not in any way connected with Mira itself. The following are some measures of the relations between these two objects:

Ḣ. 92·5° : 114·6″ : 1782·7.
Σ. 88·6 : 114·3 : 1820·0.
O.Σ. 85·2 : 115·6 : 1852·0.
β. 82·4 : 116·0 : 1879·5.

The change is due to the proper motion of the variable star, 0·23″ in 184° annually. ζ (Zeta) Tauri I do not know as a close pair. There are two 10-mag. stars north of it, for one of which P. Rosa found 347·0°, 176·7″, 1856·1; but this star is entered in the fourth edition of "Celestial Objects," because of the curious curved row of stars and Chacornac's strange variable nebula in the preceding portion of the field. 80 Tauri is too difficult an object now for Mr. Ruthven's aperture; for O. Σ. 98 Mr. Perry gave 203·5°; 1·03″ 1884·10. The pair *n.f.* this last is entered in error in Webb in this place (Cf. *Knowledge*, January 4th, 1884). It is really *n.* of ι (Iota) Orionis, and is formed of Nos. 719 and 725 of Bond's catalogue of stars near the nebula of Orion. According to Bond there is a 13·1 mag. at 37″ *f.* the pair nearly on the parallel, which Mr. Ward has not noticed. "Bright star *s. p.* δ Tauri" I cannot identify, unless it is Ḣ's *comes* to δ (IVh. 18·6m.+17° 38′) at 233° : 77″. The pretty little triple *s.f.* 135 Tauri must be that interesting pair So. 503; at least, I can find no other near, and the bright white pair near it would then be σ 210. For So. 503 (Vh. 49·4m. + 13° 56′) we have—

So. 134·1° : 39·95″ : 1825·1.
De. 120·0 : 8·08″ : 1873·9.
β. 82·6 : 2·90 : 1883·1.

Colours: deep yellow, deep blue. The faint star *s. f.* is at 158·8° : 24·6″ (Burnham), and, like the distant one at 334° : 234″, is fixed. The change in A B is due to the p.m. of A. For σ 210 De. has 130·4° : 45·66″ : 1875·0.

March 18. **H. S.**

## DOUBLE STARS, &c.

[24001.]—Σ. 1228, in Cancer, has a faint *comes* at 32″ ±, immediately *f.* the south star of the pair, making it triple. There are also two more pairs in the field of 6′ of Steinheil solid e.p. The fainter, and more distant, is 8″ and 70°, the second nearer is an unequal pair a little wider at 235°. Both pairs are *n.f.* Σ. 1228.

In same field with ι Cancri 5′ *n.p.* is a faint pair 30″ 360°. None of these are mentioned in Webb, either in connection with Σ. 1228, or ι Cancri.

Two of Jupiter's satellites formed a tolerably close pair at 11 p.m. on March 18, and at same time a very dark mark was visible on N.E. belt on the following side. This spot was about ⅓ on disc, and fell over towards the preceding side, as if its south point was in advance of base; a bright white spot preceded it in contact with it. A large, long white marking was visible on north side of S. E. belt, and several others preceding and following it. The larger one extended over one sixth of the disc.

**Edwin Holmes.**

## HYPERION.

[24002.]—The question of the visibility of the Satellites of Uranus has often been referred to in "E.M.," but very little has ever appeared as to Hyperion and Enceladus.

On Saturday, the 14th inst., at 8 p.m., I saw, following Saturn, at a distance of about 4′ to 4½′ of arc, a very faint star. As nearly as I could judge, it was in a direct line following, and was a very faint object indeed. I wish to ask if it is possible I saw Hyperion with a 9in. mirror in London?—e.p. was Steinheil's solid, power about 275. On the same occasion, Enceladus was easily seen between Tethys and planet, but not in a direct line between Enceladus, being further south, just off the *s.p.* end of ring. Dione was very faint, and hardly to be seen.

On the same evening, I found ξ Cancri close pair just divisible with 5in. stop. III. P. XI. easily seen with full aperture, as was also 2054 Draconis; and 175 Gemini just divided with 600. ω Leonis was two discs, but air was fluttery, and no clear view obtainable of this star. I judge the discs were in contact, however. What is the present distance of this star?

Allow me to direct attention to θ Aurigæ. I find this star very much more difficult than δ Cygni. Webb says 2·1″. Is this correct for present date? There are two faint preceding comes which are visible with 4in. stop, but the nearer one is much brighter than the more distant.

**Edwin Holmes.**

## TRANSIT OF JUPITER'S THIRD SATELLITE.

[24003.]—On March 20th I was watching the Transit of Jupiter's Satellite III., which entered bright at 10.24. After watching for half an hour I came to the conclusion that it was getting more faint, but could not decide whether it was owing to the satellite or to the greater brilliancy of that part of the planet. At 12.12 I again turned the telescope upon II., and saw the satellite black, as I find in my note-book, "like a drop of ink"; it was then past the planet's meridian. I compared it carefully with the shadow of Satellite I., which had entered upon the disc shortly before, and found it quite as black. Telescope 6in. equatorial reflector. **J. Ellis.**

## DARK TRANSIT OF JUPITER'S THIRD SATELLITE.

[24004.]—I was able to observe on March 20th, under more favourable conditions, a repetition of the phenomenon described in my letter (23953) on p. 55. I watched the third satellite enter upon the disc of Jupiter at 22h. 24m., and saw it bright upon the north red belt for about 10 minutes; it then remained invisible for about 20 minutes, when it reappeared as a faint grey spot. This gradually increased in darkness until it was almost as black as the shadow of the first satellite, which by this time was in transit. The outline of the third satellite was not so sharp as the outline of the shadow. Clouds came up soon after midnight, and prevented me from watching the egress. The first satellite, which crossed the planet a little north of the equator, was seen bright for 18 minutes after ingress, and was then lost to sight.

Shaftesbury. **T. Perkins, M.A.**

## THE SIX DAYS OF CREATION.

[24005.]—In letter 23985 Mr. W. J. Grey finds a difficulty in the 14th to 19th verses of Genesis i. He says, "According to verse 19 the sun was not made until the fourth day; that is, not until after the period to which 'J. H.' assigns geological time, but plants could not grow nor animals live without the sun." Now this was a great difficulty with me when I first began to read the Bible in connection with science; but as I became better acquainted with it I saw two important principles almost universally running through its accounts of things, which principles greatly helped me to understand the above difficulty. These principles are—1. Only so much as is necessary to faith and religion is described; all outside or beyond these, such as science, curious questions, and even history, are omitted, and left to the intellect and research of man, for which God has given him a mind well fitted, and as proper to be exercised upon as our hands are upon the work they are evidently intended to do, and are designed admirably to do, too. 2. The Bible describes facts as seen from man's standpoint—i.e., the surface of the earth—and in the ordinary language of man, without going into the science of the facts, which science would not have been understood by, nor of any use to, the persons the Bible was given to. Of course there are other broad principles in the Bible besides these two. I only mention these as bearing on the scientific explanation of the six days of creation. Keeping these principles in view, I will give what I believe to be the scientific explanation of Genesis i., and nothing else ought to be allowed in the "E.M.," which is a mechanical and scientific journal and not a theological one. Gen. i. 1 describes the absolute creation of the universe (the heaven and the earth) by God, the same as stated by Paul in Heb. xi. 3. That an interval is supposed between verses 1 and 2 is to my mind most clear, for I find it is the custom of the Bible to put the little word "and" between events that have many years between them; but this is rather a theological than scientific branch of the subject. After the creation of the heaven and the earth there comes a time when "the earth was without form, and void; and darkness was upon the face of the deep." How long this interval was we cannot tell—we know from science it must have been long enough for all geological periods; and how this chaotic state of the surface of the earth was brought about, whether by glacial or volcanic or any other course, is immaterial for the purpose for which Genesis was written (and therefore not here mentioned)—viz., to establish the faith and religion of God among the Jews. All the Bible states is that

God created the heaven and the earth they saw, and that at the commencement of the Adamic state of things the surface of the earth was in a chaotic state and darkness was upon the face of the deep. Whether this chaotic state of the surface of the earth was universal or only confined to the earth as known by Moses is not stated; it need not have been more than what Moses understood by the term earth, it may have been even less than that, only around Eden, the place where the race of men known to the Jews started from. Now, we can easily understand that the throwing of the earth's surface into a chaotic state would fill the atmosphere with such dense mist that no light would reach the place where man is supposed to be (the surface of the earth) describing and viewing what took place during the six days; and here comes into play the second principle I have mentioned above—viz., that everything will be described in the then ordinary language, as perceived, or seen, from the surface of the earth, man's proper place of observation, and not from the moon, or some distant planet, and with our modern scientific ideas, such ideas, though true, could not have been understood by the Jews, nor were they necessary to establish them in the faith of God as the only true God, and Creator of the heaven and the earth. In verse 3 we have, "And God said, Let there be light." This, in scientific language, means that the dense mist so far decreased in density that the light of the sun was perceived around the supposed spectator and describer; but the sun was not yet to be seen through the mist, and as the sun set this light would depart, and thus the first, or previous darkness, of verse 2 and the past light of verse 3—*i.e.*, "the evening and the morning"—"was the first day" (5v.).

In the sixth verse we have—"And God said, Let there be a firmament in the midst of the waters, and let it divide the waters from the waters." This, in scientific language, means that the dense mist was cleared away from or rose from the surface of the waters, and formed clouds above, and thus the firmament was formed, the firmament meaning the space where the fowls of the air fly (see verse 20). And thus the waters in the heavens—i.e., in the clouds—were divided from the waters on the earth (verse 7). Thus ended the second day. In verse 9 we have—"And God said, Let the waters under the heavens be gathered together into one place, and let the dry land appear." This, in scientific language, means that the waters subsided, or the land was upheaved, so that the dry land appeared, and on this the grass and herbs and trees were made to grow by God (verse 11). The clouds were still dense enough above to hide the face of the sun, though perhaps gradually clearing; and thus ended the third day. In verse 14 we have—"And God said, Let there be lights in the firmament of the heavens to divide the day from the night; and let them be for signs, and for seasons, and for days, and years." The scientific explanation of this is that the clouds by this time had broken up and cleared away, and thus left the moon as the predominating or ruling object of the night, and the sun as the predominating or ruling object of the day, and thus this "evening and morning were the fourth day." But some may say, "the moon and sun are not for signs and for seasons"; but this is judging of them by our customs. The book of Genesis was written for Jews, and with them at each new moon a most important feast was held; in fact, they watched for the first appearance of the new moon to know when to commence their feast; and, of course, the sun was for days, and seasons, and years—i.e., marking them out to the Jews also. Now, with the above easy and natural explanation we have not to suppose that the animals and plants before Adam and during the long geological periods had to live without the sun, or that light was created before the sun, we have only to look at all that is said as such by one using his eyes while occupying the natural place of man—viz., the surface of the earth—and describing in ordinary language what he saw as the work of God; to such a one the visible order of the phenomena would be the very order given in Genesis i. The fifth day was taken up in forming the fish of the sea and the fowls of the air, while on the sixth day the beasts of the field, and last man was formed. I do not here go into the question of how many thousands of years man has been on the earth, or how many orders of men have been, believing as I do that science has not definitely settled these questions concerning man's origin; when it has settled these questions, it will be quite time for us to compare its undisputed teachings with the Bible account, when I have no doubt they both will be as easily reconciled with one another as the fact that the sun had an existence long before the time referred to in Genesis i. 14. **H. A. Wassell.**

Addenbrook Villa, Love-lane, Stourbridge.

## THE STATE OF MAN.

[24006.]—"J. H.," in his very interesting communication, says that at the Glacial period "the world" became "desolate and *dead*." Now, I should like to know upon what facts he bases this remarkable statement?—as it is a well-known fact that the glacial effects only extended as far as the southern slopes of the Himalayas, and that the equatorial regions were not desolated by the cold. Also, even during the intense cold, an Arctic flora and fauna lived in *these* latitudes, of which the Arctic plants of the Alps, Pyrenees, &c., are the remnants. Many fossils are found which were living animals of various species and which lived through the cold ages of our earth's history.

In reference to man's presence, Geikie says—"There can be no doubt that he inhabited Europe after the greatest extension of the ice. He not improbably migrated with the animals that came from warmer climates into this continent during the interglacial intervals. But that he remained when the climate again became cold enough to freeze the rivers and permit an Arctic fauna to roam far south into Europe is proved by the abundance of his flint implements in the thick river gravels, into which they no doubt often fell through holes in the ice as he was fishing."

"J. H." refers to the statement that "darkness was upon the face of the deep," as if that proved his case; but it only shows that there was a deep. That *it* was inhabited is proved by fossil evidence. There is no evidence that I am aware of, proving, or even suggesting, that a great interval of darkness occurred at the time of the glacial period. The molluscs of that period were almost identical with those at present in existence, as nearly the whole of the species found in the Clyde basin still live in Scottish seas, though a few are extremely rare. They had eyes, and it is therefore clear that light must have been in existence. Has "J. H." any reasons to suppose that light was absent during the Glacial period?—if so, I should like to hear them, as I am not writing in reference to the general Scripture narrative, but only concerning "J. H's." peculiar theory of the Glacial period.

**C. J. B., Ventnor.**

[24007.—THIS subject divides into two parts—1st. The general statement respecting Creation, the Fall, the Deluge, &c. 2nd. The authorship and probable date of the whole or parts.

In my last I dealt only with a portion of the second part, and may add that the 1st chapter of Genesis, and the first three verses of the 2nd chapter are written by the Elohist, while the rest of the 2nd chapter, and the story of Adam and Eve are by the Jehovist. In examining Genesis I recommend your readers to mark with a pencil the parts where the word Lord (which ought to be translated Jehovah) occurs, and compare it with the rest, remembering that the whole has been combined by a third writer. The account of the *six* days of creation is not repeated by the Jehovist, who simply speaks of "the day in which the Lord created the heavens and the earth,"—an odd statement if, as "J. H." stated, the earth was created long before, and was only furbished up anew. This idea is flatly contradicted in the first set of Commandments, where it is said that, not only did God create "all that is" in the heavens and the earth in six days, but also the heavens and the earth themselves. We may dismiss "J. H.'s" idea as flatly opposed both to the spirit and letter of the text. It is argued that the second account is only a condensation of the first, and that the word "day" is used as a general term. This might be so but for the context, which says that "the Lord God had not caused it to rain upon the earth," so that the plants which had been placed in the earth *could not grow*; that surely points to a limited time, and, moreover, is in flat contradiction to the statement of the writer of the first chapter, that water covered the earth on the first day, as, if so, the ground would have been wet enough for the plants to grow without rain. The great point gained by comparing the accounts, and observing the different names given to God, is that we see clearly two writers must have been employed.

The story of the Flood is also the work of two hands. Compare Genesis vi., from verse 9 to end of the chapter, with the following chapter. The first part is by the Elohist, who says, take of "every creature, two of *every* sort"; but the second is by the Jehovist, who says of "every clean beast thou shalt take to thee by sevens," and "of beasts that are not clean, by two." The words "clean" and "unclean" point to a time later than that of Noah, and probably long after that of Moses, and when the law was well established.

The character of many of the early statements seem poetic rather than historic; such as the speaking Serpent, the familiar intercourse with God and angels, the immense gathering of wild beasts from all lands into Noah's limited ark in the short space of one week, the strange account of the origin of languages at an apparent date long after the establishment of the Egyptian monarchy, the marvellous miracles of Moses which impressed his generation so slightly, the powers of the Egyptian magicians, who could make frogs in vast numbers at once, the stopping of the sun and moon, the prolonged age of the Antediluvians, and the statement respecting giants. These wonderful things demand more evidence than has yet been adduced; but are in general harmony with the early stories of some other nations which we look on without particular respect.

The Assyrian or Babylonian origin of some of these stories is probably because—

1st. Babylonian civilisation long preceded the establishment of the Hebrew nation.

2nd. Because the Hebrew tradition is that their original ancestor came from the neighbourhood of Babylon, and we know that the Assyrians were Semites.

3rd. We find somewhat similar stories in Babylonia, on very early inscriptions. Indeed, Mr. Sayce and other good authorities consider that the stories of the Flood and Creation were current there at least 2,000 years B C.

The Number 7 seems to have been considered holy there, and was derived from observing that there are seven heavenly bodies which move visibly across the sky, namely, the Sun, Moon, Mercury, Venus, Mars, Jupiter, and Saturn. Of their temples Fergusson says in his "History of Architecture," that they were in seven stages, and of the "Birs Nimroud," says it was "dedicated to the seven planets."

Mr. Sayce says of ancient Babylonian time measures, "So also the week of seven days, which was closely connected with the early astronomical studies of the Accadians, the days of the week being dedicated to the moon, sun, and five planets. The 7th, 14th, 21st, and 28th days of the lunar month were kept like the Jewish sabbath, and were actually so named in Assyrian," the Assyrian *Sabathi* or "Sabbath," itself being further defined as meaning "completion of work" and "a day of rest for the soul."

Respecting the Deluge, Mr. Sayce gives many notices, such as "Among the latter is the Epic of Gisdubar in its present form, which is based upon an astronomical principle, the subject matter of each of its twelve books corresponding with the name of a Zodiacal sign. The lion is slain, for instance, under the Zodiacal Leo, the sign of Virgo answers to the wooing of the hero by Istar, and the sign of Aquarius to the episode of the Deluge."

As to the date of the Deluge "F.R.A.S." need not trouble much about a year more or less, seeing that all eminent writers place the date of Manetho, the first monarch of United Egypt, at least 1,000 years before the date usually ascribed to the Flood; while some, including Mariette, one of the best authorities, places Manetho 2,675 years before the Flood.

The oldest notices of Egypt, and the most ancient of its works compel us to believe that an immense time must have elapsed previously, to account for the strange peculiarity of everything concerning it. Indeed, as Mr. Sayce says, "as far as our present materials and knowledge are concerned, the Egyptians were as autochthonous and isolated as their own civilisation." **Memnon.**

[24008.]—I DO not wish to enter the lists of theological controversy; but I had rather your recent correspondent, "J. H.," had assumed some other initials than those with which I have hitherto subscribed myself, particularly as the sentiments he avows are utterly at variance with those which I have painfully and laboriously acquired. I look upon all attempts to harmonise the old Hebrew fables with scientific fact as utterly hopeless. To me, the early history of man is written, not in Genesis, but in the caves and the river drift; in the celts and the arrow heads—implements before the date of whose vast antiquity the 6,000 years of Usher are but as yesterday.

I would rather glory in the thought that we inherit and are indebted to the labours of myriads of toiling generations whose origin is lost in the dim vistas of utter barbarism, than accept the story of the Fall, with its consequences of everlasting degradation and awful torture for the majority of the race. **J. H.**

[24009.]—"MEMNON" (letter 23980) states that there are two sets of Commandments—one in Exodus xx., the other in Deut. v.—each containing explanations respecting the Fourth Commandment, and both *differing radically*. I answer, certainly the Ten Commandments are written in both the above books, and that the sense is the same in both places. The *reason* for keeping the Fourth Commandment is given in Exodus xx., as God resting on the seventh day from His work of creation, as in Gen. ii. 3. In Deuteronomy a special reason is added why the Israelites should keep this Commandment—viz., they had been slaves in the Land of Egypt: God had delivered them, and therefore they were to keep it.

In Exodus a reason is given why men should keep this Commandment. In Deut. a reason why more especially the Israelites should keep it.

"Memnon" states that the reasons why the Mosaic origin of the Pentateuch is doubted are:—

1. Because the language used in it is the very same as that used in books known to be later in date. Remembering the difference between the English of Chaucer and that of to-day, he fails to

see how Moses can have written in the style of David or Ezra.

The answer is, that in the Pentateuch there are archaic words and grammatical forms not used by any later writer. For instance, the Hebrew word *hoo* (he) is used for the feminine (she) in 195 places, the proper feminine occurring only in 11 places. The word *naar* (a boy) is used in 21 places for the feminine *naarah* (a girl). The pronoun, with the article prefixed, *hallazeh*, Gen. xxiv. 65, xxxvii. 19, in all books after the Pentateuch, is shortened into *hallaz*. For a great many more examples of differences in words and spelling, &c., see Keil's "Introduction to the Old Testament," chap. 2, sec. 15. "Memnon" states that as the Israelites numbered but 70 souls when they entered Egypt, they could hardly have a settled language of their own. I am not aware that it is necessary to think they had a language peculiar to themselves. They spoke the same language that was spoken by the inhabitants of Canaan—viz., Hebrew. This is evident from the names which Canaanitish towns and persons bore. Examples:

| | |
|---|---|
| Kirjath Sepher ........ | City of Books. |
| Kirjath Arba.......... | City of Arba. |
| Melchizedek .......... | The righteous King. |
| Zeeb .................. | The Wolf. |
| Oreb .................. | The Raven. |

It is stated further that Genesis is clearly made up of several books written by different people, and joined together by an editor, who clearly lived at a later date. The same editor, it is stated, mentions the death and burial of Moses in Deut. xxxiv. Now, as anciently there was no division into chapters and verses, I think it is quite obvious that the last chapter of Deut. (the xxxiv.), containing the above account, really belongs to the beginning of Joshua, and, if so, the editor alluded to wrote no part of the Pentateuch.

"Memnon" further states that the editor lived long after Moses, because, in Gen. xxxvi. 31, we read, "These are the kings that reigned in Edom before there reigned any king over the children of Israel." This is explained without having recourse to a later editor. In Gen. xvii. 6, God there promises to Abraham that "I will make thee exceeding fruitful, and I will make nations of thee, and kings shall come out of thee." And, again, to Jacob, "A nation and a company of nations shall come of thee, and kings shall come out of thy loins." Moses, therefore, merely noted that Edom had kings before Israel had any, although they had been promised to both Abraham and Jacob. There is, therefore, here no proof that the verse in dispute was not written by Moses.

March 21. A. O.

## THE STATE OF MAN.

[24010.]—I would call the attention of "O. J. L." to the following list of works, as containing about the best that can be said on the subject of primeval man, from different points of view:—"Reliquiæ Diluvianiæ," by Rev. W. Buckland, 1823; "Cave Hunting," by W. Boyd Dawkins, 1874; "Etudes sur l'Antiquité Historique," par F. Chavas, 1873; "The World before the Deluge," by L. Figuier, 1867; and "Primitive Man," ditto, 1876. At the same time "O. J. L." will find, like most others, he will have to form his own conclusions, as the points of view and the periods of time are so different and diverse, as an instance or two will show. The idea of a Deluge such as told in Genesis has been ridiculed and scouted as an impossibility, from the supposed want of water; and yet we are gravely informed by these theorists that America was covered by glaciers from 7,000ft. to 8,000ft. in depth, and all Europe bears evidence of having been also covered by such another cap of solid ice. Again, the whole theory of Palæolithic man is founded upon chipped flints found in the gravels—such as at the bottom of the peat and silt formations of the Somme Valley, &c., making out man to have been upon the earth more than 300,000 years. And yet you may get a cartload of those same chipped flints in any of the chalk-pits of Hertfordshire, some of which have only been opened within a few years back. All the real flint implements used by man are Neolithic, and have always been found along with bone needles, &c., as in the remains of the Swiss Lake dwellings, along with traces of bronze, crucibles with a small bead of copper in one of them, quantities of corn, baked cakes of bread, flax, glass beads, perforated stone axes, and the remains of the dog, pig, sheep, and cow. The calculation of M. Marlet, accepted by Sir John Lubbock, mentions 6,400 years as the time that has elapsed; and Prof. Wursaal, in his "Primeval Antiquities of Denmark," thinks it was some 3,000 years ago; very different from the 200,000 years of others. But after all said and done, "O. J. L." cannot go very far wrong if, as "J. H." (23927) says, "put God at the helm of affairs," and abide by the statement of the old Record, that that same God made man upright and in his own image; but that man hath sought out many inventions, one of which was the breaking of the order of His being; and so, while some of the nations kept up the line of civilisation, which has never been lost, others have fallen away; but as you cannot get out of anything what is not in it, so man, had he been introduced as a primitive savage, would have remained so; but as far back as we can get in history and tradition, there have always been races of men who were quite able to hold their own with any at the present day.

Dens.

[24011.]—This subject is now ramifying, as I feared would be the case, and it is difficult to say to what dimensions it would attain were it not in the Editor's power to make use at any moment of the clôture.

I think it is pretty evident that much must rest on conjecture, unless we are prepared to accept the Mosaic account as beyond controversy a direct revelation; and I do not think such a theory tenable, nor do I know that Moses ever claims it as such. The Egyptian monument referred to, in which, in a series of pictures, the Six Days' Work of Creation is delineated may have been the work of the Israelites themselves, in order to prevent their own tradition dying out; or it may have been Egyptian work executed with the same object. It *proves* nothing.

To my own mind it is as difficult to accept the theory of development from a mythical protoplasm as to accept the Mosaic theory—even if God be placed at the helm in either case. Internal testimony is, I think, strongly in favour of a later date to the Pentateuch than the time of Moses, and I have long regarded the story of the Fall as allegorical; nor can I believe that the various types of humanity sprang from that one erring pair. It was suggested, however, to me lately by a lady, that the mark set upon Cain was the darkened skin and negro type of countenance, man having been created fair, and that thus originated the beauties of Africa. But then comes the difficulty of the Flood, which the thus blackened race apparently did not survive. Having asked for information upon a certain point, I have to thank all who have endeavoured to enlighten me, many of their letters being of great interest; but I think I can perceive that proof is unattainable, and that the mystery of Genesis must remain a mystery still. I certainly do not look to theologians to solve the riddle; but believe that science may do so, only the time is not yet. O. J. L.

[24012.]—In connection with the interesting correspondence now going on in your columns as to the "origin of man," &c., will you allow me to suggest to fellow-readers that the apparent discrepancy between the Biblical account of the Creation, and the views thereof deduced by geologists, arises from an under-estimation by the latter of the "power" at work. Thus the duration of the later Glacial epoch is estimated at 250,000 years. But it is evident that 91,250,000 times the power required to do the work in that period would effect the same results in one day, and as *omnipotence* was engaged in the Creation, this amount of power, together with all allowances for friction and other loss, could have been, and was, available.

I would also suggest that the Biblical account does not say that Adam was the only man created, and that the narrative ceases to be general about Genesis ii. 6, and becomes a particular history of one race; just as in Chap. xii. of the same book it becomes the history of one family.

It seems only reasonable to suppose that possibly in the early part of the history when such enormous forces were engaged, that, for some time after the actual Creation, the earth's various revolutions were far more rapid than at present, and, therefore, the years shorter, thus accounting for the long lives stated. Would one or other of your astronomical readers kindly tell me, after due consideration, if there are reasons for or against this supposition; and, if so, what they are? and thereby greatly oblige and interest T. F. W.

[24013.]—"O. J. L." seems to be in a difficulty in regard to the Bible chronology by his taking it for fact, instead of speculation, that "human existence antedates" the Glacial period. Now, there is no more *vexed question* with geologists than this Glacial period, and opinions differ as wide as the poles asunder; but up to the present time there has been no real evidence that would stand a moment's investigation in a court of justice to show that man has been on the earth for more than 6,000 or 7,000 years, and if "O. J. L." would read up the observations of the American geologists, he would soon see they have little or no faith in the deductions of their English brethren in regard to the great antiquity of man. Principal Dawson, of Montreal, in "Sketches of the Geological Periods," says: "In like manner I fail to perceive, and I think all American geologists acquainted with the pre-historic monuments of the Western Continent must agree with me, in the want of any evidence of great antiquity in the caves of Belgium and England, the kitchen middens of Denmark, the rock shelters of France, and the lake habitations of Switzerland. I may merely add that the careful and elaborate observations of Dr. Andrews on the raised beaches of Lake Michigan, observations of a much more precise character than any which, so far as I know, have been made of such deposits in Europe, enable him to calculate the time which has elapsed since North America rose out of the waters of the Glacial period, as between 5,000 and 7,000 years. This fixes at least the possible duration of the human period in North America, though I believe there are other lines of guidance which would reduce the residence of man in America to a much shorter period."

Very different from the "quarter of a million years" "O. J. L." mentions. As for palæolithic man and his flint flakes, he is only a myth, based upon just the same theoretical ideas as evolves man from Miocene apes scourged into humanity by the horrors of the glacial period. Very good as deductions to those that like them; but the accounts given in the fragments of old records preserved in Genesis have not as yet been upset, but rather the contrary; the pendulum is slowly but surely swinging back in that direction, and as the records of the Deluge have been found and placed in the British Museum, it is just possible we may yet get some of the Antediluvian records from the same source. And, in conclusion, I would ask "O. J. L.," did it ever strike him as very curious, what a very small population, both of man and animals, there is upon the earth, if they have been upon it for 250,000 years or more, and what a miserably small amount of remains have been found for such a long period in which to have lived and multiplied?

March 23rd. Dens.

[24014.]—It is refreshing, after the positive manner in which some of our friends write of the Glacial period as though the whole world was at one time covered with ice, to turn to the calm and sensible letter of "A Fellow of the Geological Society," who informs us, as I think, very clearly that no such age ever existed; that the Glacial period is local, and as much to-day that epoch as it has ever been; and that each surface of the earth may in turn have had its own glacial age, whilst other portions at the same time had sunshine, heat, and fertility. If "J. H.," "O. J. L.," and others who think differently will take a small section—the east coast of our own little England, for instance—they will find everywhere traces of mighty rivers, high banks clearly carved out by long ages of water, sometimes even a mile wide, where now flows only a little brook not worthy to be called a river. A big river means the draining of a vast continent; such a continent must have existed, and has sunk countless ages ago below the ocean level, leaving only Great Britain and these records of its existence. Now, supposing the same depression is silently taking place in Switzerland, too slowly for man to even suspect the fact, in some distant epoch the ranges of the Alpine peaks will be what England now is, undulating and fertile, but with everywhere a trace of the great glacial period of their existence. The alteration of the levels of the earth's crust, always proceeding silently and almost unobserved, would thus account in a large degree for the marine fossils on the tops of lofty mountains, and the glacial scratchings on hard rocks in low-lying lands. But there is another age of which none of our correspondents on this interesting topic have touched—the drift, and the countless ages that preceded it. If "J. H." will get a map of the world on Mercator's projection, and rule a nearly straight line down from the Arctic Ocean a little to the west of the American lakes, on to the Antarctic Ocean, and another straight line to the east of the Volga again to the extreme south, he will have practically taken in about half the globe. Between these lines everywhere, in varying thickness, is found that marvellous mass of unstratified clay and gravel which we term the drift, filling up valleys, carved through by rivers, but lying upon the surface of the earth, or only buried by volcanic ashes or drifting African sands. At what distant time, or from whence came this mass of matter, is a mighty mystery, but there it is; and yet below that drift, sometimes at great depth, is found, by evidence which cannot be gainsaid, the remains of the works of prehistoric man. In the words of Tennyson—

> "There rolls the deep where grew the tree.
> O earth, what changes hast thou seen!
> There, where the long street roars, hath been
> The stillness of the central sea.
>
> The hills are shadows, and they flow
> From form to form, and nothing stands;
> They melt like mist, the solid lands,
> Like clouds they shape themselves and go."

Priam.

[24015.]—With reference to the interesting correspondence now appearing in your valuable journal under this head, I beg to inclose an extract from the "Diary of a Tour through Oudh," by my grandfather, the late Sir W. H. Sleeman, then the President at Lucknow, which seems to me pertinent to the matter. If desired, I can send other accredited instances of children brought up by female wolves from the same book:—

"There is now at Sultanpoor a boy who was found alive in a wolf's den, near Chandour, about ten miles from Sultanpoor, about two years and a half ago (1848). A trooper, sent by the native Governor of the district to Chandour to demand payment of some revenue, was passing along the bank of the river, near Chandour, about noon, when he saw a large female wolf leave her den followed by three whelps and a little boy. The boy went on all fours, and seemed to be on the best possible terms with the old dam and the three whelps, and the mother seemed to guard all four with equal care. They all went down to the river, and drank without perceiving the trooper, who sat upon his horse watching them. As soon as they were about to turn back, the trooper pushed on to cut off and secure the boy; but he ran as fast as the whelps could, and kept up with the old one. The ground was uneven, and the trooper's horse could not overtake them. They all entered the den, and the trooper assembled some men with pickaxes, and dug into the den. When they had dug in about 6 or 8ft., the old wolf bolted with her three whelps and the boy. The trooper mounted and pursued, and headed them, and turned the whelps and the boy back upon the men on foot, who secured the boy, and let the dam and her three cubs go on their way.

"They took the boy to the village, but had to tie him, for he was very restive, and struggled hard to rush into every hole or den they came near. They tried to make him speak, but could get nothing from him except an angry growl or snarl. He was kept for several days at the village, and a large crowd assembled every day to see him. When a grown-up person came near him he would try to steal away, but when a child came near him he rushed at it with a fierce snarl like that of a dog, and tried to bite it. When any cooked meat was put before him, he rejected it in disgust, but when any raw meat was offered, he seized it with avidity, put it on the ground under his paws like a dog, and ate it with evident pleasure. He would not let anyone come near him while he was eating, but he made no objection to a dog coming and sharing his food with him. The trooper remained with him four or five days, and then returned to the Governor, leaving the boy in charge of the Rajah of Hasunpoor. He related all that he had seen, and the boy was soon after sent to the European officer then commanding, Captain Nicholetts, by order of the Rajah of Hasunpoor, who was at Chandour, and saw the boy when the trooper first brought him to the village. This account is taken from the Rajah's own report of what had taken place.

"Captain Nicholetts made him over to his servants, who take great care of him, but can never get him to speak a word. He is very inoffensive, except when teased (Captain Nicholetts says), and will then growl surlily at the person who teases him. He has come to eat anything that is thrown to him, but always prefers raw flesh, which he devours most greedily. He will drink a whole pitcher of butter milk when put before him without seeming to draw breath. He can never be induced to wear any kind of clothing, even in the coldest weather. A quilt stuffed with cotton was given him when it became very cold; but he tore it to pieces, and ate a portion of it with his bread every day. He is fond of bones—especially uncooked ones—which he masticates apparently with as much ease as meat. He has eaten half a lamb at a time without any apparent effort, and is very fond of taking up earth and small stones and eating them. His features are coarse, and he is very filthy in his habits. He continues to be fond of dogs and jackals, and all other four-footed animals that come near him, and allows them to feed with him if he happens to be eating when they approach."

**Hugh Lockhart Ross.**

## ETERNITY OF MATTER.

[24016.]—To get back to the time when all was infinitely hot, we must go back through an infinite time, for however far we go, we can always imagine an anterior and hotter time.

**E. G. Tindall.**

[24017.]—In reply to "A. W." (23997) I would point out that although the material universe at present exists in a state of heat, it did not necessarily always exist in that state, as heat is merely a *state* of matter which may be imparted to such through its coming within certain forces (either chemical or otherwise).

Therefore, although the universe—so far as we are able to see it—may at present exist in a state of heat, its elements, after having parted with that heat, may again be brought within such influence as will cause it once more to assume a state of heat equal to that which previously existed within it.

It is, of course, impossible to say what the origin of this heat is; but it is probable that it is brought about by the continual motion which matter as a whole assumes through space.

**R. W. B.**

## EXPERIMENTS ON FRICTION.

[24018.]—Those who are interested on the subject of friction set up in the bearings of screw shafts of steam vessels I submit should pay a visit to South Kensington Museum, and study the patent screw shield of the late celebrated Robert Griffiths ("Screw Griffiths"), or to Mr. A. A. Wade, M.A., F.R.S.A., 108, Fleet-street, who has a rough model, and will be glad to show it; and also see the discussion on Barnaby's hydraulics, which took place last year at the Institution of Civil Engineers, Great George-street. The shield has the effect of giving an equal grip to the propeller throughout the entire revolution, thereby preventing the great pressure on the upper bearing, does away with vibration, and gives from six to eight better results. Mr. Wade will give particulars to inquirers.

**C. Curtis, Retired Captain, R.N.**

## A TWO-INCH SPARK COIL.

[24019.]—Your printer has, I see, in setting up my description of this coil, termed it a "Quick spark," instead of a "2in. spark" (as I wrote it), which may much exercise the minds of some of "ours" to know what it means, unless corrected.

**B. Harcourt.**

## MUSICAL SCALE.

[24020.]—On page 10 of "our" new volume Mr. S. E. Hunt gives an exposition of the ratios of the notes of the natural scale according to the harmonic theory. I call it the harmonic theory, because, according to it, the points at which a monochord sounding the keynote must be stopped or shortened to produce the other notes of the scale are some of its nodal points—points which remain unmoved when the string, becoming divided into a number of equal parts, vibrates in each of these parts separately, and gives forth a "harmonic" note, the pitch of which corresponds to the length (and, of course, number) of the subdivisions. These harmonic notes can easily be produced on a monochord by gently touching it at a nodal point while it is being struck or plucked, or otherwise caused to vibrate. Thus, if the middle point is so touched, the two halves of the string vibrate separately, giving the harmonic note due to the half-length, which note is the octave above that sounded by the whole string. When the string is stopped at the same point—that is, if its effective length be reduced one half—the resulting note is the same. If it is touched at either of the nodal points which divide it into three equal parts, the harmonic note produced is the octave above the fifth of the scale of which the whole string sounds the keynote. When the string length is reduced to two-thirds by stopping it at the same point, the fifth note of the scale is sounded. If touched at one of the nodal points which cut off a quarter of the length from either end, the string sounds the harmonic note, which is two octaves above the keynote. Reducing its length to three-quarters by stopping it at the same point makes it sound the fourth of the scale. These simple harmonic ratios having been found to subsist between the keynote and the octave, the fifth, and the fourth of the scale, it seems to have been assumed that similar ratios must also exist in the case of all the other notes of the scale. Mr. Hunt, indeed, goes so far as to say that "the natural musical scales appear to arise out of the *demand* of musical ears" for such ratios. Now, all that musical ears demand is only that the notes of the scale shall sound *in tune*. They no more take note of ratios, simple or other, than does the eye of the different rates of light-vibration which impress it with a sense of various colours. Assuming, then, that the second, third, sixth, and seventh notes of the scale *must* each bear some simple ratio to the keynote and other notes, Mr. Hunt assigns to them certain values which he gives in a table, showing ratios ranging from $\frac{4}{5}$ (which is simple enough) for the major third, to $\frac{8}{15}$ for the major seventh, $\frac{9}{16}$ for what he calls the "grave minor seventh," and $\frac{15}{16}$ for "flat minor second"; none of which latter can be called very simple. He has two major seconds and two flat sevenths—apparently because he could not find a single second or flat seventh which would answer the requirement of bearing simple ratios at once with the keynote and with other notes of the scale. One of these duplicated notes is, it seems, used only in ascending passages, and the other in descending ones; because "the ear prefers the large tone to the small one when the choice is offered." Now, this "large tone" is the correct $\frac{8}{9}$ interval, the small one the disputed $\frac{9}{10}$ interval. If, as Mr. Hunt truly says, the ear prefers the former, surely that fact should cast considerable doubt upon the correctness of the latter. Does the ear demand simple ratios, and yet prefer an interval incompatible with them? I find (*by experiment*) not only that the ear prefers this "large tone" for all the whole-tone intervals of the scale, but also that the reduction of two of them to $\frac{9}{10}$ necessitates a widening of the semitone intervals, which is most unsatisfactory to the ear. In fact, I believe it is only a defective musical ear which can accept as in tune a scale in which any other ratios than $\frac{2}{3}$ for all the fifths and $\frac{3}{4}$ for the fourths are admitted. A series of notes calculated upon the basis of these two ratios (see monochord scale, page 478 of the last volume) embraces a complete and consistent system of diatonic scale in every possible musical key, each key being related to certain others according to the laws of musical modulation. Every note in it has a definite and invariable pitch in relation to the others, which does not require to be altered in changing from one key to another, or from ascending to descending phrases. It is the want of this consistency and fixity in the harmonic scale which seems to have puzzled Mr. Cass and, no doubt, others. Taking that scale as perfect, "J. A. S." was quite correct when he supposed that the key of G must require *two* notes not to be found in the key of C; not only a new seventh (F sharp), but also a new second which will change the first interval from $\frac{9}{10}$ to $\frac{8}{9}$ of the keynote. This, however, as every musician knows, is not necessary, and the reason is that the interval G-A is the same ($\frac{8}{9}$) in both keys. The inconsistency of the harmonic scale may be shown thus: Calling the keynote C 1, we have D ($\frac{8}{9}$) = 0·888, E ($\frac{4}{5}$) = 0·8, G ($\frac{2}{3}$) = 0·666, A ($\frac{3}{5}$) = 0·6. Here E, being made $\frac{4}{5}$ of the keynote C, is necessarily $\frac{9}{10}$ of D. But E is also the second of the key of D, and in that capacity it must be $\frac{8}{9}$ of D, or 0·7911. Again, A, besides being the sixth of the key of C (as which it is said to be $\frac{3}{5}$ of the keynote, and $\frac{9}{10}$ of G) is likewise the second of the key of G, and the fifth of the key of D; but in either of these cases its value is not 0·6, but 0·592. Thus the harmonic theory unavoidably gives two separate values to each of two notes of the scale (to begin with). Each of these four values of course forms a starting-point or keynote from which to calculate other values, and there are thus produced four different sets or systems of notes. But every new third and sixth of a scale so calculated necessarily assumes two separate values, as did those of the original scale. These in their turn became fresh starting-points or keynotes for new sets of scales, and consequently there results, if the process of calculation is carried far enough, an innumerable host of values assignable to every note of the chromatic scale. In the the true natural scale, I repeat, every note has, and can have, only a single value which bears a definite ratio to that of every other note, according to its distance in the scale from it, the same distance in every case giving the same ratio.

On page 37 in "E. M.," March 13, Mr. Elphick, in reply to me, undertakes to try to prove the correctness of the harmonic scale. His offered proof (of "the mathematical part of it"), which at first sight looks alarmingly elaborate, turns out to be nothing more than showing that the ratio of each note to the keynote agrees with the product of all the intermediate interval-fractions multiplied together. Mr. Elphick does not seem to be aware that this is a mere illustration of a general arithmetical fact which is true of any series of numbers. Thus, suppose we take the arbitrary series $\overset{a}{10}\ \overset{b}{7}\ \overset{c}{4}\ \overset{d}{3}$, the successive fractions representing their ratios are $\frac{7}{10}$, $\frac{4}{7}$, $\frac{3}{4}$. Now, $a = 10$, $b = \frac{7}{10}$ of $a$, $c = \frac{7}{10} \times \frac{4}{7} = \frac{28}{70} = \frac{4}{10}$ of $a$, and $d = \frac{4}{10} \times \frac{3}{4} = \frac{12}{40} = \frac{3}{10}$ of $a$; but it is evident that $d$ would still have been $\frac{3}{10}$ of $a$, whatever other numbers had been chosen for $b$ and $c$. In the same way, in the scale the ratio of any note to the keynote will remain unchanged, whatever values may be given to the intermediate notes, and if Mr. Elphick will apply his method of proof to the monochord proportions and intervals given on the same page with and immediately preceding his reply, he will find them also correct; but of course the process is no proof at all. Having given his supposed proof, Mr. Elphick proceeds to show the anomalous nature of the harmonic scale by pointing out that every interval in it except the octave has no less than three different dimensions according to the part of the scale in which it occurs, and he makes this confusion worse confounded by reckoning the *minor thirds* among the "thirds"; also by classing the interval F—B as one of the fourths, the true fourth interval above F reaching to B flat. Moreover, he points out particularly that two of the so-called fifths fail in the sum of their component intervals to make up the $\frac{2}{3}$ ratio necessary to constitute a real fifth. One of these two however (B to F), is not, at any rate, a fifth at all, the real fifth above B being not F, but F sharp. I offer Mr. Elphick my best thanks for so ably assisting me in demonstrating the inconsistencies of the harmonic scale. In concluding, Mr. Elphick assures us that he has tested theory by the aid of certain wind instruments; but it is questionable whether these were instruments of precision capable of making the exact measurements required in a scientific investigation. I would advise him rather to use an accurately-divided monochord, and try its effect upon persons having reliable "musical ears." **Walter Bardie.**

9, Dalkeith-street, Joppa, March 16.

### PNEUMATIC TRANSMISSION OF THE MAILS BETWEEN LONDON AND PARIS.

[24021.]—In the Scientific News of the "E.M.," March 20th, it is stated that a plan has been devised by a M. Berlin by which mail bags can be sent 295 miles in one hour, with an engine power of from 20 to 30 horses. I, and probably all your readers, would be glad to have further information on what would appear to be an enormous advance over methods now in use.

A paper was read at the Institute of Civil Engineers in 1872, which led to a very interesting discussion, in the course of which Mr. E. A. Cowper, no mean authority, spoke to this effect:

If it were attempted to carry heavy mails at high speed through tubes, friction must be reduced by increasing the size of the tube. A pipe 24in. diam., 4 miles long, would only give a speed of 47 miles an hour, with a vacuum of 11lb. per square inch. With proper arrangements for letting in the air every half-mile, a speed of 131 miles an hour might be maintained if the piston would bear the wear and tear. The power required, however, would be about 390h.p. every 4 miles.

The pneumatic system in London requires three 75 h.p. (indicated) engines for very light carriers, and a speed under 20 miles an hour. This being so, one cannot well help feeling a desire to know more of a system said to be able to carry heavy weights 295 miles in a single hour, with 30 h.p. engines, even if one is mistaken in supposing that the paragraph intends to convey the idea that only one such engine is required.

It may be said that a speed of sixty miles an hour was obtained on Brunel's atmospheric railway; but there the air was admitted directly behind the piston, so as to avoid the necessity of moving a long column of air, the friction of which constitutes one great difficulty of the problem.

**Emeritus.**

### DR. KOCH'S "COMMA" BACILLUS.

[24022.]—Might I ask you to allow me to point out a slight mistake in your report of the proceedings of the R.M.S. in your issue of March 20? The drawing I exhibited was of Dr. Koch's "Comma" bacillus, and not of the *B. subtilis* as stated.

Before Mr. Fowke's statement can be accepted "that the Comma bacillus of cholera was known and recognised 35 years ago by Messrs. Brittain and Swayne," two points want to be proved: 1, That the art of staining micro-organisms was known at that date; 2, that the "microscopy" of that day was equal to the occasion.

In the term "microscopy" I include the whole of the brasseries, glasseries, lighteries, and *the method of using them*, so as to develop their full powers.

I believe I am correct when I say that an unstained "comma" bacillus has never been seen by the "microscopy" of the highest type of the present day; also that the art of staining micro-organisms is a comparatively recent invention.

It is very unlikely that Messrs. B. and S. possessed "microscopy" so far in advance of that which we believe was extant at the period stated as to be enabled to discover the "comma" bacillus.

March 21. **Edward M. Nelson.**

### MINERAL-OIL LAMPS.

[24023.]—I have read with some surprise the extract in this week's "E.M." of Sir F. Abel's lecture on "Mineral-Oil Lamps" in respect to metal containers, and as his observations are so much at variance with practical experience, I think a little more explicit information from him (the highest authority on the subject) would be of general interest, as while these lamps are made in their present form any general adoption of his views might, in ignorant hands, lead to disaster.

Sir F. Abel distinctly advocates the use of metal containers in preference to opal glass or earthenware. Now, these latter materials have been adopted by all the best makers, as, from the fact that they are non-conductors of heat, they are the best substances to use, and consequently the only safe containers for lamps of the present make; for metal heats at once, and in a very short time raises the oil to a temperature that throws off inflammable vapour, and, in fact, converts the ordinary domestic lamps into a "close testing machine, without the safeguards possessed by that article."

The "flashing point" of average oils in the close test is but little above 75°, and in an open test is from 107° to 115°, and as any metal container, with an ordinary wick at full combustion, will soon raise the temperature of the oil above the highest of these, and though there may be no opening near the flame, yet if the wick should be in the least too small for the sheath, the vapour must mount beside it and directly enter the flame. This will not of itself of necessity cause an explosion, as if the stream of gas so escaping be limited, it will be steadily consumed by the flame to which it is carried by the upward draught of the chimney; but let this draught be checked, by carrying the lamp about, or blowing down, or even across the top of the chimney, an explosion is very likely to happen.

Sir F. Abel advocates the filling of the container with oil; this he does for stated scientific reasons—let me add a practical one: Few wicks have a "pull" beyond 4in. from the point of ignition, and that only with the better class of oil, consequently, the fuller the container is, the shorter is the "pull," and the better the light from the more perfect combustion of the oil.

What, I have no doubt, the learned Professor meant was that "as lamps are now made," it was better to choose the lesser of two evils, for the opal or glass container lamps so easily break on being let fall, and the concussion converts the oil into a spray, mixed with atmospheric air, which is the most dangerous condition possible. But I am convinced that far more danger would accrue from the general heating of the oil in metal containers than from the few occasional fractures. **J. Hughes.**

### GRATES.

[24024.]—In the "E.M.," No. 1032, January 2, your correspondent "Dover" makes a suggestion about an addition to our "common English grate," and asks for any practical correspondent to criticise his idea. Without presuming to do this further than saying I do not consider the presence of water quite in character with a drawing-room or sitting-room, I will state what I did to my drawing-room in a house where the fireplace was against the outside wall, with a similar intention of utilising the heat.

An opening was made from the outside exactly opposite the centre of the grate, to lead into a channel made at the back of the grate level with the hearth, which channel divided behind the ash-place, and passed up both sides behind the sides of the register stove, uniting again into one large channel made at the back of the mantelpiece, and an opening 1in. wide was made into this cross channel the whole length of the mantelpiece, opening underneath the looking-glass, the looking-glass being raised 1in. to allow the warmed air to enter the room through this opening.

By this arrangement all persons at or near the fire experienced a pleasing and most refreshing current of warmed fresh air, which passed afterwards into the room and, rising, mixed with the results of combustion from the gas, uniting with the cooler air on the opposite side of the room and returned with a lower current to the fireplace, thoroughly ventilating the entire room. The course it took from the mantelpiece had often been followed and traced by the aid of placing anything giving off smoke on the mantelshelf and observing the direction it took; this was invariably as described, and the agreeable character of the air in the room and the success of the principle received the approval of all who remained in the room for any length of time. The opening in the outside wall was covered by a perforated door, and inside the door was fixed a sheet of canvas or wool, or of any other fibrous material, to filter the air; this was found necessary from the large quantities of impurities always present in the air of London. This diaphragm was replaced by a fresh one as often as found necessary by the air not passing in freely. Should any of our readers care to try this experiment, they would be very pleased with the result. **J. S. B.**

### LATHE MATTERS.

[24025.]—The question of the possibility of hardening lathe mandrels with the least degree of warping, or without distortion, must rest in the hands of those who, by the selection of the most suitable metal, manipulated with this object solely in view, and who are willing to experiment in this direction. I have given my experience, which, of course, I expect to be negatived by those who will never deviate from the old groove; yet I can show good results.

If I had a prize to award for one of a series of mandrels by unknown makers, it would probably not fall to the share of the one most highly finished and dressed up; but for that with all the accuracy of the soft state retained, and having been untouched after hardening. It is not a difficult feat to turn up and finish a mandrel in the soft state; most average light turners can do this perfectly, and consider it nothing to brag about. I cannot reason with Mr. Hines, as he says that he uses "the very finest and best quality of cast steel" for his mandrels—a material that I repudiate for this purpose, because the finer and harder the quality of cast steel, the more certain it is to warp in the hardening.

I advocate the very mildest homogeneous steel, that without a little extra surface carbonising will not harden sufficiently to resist a file scratch.

I do not "evade the question" of makers who use diamond turning tools; but answer it in the way that I think most proper to those whom it may concern; and I shall be willing to notice further applications.

In a discussion of this sort, makers of foot lathes of course avail themselves of the opportunity of drawing attention to their own merits, or induce others to do so for them. Would Mr. Hines like me to announce another maker's lathes as preferable to his own for quality of workmanship? I think not; so those who ask my opinion must do so privately. But I may properly go beyond lathe makers. Sir J. Herschel turned up the hardened steel axes of his transit by means of a diamond. Mr. E. Troughton, F.R.S., also used a diamond turning tool for finishing up the hardened steel work in the instruments that he manufactured; so also that eminent maker of astronomical and philosophical instruments, Repsoldt, of Hamburg, and Julius Wanschaff, of Berlin, now exclusively use diamond turning tools for giving the high degree of accuracy to the hard steel spindles, &c., in the work for which they have acquired such celebrity.

With the aid of our best modern screwing lathes, screws and taps may be cut so as to run absolutely true in every part in the soft state. It is in the hardening operation that the distortion occurs, and the effort should be to quench them so as to remain free from error, so that the screw retains its perfection as a centring agent. Mr. Hines, however, names another liability to error—that "the first bruise on the end of the mandrel would spoil it." From this we may infer that the ends of his mandrel noses are soft. The knowing ones who before choosing a lathe feel the mandrel all over with the corner of a file may perhaps note this. He also informs us that the "model mandrel" as exhibited at the "soirée" should have the screw made as a "loose fit in the chucks," to allow them to accommodate themselves to the blank cylindrical base, and so in case of eccentricity the screw would not force the chuck against the mandrel face in the direction of its centre, but all on one side—a most complaisant state of uncertainty, to be sure. If the screw is turned absolutely true, and this truth can be retained in the hardening, then the cylindrical base is worse than useless, and we had better be without it. If, on the other hand, it is (as some would consider) impracticable to get a perfect screw hardened so as to remain true, then in cases where we can we had better dispense with it altogether for a mandrel nose, and make it as a slightly tapered plug, as this, of course, can be finished absolutely true after being hardened. Some of the mandrels for watchmaker's lathes are made this way, and Mr. S. Varley's optical lathe made sixty years back had a mandrel of this description. The lathe is described in Vols. I. and II. of "Gill's Technological Repository," from which I quote. "The mandrel of this lathe has a tapering end to it on which the chucks are fitted tight, by merely giving them a slight twist on placing them thereon. The proper degree of taper should be 4°; if of a greater angle than that, the work is apt to loosen the chuck, and it will come off the mandrel; and if of a lesser angle, it is liable either to burst the socket of the chuck, or to stick so firmly upon the mandrel as to endanger the work in geting it off." Of course this cannot be recommended for foot-lathes for heavy turning for which the chucks must be locked in some way; but I can show my friends a heavy engineer's lathe of recent construction meant for very accurate work, with a plain mandrel nose of this description, having a diameter of about 4in. The chucks are locked and drawn on the conical nose by a key passing through the sockets and through a slot in the mandrel end. This would not do for a lathe where the removal of chucks is frequent; but in a heavy engineer's lathe the work is nearly all done from the large face-chuck which is seldom taken off, even for turning between centres. I do not know whether this mandrel-nose has been turned up true after being hardened by a diamond turning tool. I think it probable. I should do it that way myself, but I can easily learn this from the maker.

In quoting "Vulcan" as having pronounced me altogether wrong in saying that a rotary cutter will produce a distorted thread, Mr. Hines has strayed beyond the lines. If he will refer to No. 23973, on p. 60 of this journal (last issue), he will see that "Vulcan" quite realises the position, and explains it graphically, having candidly withdrawn his first impression. Let a milling cutter or saw be set with its plane to line with the angle of the top of, say, a square-threaded screw. For the bottom near the axis, another angle of plane would be required with a greater twist; a clumsy compromise might be effected by turning away the sides of the milling-cutter and making it narrower at the edge so as to fit in the thread, and then finally to obtain an accurate square bottom, the periphery of the cutter would require to be hollowed out to an elliptical curve, and a most horrible job all this would be. I

FIG. 11.

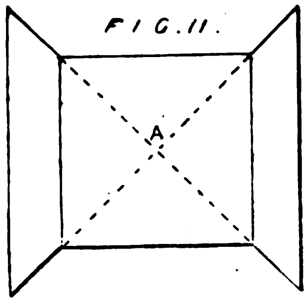


FIG. 3.

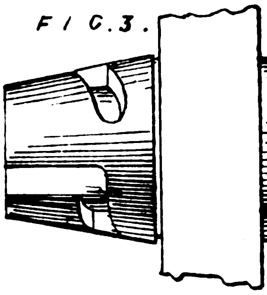
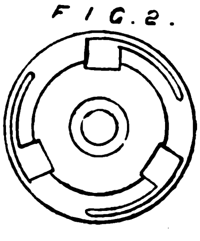


FIG. 2.



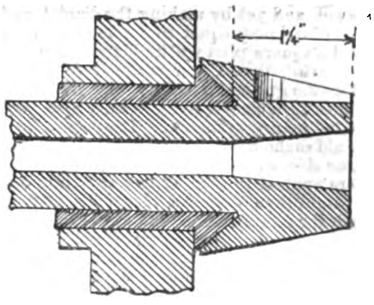


FIG. 1.

FIG. 12.

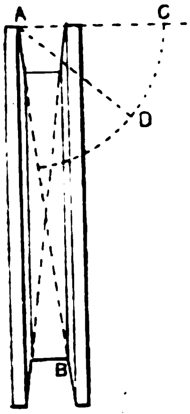


FIG. 10.

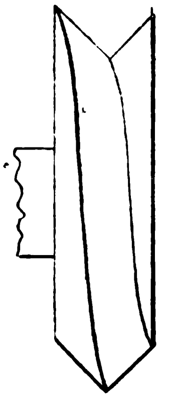


FIG. 5.

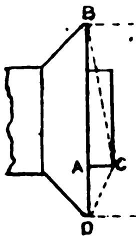


FIG. 6.

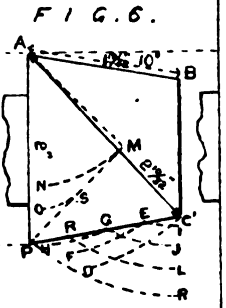


FIG. 7.

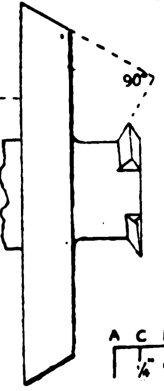


FIG. 4.

FIG. 9.

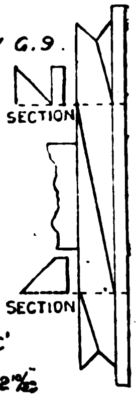


FIG. 8.

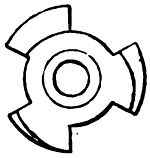
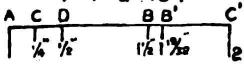


FIG. 13.



have had something to do with screw-cutting where the greatest accuracy has been the aim, and the idea of having to work up and finish a fine-threaded and deep-cut screw for micrometrical or dividing purposes, by means of revolving cutters and grinders, is enough to make one shudder. If Mr. Hines, for the sake of maintaining his point, is trying to persuade us that for "standard taps," &c., the revolving grinder has been adopted, all that I could say further on this point might be summarised in the somewhat uncourteous phrase, I do not believe it, and this must be the end of the argument. I had given Mr. Hines a timely caution not to risk his status by being beguiled into supporting this gross error, originating from another quarter, which would necessarily bring replies to prove it as such. **F. H. Wenham.**

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[24026.]—DOES Mr. Wenham really mean the diamond gem or bort or carbonado? I fancy the latter.

I like Mr. Wenham's expression, "the traversing mandrels trued up"—*i.e.*, not lapped or abraded, but turned up true by what he calls the diamond tool. There is no difficulty in setting pieces of a real diamond or pieces of carbonado in a tool. I fancy Sir Henry Bessemer has been using diamonds for cutting telescope lenses.

Mr. Wenham refers to case-hardening iron. I prefer the plan of which a practical manager of a large London manufactory told me—viz., take a piece of iron, put it into an iron tray or box filled with two-fifths of quarry limestone (black marble best) and three-fifths wood (oak) charcoal, cover up and put in a lid, put into a furnace and heat well. According to time of heating so will be depth of steel. I have done this, and in filing end I have seen the depth of steel, or steely or carbonised iron.

14th March. **Z. Y. X.**

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## LATHE MANDRELS, CHUCKS, &c.

[24027.]—ON p. 562 Dr. Edmunds says: "If an acute cone were used we should need a very long (mandrel) nose, or we must go back to double surfaces." Fig 1, which illustrates my system, No. 1, is a section of a double steel mandrel nose, and it will be seen that, for the sake of comparison, I have adhered to as many of the dimensions of the Standard mandrel as possible, and in order to increase the length of the cone, which is one of an angle of 20°, I have made the hard steel collar project slightly, the base of the cone being countersunk to receive it. I do not know that I should recommend this in practice, as it might tend to weaken the mandrel neck; but whilst securing a length of cone of $1\frac{19}{32}$in., it still necessitates the nose projecting only 1¼in. beyond the support of the collar, or, in other words, a length of projection identical with that of Dr. E.'s design, and I presume that a cone of such length will not be called a very long one; and, being tapered to an angle of only 20°, brings it within the definition of an acute cone, so we are not yet "obliged to come back to the two (*rectangular*) surfaces." In Fig. 2, which is an end view of the nose, and in Fig. 3, which is an elevation, the triple bayonet joint, the means employed for keeping the chuck in its place, is clearly shown, the spiral part of which is about 1in. pitch. This, in all probability, would be much improved by being made of much greater pitch, the precise amount being governed by the angle of conicity given to the nose. The chucks coned out to accurately fit this mandrel would have three equidistant holes bored in the same plane, into which the hard steel pins (Fig. 4) would fit tight, the flat surfaces of which would engage with the sides of the bayonet joints. Fig. 5 is a view of the rectangular surfaces of the Edmunds mandrel, and if we take A as the centre about which angular variation or declination takes place, we should find that the opposing surfaces to motion in an upward direction are represented by the lines A B and *a c*, and to motion in a downward direction by surface A D only; see Fig. 13 for comparison of length of these resisting surfaces with those afforded by my (Fig. 1, 2, 3) mandrel nose; and now turning to Fig. 6 and taking corner A as a centre of angular variation, we find that the side P *c′* would oppose such upward motion, as shown by arcs H G, F E, and D *c′*, which are intercepted by the suface P *c′*, the distance from A to P being 2in. and from A to *c′* $2\frac{19}{32}$in., or more than ⅝in. extra leverage over that of Dr. Edmunds's. Side A B′ would not oppose this upward motion; but if the motion were a downward one, side P *c′* would not resist, as shown by arcs *c′* D, E F, G H, but A B′ would now oppose, and as the length A B′ is $1\frac{19}{32}$in. there is still $\frac{3}{32}$in. in my favour over surface A B in Dr. E.'s, or, if you combine surfaces A B and A C in Dr. E.'s, there would be little difference between the two. Now if B′ were the centre of variation, then for the upward motion, surface P C′ would resist, as shown by arcs I E, J G, L K, and R P; but surface B′ A would be inactive, if the motion tended the contrary way, the result would be vice versâ. If, however, the cone was of an angle of 90° (see dotted lines in Fig. 6), and A be taken as a centre of angular variation tending downwards, then, not only side A M, but also M P, would oppose, as shown by arcs M N and S O. Each of these sides are about 1⅜in. long, or about 2¾in., together equal 1¼in. in my favour, although, if looked at as a lever, this must be reduced to ⅜in. And, to avoid being misunderstood, allow me to say here that I do not bring forward these designs as the best that can be done, but only as illustrations of what could be done; and if it is the means of leading some inventive genius to hit on the right thing I shall feel myself more than repaid for my trouble. On p. 13 of No. 1041 William Granger suggests the very good plan of placing the screw between the two cylindrical surfaces, and in this method anticipates me in publication, although my drawings one to four were completed on 28th ult., and the design worked out some two months previous to that date. Now, glancing at Fig. 7, we see an illustration of my system 3, viz.: two cones in opposition to each other, and here we have one as much as 4in. diam., and the other 1½in. diam., with their conical surfaces on the same side at an angle of 90° to each other; this, of course, is not compulsory, but I shall say more on this subject when I come to Fig. 11. The smaller cone consists of a single screw thread of ¼in. pitch, out of which three alternate sixths have been removed, and thus necessitating the removal of similar and corresponding sixths in the chuck to those left on the mandrel; and this being a single screw chuck and mandrel, would only interlock when the proper fraction of screw in chuck was placed in the proper space in mandrel, as pointed out on p. 499 by "F. A. M." But this cutting out of sixths is not very necessary, and is only useful to save time, and is merely a development of the bayonet joint. Fig. 8 is an end view screw cone, part of Fig. 7, and shows the alternate sixths removed, and in order that this might interlock at any meridian, it would be necessary to have a triple threaded screw; this I have endeavoured to show in Fig. 9, illustrating my system No. 2—viz., a cone in opposition to a flat face, and to make it clearer, I give sections of screw-cone at commencement and termination of one-sixth of a complete turn of a triple-threaded screw of about 2¼in. pitch; this is represented as 4in. diam. and ⅜in. thick. Fig. 10 illustrates a simpler form of system, No. 2, being a thick face plate solid with mandrel, and having a coarse angular screw, to supply the cone, turned on its outside circumference.

We have seen the good and bad points of Fig. 6, and no doubt it will have struck some that if the surface P C′, instead of occupying its present position and direction, had been a prolongation of line A C′, it would much more effectually oppose the upward motion of variation about A as a centre, and in Fig. 11 with a base of only 1⅝in., and with a similar length for the sides, we get resisting lengths equal to the diagonals, or about 2⅜in. with a base of 2in.: this would equal resisting lengths of nearly 2⅞, and these figures are so favourable that really comment is unnecessary—if this principle be modified so as to become 4in. in diam. by only ¾in. long, we arrive at Fig. 12, where the diagonal system is still preserved, but the conicity of the surfaces so nearly approximates to the perpendicular that, although very useful for preventing angular variation, their value as a concentring means is almost *nil*. Similar unsatisfactory results would follow a very great prolongation of the length and diminution of diameter if the diagonal system be preserved, and yet by making the diameter of the base of mandrel nose equal to its length, or by starting with a square plan we find the diagonal system so successful, that I am inclined to think this form offers the greatest stability and the best corrective angles for a cone system, which also would be included in my system 8. The cones in this case would make an angle of 90° with each other on the same side, and 45° with the axis, and if these angles were applied to Fig. 12, as shown in dotted lines, it would then become a very efficient truing means both for face and centre; but it has struck me that the best angle might be one found by bisecting the angle made by the diagonal A B and A C as at A D. The following questions suggest themselves to me:—

(1) Is it as easy to make a male cone in hardened steel as a female cone in cast iron—say, as true as it is to make two rectangular surfaces, one of which is parallel to the axis, on hardened steel, and counterpart ones in cast iron?

(2) Can a screw of fine or coarse pitch and of square or angular thread, by any moderately cheap means, be made absolutely true, or true enough to answer as a centring means for ornamental lathe work.

I think two cones easier to make than four rectangular surfaces, and I also think it possible to make screws sufficiently true for the purpose named, but am looking for "Bow's" answer to Dr. E.'s questions on p. 562, and also want to see what he will say to letters 23945-6. It seems to me that if we are speaking scientifically of an object, we shall not be able to get on very well unless we give distinctive names to the different parts, and I do not see how the geographical nomenclature of Dr. Edmunds can be improved.

E. J. S.

The Laurels, Westbury-on-Trym.

[24028.]—WHY does not Mr. Wenham state the names of the manufacturers who have used diamonds (query, carbonado) to turn up hardened lathe mandrels or other process of hardened steel? This would stop Mr. Hines and others from making remarks and doubting his statement.

If diamond or carbonado will, as I believe, do all that is wanted in the way of cutting hardened steel, I should prefer to use it in preference to any number of emery wheels, for I cannot in my own mind get rid of the notion that emery wheels *may* leave some bits of emery (small they may be) *in* the steel.

No mechanic will, I think, say that a lap ever produces "truth." If so, then a wheel is best, unless a wheel is in its turn superseded by diamond or carbonado.

Z. Y. X.

### INTERCHANGEABLE MANDRELS.

[24029.]—As Dr. Edmunds says, vested interests of some lathe makers is very strong. I think the doctor is right in the course he is taking in advocating the change, and if he overcomes the vested interest, why, then, so much the more honour. Years since I felt very much the want of the "interchangeable" chuck arrangement.

If this plan is feasible, as I think it is, then a poor man (amateurs are often poor) can have first a good lathe made, and then from time to time have an additional chuck without having to part with his lathe-head for, say, a month. And, moreover, an amateur could go out to spend the evening with a friend, and take his chuck with him! This may seem nonsense, but it shows what could be done if the scheme is carried out. Then the friend would want to have a similar chuck, and so trade would go on and the art of turning also.

Z. Y. X.

### NEW MIDLAND ENGINES.

[24030.]—I HAVE been too busy to answer the reply of "A Disappointed Driver" to my note concerning these engines. Since reading his letter I have been more than ever convinced that these engines are not having their due at the hands of the drivers, and if "A Fireman" in a recent issue of "E. M." expresses the opinion of the driver he is under, it may be considered proof positive that at least one engine will always be behind time, for no good driver who intends to keep time will let down his steam to half the proper working pressure: experience will teach him, if he does not reason it beforehand, that this is not the way to get along.

I repeat the opinion I expressed, and tried to explain, that nothing more is wanted than to notch up the gear till no more steam is used than the boilers will comfortably supply. This is just how the engines were expected to work and the only way they can be expected to work; and to show to "A Fireman" how far the driver was from the right method when he run down to 60lb. pressure with full gear forward, I may state that steam cut off at ⅛ stroke and at 120lb. pressure gives about a quarter better results than running steam full stroke at 60lb. pressure, and is also very much easier to supply. I say emphatically that these big cylinders are not a mistake, and as soon as drivers fully recognise this fact and act up to it, these fine engines, against which there seems to be so much prejudice, will become favourites with the drivers, and we shall hear no more of their not being up to their work, but have a good name all along the line.

I am aware that a good distribution at all points of the links alike is a difficult matter; when near mid-gear the valve is likely to throttle both steam and exhaust, and the man that invents a valve that gives a good opening with an early and rapid cut-off, a clear exhaust, and without any extra complications, will gain the lasting gratitude of railway engineers throughout the world.

I notice that Mr. Webb, on the L. and N.W., uses the Allen-Trick valve on his compounds, and this valve is no doubt a great advantage where an early cut-off is desired. I think this is worth more attention than it receives, and in conjunction with Joy's gear forms the best combination at present in use on locomotives.

I should like to hear something more of the experience of engineers with regard to balanced valves for locomotives. I believe they have been tried without much success. Can any readers of "E.M." state why? There is no doubt a balanced valve would lead to a considerable saving, not only in fuel, but also in repairs and lubricants.

Messrs. Alex. Wilson and Co. have been very successful in the application of Dayton and Wilson's patent balanced valve to marine engines. In one instance the bottom strap of the eccentrics still showed the marks of the tool after two years' wear, so easily was the slide moved. If such a result is possible in marine engines, why not with locomotives?

Will some of our friends who are drivers kindly give their experience on the following?

In starting a train the usual method is to put the gear fully forward and open the regulator just as much as she will take without causing the wheels to slip. Sometimes it is a very difficult matter to adjust the regulator so as to get a good start without slipping, especially when the rails are greasy. Now, I think that as soon as the engines begin to move, the best way is to put the gear to near the centre, open the regulator wide, and gradually set forward the gear to suitable position to full speed forward. The tendency to slip would not be great when the gear is near the middle, for although the steam pressure at the beginning of the stroke is great, the cut-off being early, the steam would expand, and the pressure immediately decrease as the piston advanced. Of course, this is only possible with screw or steam-reversing gear.

Luton, March 16. Helvellyn.

[24031.]—HAS not "Fireman" given us the truth respecting new Midland Engines? They seem to be designed with large cylinders and early cut-off so as to work very expansively, and yet have a large reserve of power for emergency. Instead of giving her all the pressure of steam, and notching up to speed required, "Fireman" says the regulator is open *three-quarters*, thus throttling steam before it gets to the cylinder, and requiring the lever to be put further over to get the speed. How can these engines be expected to do what is required of them under such conditions? The only wonder is that the result was not much worse.

Vortex.

### CONTINUOUS BRAKES.

[24032.]—UNDER the heading of "Scientific News," page 556 of last volume, reference was made to a new or improved vacuum brake introduced on the Midland Railway on Monday, Feb. 16. The circular of instructions for working the brake has been sent to me from Derby, and is herewith inclosed for the information of your readers.

It is satisfactory to find that at last the Midland Railway Company has become aware of the dangerous character of the "two-minute" brake; but it is to be deplored that when making a change something better than the new appliance has not been adopted. On and since Feb. 16 I have ridden upon several occasions with trains fitted with this brake, and find it slow in action, compared with air pressure. It is also very inconvenient that when an engine is changed, or shunting performed, the brake goes on, and has to be released by hand on each vehicle. Difficulties have quickly become apparent in releasing the brake. For instance, on Feb. 20, the 10.35 a.m. train from Leicester to Bradford was delayed a minute and a half at Sileby, and five and a half minutes at Barrow, as the brake would not come off. The piston rod packing is now new and in good order; yet some leakage takes place. What, then, may be expected in the course of a year or two?

Clement E. Stretton,
Hon. Mem. A.S.R.S., Leicester.

[CIRCULAR.]

"MIDLAND RAILWAY: THE AUTOMATIC VACUUM BRAKE WITH BALL VALVE.—This brake can be applied throughout the train by the driver from his engine, or the guard from his van. Engine-driver's instructions: Before starting from any station see that your gauge indicates at least 18in. of vacuum, and that not less than this amount is maintained during the journey and while standing at stations. To apply the brakes, open the air-valve on the engine. To release the brakes, close the air-valve and restore the vacuum to the same amount as it existed before their application. When the engine is attached to the train and the brake-pipes connected, put on the small ejector, and keep it on to maintain a constant vacuum during the journey. The large ejector may be used to raise a vacuum rapidly, or when the brakes require to be taken off again quickly; but in either case it must be closed again gradually. Guard's instructions: To apply the brake, lift up the lever of the valve. This admits air throughout the train pipe, and is to be only employed in cases of emergency. This valve opens automatically when the brake is applied with full force by the driver, and insures rapid action. See that all pipes between carriages are properly coupled together, and that the couplings on the end coaches are placed upon the stop plugs. See by your gauge that a vacuum of 18in. is maintained, and report if otherwise to the driver. General instructions: To release the brakes for shunting purposes—the engine having left the train—first see the hose coupling at one end of the train is off the stop-plug, and then pull the cord which is fixed under the frame of each carriage. This admits air to the top side of the cylinder and the brakes come off by gravity.

"Derby, Feb. 12, 1885. JOHN NOBLE."

### ACCELERATION OF TRAINS, BRAKES, &c.

[24033.]—A FEW days ago the Postmaster-General stated, in answer to some inquiry in the House, that there was in contemplation a considerable acceleration of the mail service between Yorkshire and the Continent. At present the Continental mails arrive at Charing-cross at 6 a.m., and are forwarded to Leeds by G.N. train at 9 a.m., arrive at Leeds 1.50 p.m., and, as the mails for transmission by the 7.40 p.m. Dover express from London leave Leeds at 1.10 p.m., it has been impossible to answer letters by return. On and after July 1, the Postmaster observes, the mails will arrive at Leeds about 11.40 a.m., and leave about three hours later. This points to a very substantial acceleration of trains on the G.N.R. Can any correspondent give us more particulars?

A striking feature of chairmen's reports at the recent meetings of railway companies has been the gradual but sure decrease of second-class traffic, and the chairman of the G.N.R., Lord Colville, unmistakably hinted that the example afforded by the M.R. many years ago will be imitated, and second-class abolished altogether for through traffic. It certainly seems as if there were a great waste of energy entailed in hauling about the country empty second-class vehicles, for, from my own personal observation, it has seemed as though the proper way to "make up" a train, such as, say, the 9 a.m. Paddington to Penzance, would be in the proportion of one first-class to four third-class coaches.

It is generally painful to see in how great a degree prejudice still reigns in the bosoms of directors. Just recently we read that the G.N. and M.S. and L.R. have decided to adopt the automatic form, being thereto influenced by the recent Penistone accident. How much better it would have been for these companies to have come to this decision *before* that lamentable occurrence. There is the North-Western, too, hovering about in a hesitating, lame sort of way between the adoption of various brakes, all of them more or less inefficient, and waiting, probably, for same serious accident to happen before deciding in favour of any of them.

A great deal seems to be made by the opponents of the Westinghouse brake of the fact that more failures occur in proportion to the miles run than in the use of the various vacuum brakes. Even if this be the case, can anyone say if in *all* such failures as many lives have been sacrificed as in the one failure of the vacuum at Penistone?

The worst that happens, in case of a Westinghouse failure, is a stoppage of the train, and, with a block, well-worked, an accident would be impossible; in fact, the word failure is inapplicable; it is simply "an excess of zeal" on the part of the brake.

Can any correspondent say whether the extra metals for narrow-gauge trains are laid beyond Bristol, and, if so, how far? I believe, however, that from Bristol to Penzance is wholly broad gauge.

Also, I should like to know what is the peculiar advantage of the longitudinal sleeper v. hollow rail, such as the G.N.R. use over nearly all their system above the usual reversible rail? Does it mean smoother running, or more economical working? Perhaps some reader could supply us with a sketch of the G.W. broad-gauge engine. I have looked through all past vols. and no such drawing has yet appeared. The only G.W. engines illustrated are the 7ft. single and the old B. and E. 9ft. tanks. If any of your readers want a really fast run let them note the speeds attained by the Midland London to Leeds expresses between Dronfield and Heeley Stations near Sheffield (down trains), especially through Ecclesball Station.

So much ridicule has been cast upon accounts of apocryphal speeds which have occasionally appeared in your columns that I am not going to attempt to estimate the speed; but I should like to know if someone of experience ever has done so, and, if not, if they would, and give it to us.

**John F. Lawrence, B.A.**

Merton Coll., Oxon.

### BORT.

[24034.]—THAT Bort dust, like diamond dust (the two being really convertible terms), and also Carbonado dust, may be adulterated, goes, in these days, without asking.

Carbonado for use ought to be the *small* pieces found with diamonds in Brazil, and not the fragments of a large piece of carbonado. The original outer skin formed by Nature is best.

What is "*Dessau Nickel Diamondiferous?*" The name takes one's breath away. When Dr. Edmunds speaks of "clear, transparent, diamond crystals," on the surface of a tool made of the above, is he not unwarily confusing the part of a crystalline body, or of a crystal, with the crystal itself?

Z. Y. X.

## REPLIES TO QUERIES.

⁂ *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[55384.]—**American Organ Reeds.**—With reference to the question about the smaller scale reeds, I have recently had an opportunity of measuring specimens of three different makers' work, and the following figures may be useful to your readers. The reeds chosen for measurement were all mid. C. The first was of that make in which the vibrator is clamped to the block by the brass of the latter being driven through on each side of the heel and burred over it; the second had the brass of the block driven through in the shape of a square or diamond rivet and burred over the hole in the vibrator heel; the third was the plain iron rivet. In the case of No. 1, the length of the block over all is 2·1in., of the slot through which the tongue vibrates, 1·1in.; No. 2 has the block a trifle longer, 2·15in., and the slot corresponds 1·15in.; No. 3, or the common iron rivet reed, is 2·25in. long over block, and 1·25 in the slot. They thus all preserve similar proportions for the standard set of reeds giving the diapason tone. Then a reed was taken from an organette, the same make as No. 3, that is, common iron rivet; it is 1·9in. over block, and the slot is 1·15in. long. It is evident that the vibrating length of mid. C must be over an inch to obtain good results, for breadth and thickness of vibrator are confined within narrow limits, except, of course, for special reeds.—FLIEGEN.

[55384.]—**American Organ.**—Mr. Fryer (page 37) still seems to be "up in the clouds" with regard to the matter of placing 8ft. reeds into cavities originally intended for 16ft. reeds, but which have been planed off to suit 8ft. reeds. Because I told a querist he could do this, and so utilise a 16ft. solo set tubeboard for the job he contemplated, Mr. Fryer has ever since been discoursing on the folly of placing 8ft. reeds in 16ft. tubes. May I ask Mr. Fryer to again read my former explanation on page 501 last vol., and also "Fliegen's" remarks on page 37? If he then fails to comprehend the matter, I would respectfully advise him to think it over, and try a few experiments, and not again occupy valuable space in discussing what must be quite clear to other correspondents. Mr. Fryer should also look up "Joiner's" description of his two-manual organ, which appeared in a back vol.; he will there find a little variety of tube dimensions, and I can assure him, from personal inspection, that that instrument did not "talk nonsense"; on the contrary, there was a pleasing variety of tone, such as is not generally found in similar instruments. Mr. Fryer seems to take it for granted that the theoretical notions I alluded to were his.—J. E. FLOYD.

[55571.]—**Turbine.**—A draft tube will work inclined; but the first foot or two should be perpendicular, and the shaft of the wheel also; this to prevent the step wearing sideways, and the wheel binding in its case and permitting leakage. Keep in view that the column of water below the wheel is practically suspended upon it, and that a column of 20ft. by 10in. diameter means, without wheel and shaft, about 1,000lb.—a serious item of friction to provide for—and if the gate is not made to close very slowly, this pull is intensified enormously in checking suddenly the column in motion. I have several turbine manufacturers' pamphlets. Most provide and calculate on the use of a draft tube where necessary; none recommend them otherwise. Except to the extent of keeping the wheel above tail water for inspection and cleaning, my own experience and observation is in perfect accord with this.—MILLWRIGHT.

[55827.]—**Gravity and Dead Escapements.**—I am pleased to see the correspondence on this subject which has appeared in "Ours"; the more so because I had just decided on the dead-beat for a regulator I purpose making. Some few years back I made a gravity regulator with lantern pinions of 12 and 10, and a 30lb. pendulum, zinc tube compensation. This clock has gone well so long as it is kept clean, and the oil fresh; as soon as it gets a little stiff it fails sometimes to lift the pallets, although the weight is a heavy one. I am decidedly of opinion that the train for a gravity regulator should be as fine and as good as for a dead-beat; and I should also want to be paid more for a gravity clock than for a dead-beat of equal finish. Beside the objection of the heavy weight required, and its effect on the longevity of the clock, the gravity escapement, to my eye, has a very cranky appearance, if lightly made, as it should be; also its shaky double beat is not desirable in a regulator. The place for these escapements is without doubt in turret and church clocks, for which they secure an excellent rate, if correctly made. For some years I have had charge of a fine church quarter clock with gravity escapement by Gillet and Bland, and its performance has been all that one could desire. I, however, take care to keep the escapement clean and fresh oiled, and for this purpose usually visit it once a month. It has often gone for several consecutive months without requiring alteration. The pendulum is plain wood rod, and beats 1½sec. I note that Mr. Glasgow in his late addition to horological literature is also in favour of the dead escapement for regulators; and Sir Edmund himself, see page 16, admits that it is as good as some others he mentions. Does any correspondent know anything respecting the suitability of aluminium bronze for dead-beat 'scape wheels—its durability, effect on the oil. &c.? Perhaps Sir E. Beckett will oblige.—J. E. FLOYD.

[55876.]—**Improving Light in Coal Gas.**—Your idea would, no doubt, be an improvement for capillary attraction if required, as is the case with heavier bodies, such as paraffin and colza oil, but not in this. The benzol being very volatile, gives off its gas very easily, and this rising is taken up by the gas passing through carburetter. You will not want to put spirit in oftener than from 7 to 10 days, for you will see, by experience, if you keep the taps turned off constantly when not in use, the spirit will be retained, so to speak, in the carburetter. Of course you can make it any size you like, but I have given one for from 10 to 20 flat-flame burners, the Argand being very little in common use. You never need fear the cotton wool becoming too dense for the reason given above.—ARVONIA.

[55902.]—**Irish Land Act.**—Any Parliamentary papers which have been "ordered to be printed" can be obtained of Hansard, Great Queen-street, W.C.; the Queen's printers, East Harding-street, E.C.; or of Harrison, St. Martin's-lane, W.C. There are also booksellers in all the chief towns who either keep on sale or procure any Act or Parliamentary paper that has been published.—C. T.

[55915.]—**Inhabited House Duty.**—"Chelsea" can pay the demand under protest, and then appeal to the Commissioners at Somerset House in writing. As he states the case he ought to pay only 6d. in the pound; but does the tenant of the shop pay the rates and taxes?—LIMB O' TH' LAW.

[55916.]—**Battery for Sewing-Machine Motor.**—"Stitching Machine" should have six cells with zincs in each of not less than 5in. by 3in. within the liquid, or in all 30 sq. in. of zinc surface, with carbon on either side and about ⅜in. distant. Each carbon should not be less in area than the zinc, but may with advantage be considerably larger. Charge with a solution of potassium bichromate, 3 parts; sulphuric acid (strong), 9 parts; and water, 20 parts; or, to partially prevent local action on zinc, 25 to 30 parts of water, all parts by weight. Mr. Lee, who advertises in this journal, has lately introduced an entirely new bichromate salt which has every advantage as compared with the bichromate of potash. 1st. It is soluble in its own weight of cold water. 2nd. It contains more chromic acid than the ordinary bichromate or potash. 3rd. It is cheaper. 4th. It does more work. And 5th. It does not crystallise on the carbons or in the cell. I have in my house such a battery that was charged last December, and thoroughly fulfils what I have above stated.—JOHN E. CHASTER.

[55942.]—**Dry Battery.**—"F. W. L." will do well to discard the use of sal-ammoniac, and use a rather strong solution of zinc chloride. The action in the battery when using sal-ammoniac resolves itself ultimately into the De la Rue chloride of silver battery, with a solution of $ZnCl_2$. The disadvantages in using sal-ammoniac are those complained of—viz., abundance of gas evolved, and also there is more local action at the zinc when left on open circuit. It is necessary to have a small aperture in the top, if only a pinhole. There is also an advantage in using chloride of zinc solution in place of sal-am. sol., and that is, there is no tendency to creep.—JOHN E. CHASTER.

[55981.] — **Oxidation of Carbon in a Galvanic Cell.**—"Quæsitor" asks if an efficient battery has been made by using a platinum-carbon couple in fused caustic alkali or nitrates of the alkalies. It has been sufficiently demonstrated by experiment that the cost of keeping the caustic or nitrate of the alkali fused by means of gas is quite prohibitory, apart from the consumption of the carbon element and chemicals. If a coke fire be substituted for the gas, the cost and trouble of attention is out of all proportion for the current obtained, as compared with batteries of the Bunsen and bichromate type. When using fused nitrates of the alkalies, the clouds of dense and poisonous fumes of the lower oxides of nitrogen arising, apart from the danger of having such a compound near a fire, is at once sufficient to condemn a battery in which they are used. Jablochkoff has described a battery in which plates of carbon and iron are placed in fused nitre, the carbon being rapidly consumed. This battery which I believe had its nativity in Paris, has been likewise buried there, not having sufficient vitality for its existence. —JOHN E. CHASTER.

[55982.]—**The Zinc-Iron Cell.**—Using iron as either the positive or negative pole in any battery gives low E.M.F. Take Mr. Sprague's list of the cost of battery working, Table VI., and it will be noticed that the E.M.F. of Slater's iron battery (which is merely iron replacing the zinc of a Bunsen) is 1·1 volt, as against 1·6 for the Bunsen, or about 40 per cent. less. In the Lalande and Chaperon cell, in which iron is the negative element, the available E.M.F. is stated by those interested in the company as being 0·7 volt, though I cannot obtain more than 0·6; merely a difference of 15 per cent. Respecting this loudly vaunted cell, of which I have had too much experience, seeing the almost worthlessness of it from a practical point, I shall have something to say about it within these pages very shortly. If "Noad" uses the term "surprising intensity" as being the intensity I, as written by some electricians, and meaning quantity of current or C, that statement goes for nothing, as a single cell of any sort might be constructed to give 1,000 ampères. If, on the other hand, he means E.M.F., he is wrong, and Mr. Sprague quite right. The indefinite term of intensity, as a measure of electricity, requires altering. It might not be out of place to state here that whatever Mr. Sprague states in his book is quite correct, as I have verified from time to time, and he is one of the few writers we have who prefers to make his own observations before committing them to print. He is one of the most valuable contributors we have to this journal, whether under his own name or that of "Sigma," and well remembers to carry out what Montaigne would have us learn, and which appears weekly quoted as a prefix to Letters to the Editor.—JOHN E. CHASTER.

[55987.]—**Zinc.**—To "R. W. J."—Surely the best zinc of commerce is sufficiently impure for battery purposes, without seeking to render it still worse. Whatever you mix with it will tend to destroy its value for using in a battery. Rolling it cold, as suggested by "Dens," is impossible. Prof. Bloxam, on the manufacture of zinc, states:—"Rolling of Zinc into Sheets.—Before the year 1812 zinc was used almost exclusively for the manufacture of brass, since it is brittle both at the ordinare temperature and at high temperatures; but it was then discovered that a temperature between 200° and 250° F. rendered it malleable and capable of being rolled into thin sheets. For this purpose, however, it is necessary that the zinc should not contain iron or lead, the former of which it acquires when re-melted in iron pots, while the lead is carried over in the distillation of the zinc, in consequence of the presence of galena (sulphuret of lead) in the ore. To prepare the zinc for rolling the ingots of spelter are remelted upon the fireclay hearth of a reverberatory furnace, which is made to slope down to a deep cavity or sump at one end, into which the melted zinc flows. Lead (specific gravity 11·4) being much heavier than zinc (specific gravity 6·9), and the two metals having very little disposition to alloy with each other, the bulk of the lead settles down to the bottom of the cavity so that the upper portion of the melted metal is comparatively free from lead. It is then ladled out and cast into ingots of convenient size for rolling, and after these have been again heated to about 250° F. by the waste heat of the furnace, they are passed between cast-iron rollers and reduced to the required degree of thinness."—JOHN E. CHASTER.

[56008.]—**Bichromate Cell.**—"Anglo-Dane" will find in time that the lead lining for battery cell, using bichromate solution, will be eaten through. As the action is not rapid, there may be instances when its employment might be advantageous. The joints must be "burnt" and not soldered, as the solution attacks solder. (See also reply to 55986.) —JOHN E. CHASTER.

[56014].—**Internal Gear Wheels.**—Alas! my friend, I do not understand you. "Pitch of large wheel is 4⅞in. with 48 teeth. Pitch of small wheel is 4¼in with 44 teeth. Length of large wheel is ¼in. bare." What can this mean? The pitch is the distance from centre to centre of tooth, measured on the pitch line. Do you mean that you are trying to get a wheel of 4⅞in. pitch to work with one of 4¼in.? I cannot think you mean that, yet I am unable to read your query any other way. For, assuming that you mean pitch diameter instead of pitch, it is clearly impossible for an internal pinion of 4¼in. diameter to gear with an internal ring of 4⅞in. If these were pitch diameters in ordinary wheels, the number of teeth would work out to $\frac{5}{16}$in. pitch, but teeth of such pitches would be cut by machine with straight flanks and rounding points. If the pitches were 4⅞ or 4¼, the following proportions would be suitable:—

Length of tooth above p. line = $\frac{5\frac{1}{2}}{15}$ths of pitch.

" " below " = $\frac{6\frac{1}{4}}{15}$hs "

Thickness of tooth = $\frac{7}{15}$ths "

The tooth flanks may be struck with rolling circles —a point in a generating circle rolling upon the pitch line forming the curves of the tooth flanks and faces—the circle never to be smaller than the radius of the smallest wheel of a set. The same circle which strikes the points of one wheel must strike the roots of the pinion which works with it, and *vice versâ*. The whole subject was fully described on pp. 99 and 143 of the ENGLISH MECHANIC, Vol. XXXVII. I trust I shall not give offence to any of my fellow subscribers in what I say; but I cannot help thinking that much disappointment and irritation would often be avoided if querists were more exact in their choice of terms and definitions. I have repeatedly seen questions put in these columns which nobody could possibly answer satisfactorily. Of course querists themselves know what they want, but in the absence of correct definition they should not be chagrined because others fail to understand their wants. If a question is deemed worth answering, it is surely worth the querist's, while to put it as clearly as words will express it.—J.H.

[56025.]—**Trueing Grindstone.**—If "Z.Y.X." reads my reply carefully, he will see that I ask no question whatever—I only state facts; but I am very much interested in his emery-wheel turning. It will sometimes happen that we require a round or hollow face to the emery wheel, and this in the ordinary way requires a diamond; suggestions are not sufficient. Will "Z. Y. X." therefore give a full explanation, sufficiently clear to enable those who are quite unacquainted with the subject to understand how the bort or carbonado (the action being more important than the name) is set?—is the turning done wet or dry—at what speed—where can the carbonado be obtained—its selection, price, &c.? I am sure the subject is of general interest. I once obtained some pieces from a china mender. I considered them only fragments of emery, as I could not get my settings to stand for turning; diamonds are far too expensive for workshop use, and a cheaper substitute would be a boon to many readers of the—E. M.

[56038.]—**Restringing Grand Piano.**—If there are no holes in the wrest pins, replace with a new set of drilled ones; they are cheap enough. It is a difficult matter to get the wire to bind tight enough on wrest pins that are not drilled. You will save time, and evidently a deal of trouble, by taking the advice now offered. If you experience any difficulty afterwards, write again, and I will help you all I possibly can in the way of writing. It requires a little practice before anyone can put a string on neatly. See that the coils of wire round wrest pins are close together; but do not let the coils overlap each other.—G. FRYER.

[56040.]—**Knocking in Gas-Engine.**—I was in same fix as you, and examined crank brasses and found no play, same at coupling of connecting-rod to piston, then the flywheel, and found it apparently tight; thinking the key might be tight sideways, I hammered it in very tightly, and that cured it. Mine is a 3½ h.p. Otto.—SAMUEL SHAW.

[56041.]—**Gun-metal.**—Alloys known as gun-metal, or by the names of their patentees, contain copper, zinc, tin, and iron—always two of those metals, very often three, and occasionally four. Most of those containing iron are, or have been, the subjects of patents I believe. I do not apprehend the difficulty of "Z. Y. X." The metals are not always "melted together," but are mixed together when in the molten state. Unquestionably some difficulty is experienced then, owing to the different temperatures of the melting points; but when copper and zinc are mixed together and called brass, those who do the mixing take special precautions not to lose any more zinc than they can help. Some alloys are very complex in their character; for instance, a maillechort, or German silver, patented many years ago, had a composition as follows: Copper 55, nickel 23, zinc 17, iron 3, and tin 2; the Chinese packfong, or white copper, has a composition of nickel 31·6, copper 10·4, iron 2·6, but it must not be assumed that these metals are put into the melting pot in the cold state and melted together. Very often, when it is desired to produce a mixture of copper, zinc, and tin, old brass would be used to give the copper and zinc, and so when it is desired to add iron, the latter would probably be melted before it was added to the molten brass. If "Z. Y. X." will look through his back volumes I have no doubt he will find descriptions of patented alloys which are quite as complex as any I have mentioned above; and if he will put some definite question, I will endeavour to give a description of the order of mixing the metals—always providing the answer is likely to be of service to my brother readers.—NUN. DOR.

[56053.]—**Singing Noises in the Head.**—What I said with regard to this query was that a person had lost it after becoming an abstainer from flesh. I see someone answered it on p. 41, and then threw some mud at me. If he can find anything wrong with any of my answers, let him criticise them at once in his most severe style. But to abuse is no argument. As far as possible, I answer questions relating to my own work, and do not rush in where my knowledge is inferior. Would that other correspondents would do likewise!—T. R. ALLINSON, L R.C.P.

[56071.]—**L. and N. W. Engines.**—Thanks; but the 6ft. 6in. are quite a different class. As there are about 80 of Ramsbottom's 6ft., it is strange you should never have heard of them. There are a few of Webb's of the same dimensions as well. W. B. P.

[56080].—**Helical Teeth.**—I trust the following will be an answer to the questions put by "Athos." Helical gear should differ in no respect from ordinary gear in regard to proportions. The teeth sections struck at right angles to their axes in any given portions will be the same as those for ordinary gear, and will be struck accordingly either by rolling circles, or by the odontograph scale. But as the teeth require to be marked out upon their ends, and as these ends are cut to the angle of the obliquity of the helix, the section at right angles would not give the correct lines for the ends. Hence the simplest practical method of getting the shape thereon, is to strike out the teeth first in the ordinary way, and to make one tooth as though for an ordinary spur wheel, and then to cut it across the end to the angle required (Fig. 1), and from the section thus produced obtain the width and the striking lines. In the case of the 60-toothed wheel of 5in. pitch which you instance, the dimensions are as follows:—The length of the tooth above pitch line is 1¾in., below pitch line 2in., the thickness on the pitch line is 2⅜in., and by using the Odontograph scale, the striking radii, and their centres come as shown by the full lines in Fig. 2. Cutting off the end of the tooth to an angle of 65°, the apparent thickness on the pitch line is increased to 2⅝in. Then, though the same radii may be employed, their centres require to be moved above and below these used for the normal section, to the positions shown by the dotted lines, and from these new centres and to the increased width the ends of the teeth are struck. Now if this wheel happened to be one of small diameter and pitch, and a pattern were to be made, the way to do so would be to cut the teeth out of the solid, the pattern being jointed in the centre. Thus if the pattern were 5in. deep, it would be jointed in two thicknesses of 2½in. each, held together by a couple of loose dowels, so that the teeth once worked could not shift around from their relative positions, and the teeth would be pitched out on the top and bottom faces and in the joint faces to the increased width, and from the new centres obtained by cutting the templet tooth to the angle of the helix. Then a slip of paper, equal in length to the circumference, and having lines equally pitched out, and corresponding with the tooth points; drawn diagonally across it to the angle of the helix—will be glued round to afford guidance for the templet (Fig. 3), which is used for working out the inter-tooth spaces. If the wheel were too large to be made of solid stuff, the rim would be built up in the usual way, and the tooth blocks fitted and glued on in the rough, and their faces turned and pitched out as before on top and bottom and in joint. But, instead of paper, a strip of thin straight steel (a clock spring for example) would be curved around the points of the teeth, and its edge would form the guide by which the lines representing the width of the teeth at the points, would be drawn across from the curves struck upon one face to those on the other. The teeth as before should be worked to these lines by templet. If the wheel is so large in diameter that the arc of the circle which is embraced by the length of the tooth, when laid at its diagonal position, shows no appreciable amount of curve, then there is no need to work the teeth in place at all, but simply to plane them up as straight teeth, and put them on at their angle. This effects a great saving of time, and may always be adopted in the case of large or of shallow wheels. In all such pattern wheels jointing is necessary through the centre, and there is little difficulty in moulding, the halves being screwed out, precisely as in the case of angle wheels, or wheels whose teeth are at an angle of 45°, the moulder simply drawing out the pattern in the direction which his sense of touch tells him is the line of least resistance of the sand. A trifle of taper of course is put in the teeth. The same remarks as to marking out with a bent steel apply to the blocks for machine-moulded wheels, but they are not jointed in the centre, because the horizontal arm of the machine is drawn backwards instead of upwards. Neither are they necessarily jointed along the central plane of the wheel in a core box, although it is better to do so for convenience of marking out and working, even if they be fastened together afterwards. But in the hands of a careful workman, the top lines are sufficient guide to the templet. Fig. 4 shows how this box is made, and is almost self-explanatory. The front side is removed to show the teeth. We have therefore ends A A, with their blocking-up angle pieces B B, sides C, one only being in place, and the tooth blocks D D jointed in two pieces at *a*, this jointing being necessary where the curve of the wheel radius is so great that the outer flanks of the extreme teeth would, by their leaning over, tear the sand up. There are five teeth shown in this box, making twelve cores for the wheel of 60 teeth. If you were to put ten teeth in the box, probably two joints would be necessitated. The bottoms of these blocks are planed flush with the ends of the pieces A, A, and rest directly on the core maker's bench without being screwed to the sides. It is not necessary that the angle ends partake of the twist of the teeth, so long as the half-tooth at one end of the box is an exact supplement of that in the opposite end. In ordinary spur gear, too, the teeth are usually jointed along one edge, to prevent the joints of the cores from showing in the casting, so that the tooth segment at one end of the box has one half the thickness plus one half the width on the point, while at the opposite end the supplementary segment has one half the width minus one half the width at the point. In the case of a helical wheel, if the tooth has much twist upon it, joint approximately down the centre; if little or none, joint at the edge, as in ordinary gear. Of course the ends A A of the box must converge exactly to the centre of the wheel; else the cores will not match, and the angles of the blocking pieces B B must match. The making of wheels in core boxes like this has become almost obsolete, except in the case of those of very large diameter, owing to the almost universal employment of the wheel moulding machines.—J. H.

FIG. 1.

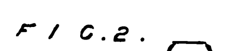


FIG. 3.

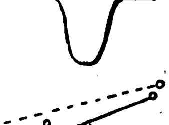


FIG. 2.

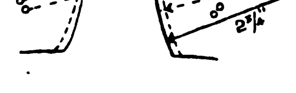
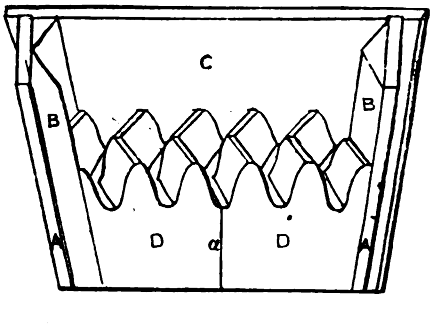


FIG. 4.



[56089.]—**Fasting and the Jews.**—The Jews do not abstain altogether from either food or drink one day a week, so that "S." will require to look somewhere else for the cause of their health and long life. Their hygienic laws are excellent; but the rite of circumcision has more to do with their immunity from disease than anything else. Passover cakes are biscuits about 8in. in diameter, but so thin that they will hardly hold together; they are made without leaven, and taste exactly like our common water biscuits.—B.Sc., Plymouth.

[56097.]—**Conics.**—Let P, Q, R be points on a parabola whose vertex is A, and latus rectum $4a$. Let $Pa$, $Qb$, $Rc$ be tangents at these points, cutting axis in $a$, $b$, $c$, and let the tangents of the angles they make with the axis be in harmonical progression. Let the tangents at Q and R cut in E, those at R and P in F, those at P and Q in G. Let PL, QM, RN be ordinates. Then $\frac{PL}{aL}, \frac{QM}{bM}, \frac{RN}{cN}$ are in H P. $\therefore \frac{aL}{PL}, \frac{bM}{QM}, \frac{cN}{RN}$ are in A P. $\therefore$ Also, since $aL = 2AL$, $bM = 2AM$ and $cN = 2AN$, we may put $\frac{2AL}{PL} = p - m$, $\frac{2AM}{QM} = p$, $\frac{2AN}{RN} = p + m$. Now, area of $\triangle EFG = \triangle aGb + \triangle bEc - \triangle aFc$. $\triangle aGb = \frac{1}{2} . Ab . \frac{PL + QM}{2}$. Since G is equidistant from diameters through P and Q. $\therefore \triangle aGb = \frac{1}{4} (AM - AL)(PL + QM) = \frac{1}{4}\left(\frac{QM^2}{4a} - \frac{PL^2}{4a}\right)(PL + QM) = \frac{1}{16a}(QM + PL)^2 (QM - PL)$ &c.

$$\therefore \triangle EFG = \frac{1}{16a}\left[(QM + PL)^2 (QM - PL) + (RN + QM)^2 (RN - QM) + (PL + RN)^2 (PL + RN)\right].$$

$$\text{But } p - m = \frac{2AL}{PL} = \frac{2 . PL^2}{PL . 4a} = \frac{PL}{2a}$$

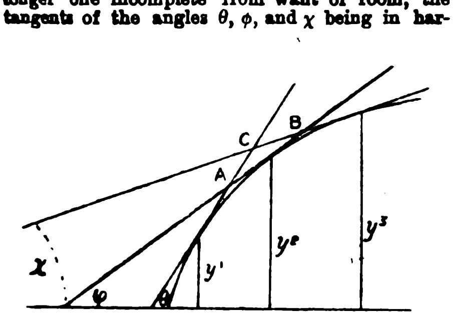
$$p = \frac{QM}{2a},\ p + m = \frac{RN}{2a}$$

$$\therefore \triangle EFG = \frac{(2a)^3}{16a}\left[(2p - m)^2 . m + (2p + m)^2 . m + (2p)^2 . (2m)\right]$$

$$= \frac{a^2 m}{2} . \left[4p^2 - 4pm + m^2 + 4p^2 + 4pm + m^2 - 8p^2\right] = a^2 m^3.$$

A result independent of the position of the points P, Q, R, provided the harmonical progression be constant. — E. J. L., 4, Clevedon-terrace, Rochester.

[56097.]—**Conics.**—The figure represents a parabola with three tangents meeting the axis, the longer one incomplete from want of room, the tangents of the angles $\theta$, $\phi$, and $\chi$ being in harmonic progression, it is required to find the area of the triangle A B C; now when three numbers are in harmonic progression, their reciprocals are in arithmetical progression, consequently the co-tangents of the three angles are in arithmetical progression. The equation to the parabola, the origin being at the vertex, is $y = \sqrt{4ax}$, $a$ being distance from vertex to focus; differentiating, we find $\frac{dy}{dx} = \sqrt{\frac{a}{x}}$ or $\frac{2a}{y}$, the latter being the simpler expression, will be used in what follows: as the diff. co-efficient at any point $x_1 y$ = the trig. tangent of the angle of inclination of the line touching the parabola at that point, we get tan. $\theta = \frac{2a}{y}$, and so on for the other two angles; then inverting the last expression we get cot. $\theta = \frac{y_1}{2a}$ we have, therefore, $\frac{y_3}{2a}$, $\frac{y_2}{2a}$, and $\frac{y_1}{2a}$ in arithmetical progression. Now suppose $b$ to be the common difference, we have $\frac{y_3}{2a}$, $\frac{y_3}{2a} - b$, $\frac{y_3}{2a} - 2b$ representing the co-tangents of $\chi$, $\phi$, and $\theta$, or calling $y_3 = c$ and inverting, we have the tangents of these angles $= \frac{2a}{c}$, $\frac{2a}{c - 2ab}$, and $\frac{2a}{c - 4ab}$ respectively, these being equated to the diff. co-efficients $\frac{2a}{y_3}$, $\frac{2a}{y_2}$, $\frac{2a}{y_1}$, we get $y_3 = c$, $y_2 = c - 2ab$, $y_1 = c - 4ab$. The general equation to the tangent to a curve is $y^1 - y = \frac{dy}{dx}(x^1 - x)$, $y^1$ and $x^1$ being the ordinates of the straight line, and $y$ and $x$ being those of the point of contact; hence our three straight lines touching the parabola will be represented by three equations of this form, and in each of the three we must substitute one of the values of the tangents found above, and also the corresponding values of the ordinates found above. We can then find the ordinates of the two points of intersection which are at the ends of the base A B of our triangle, and thus we can calculate the length of that base. We must now calculate the angles A, B, and C, referring to "Euclid," Book I. Props. xv. and xxxii., we find that $A = \theta - \phi$; $B = \phi - \chi$; $C = 180^\circ - (\theta - \chi)$. Now $\theta = \tan.^{-1} \frac{2a}{C - 4ab}$ and $\phi = \tan.^{-1} \frac{2a}{c - 2ab}$. Now in order to get sin. A, we must have recourse to a trig. formula. Let $m$ and $n$ be any two numbers, then sin. $(\tan.^{-1} m - \tan.^{-1} n) = \frac{m - n}{\sqrt{(1 + m^2)\ (1 + n^2)}}$ putting $\frac{2a}{c - 4ab}$ and $\frac{2a}{c - 2ab}$ for $m$ and $n$, we get the value of sin. A, and similarly we can get an expression for sin. B and sin. C. The formula for the area of a triangle suitable to our purpose is area $= \frac{(AB)^2}{2} \frac{\sin. A . \sin. B}{\sin. C}$, the value of A B having been found as above, and the values of the three sines being substituted in this formula, it will be found that everything cancels out, leaving only area $= a^2 b^3$, which is a very neat result after all our labour, where $b$ is the common difference between the co-tangents. Were I to re-write this paper, I would reverse the order of the co-tangents, making cot. $\theta$ the first term in the progression, and $y_1 = c$, so that $b$ would be positive; however, the result is the same.—M.I.C.E., Bath.



[56100.]—**Ox-hydrogen Lantern.**—If you will refer back to p. 15, you will there find a sketch of a bellows of oblong shape that is practically identical with the double gas-bags. The way they are made is to first get the three boards cut to size, and glued up the thickness, say ½in. Let the board for the partition through the centre be a piece of sound wood without a shake or knot of any size. And to make doubly sure, I should recommend glueing over one side a piece of calico, and well painting the calico when the glue is dry with black varnish or Brunswick black. Appearance being also an element, you will want to cut up some strips of wood ½in. by ⅜in. Having cut the mackintosh cloth to shape, and well payed the seam with rubber cement as well, commence to put together. And here the ½in. by ⅜in. strips come in. Glue the edges of the boards, and stitch the mackintosh cloth over them; then glue the outside and screw on the strips of wood, which then form a bead all round. Well rub in glue all round the joints, and when dry you will find, if you have done the work as stated, to be quite tight. Bring out the outlet for the one gas through the top board, and the one from the bottom chamber in a similar way. You will want two pieces the width of the bag, and say 2½in. by 1in. for the whole to stand on, and this allows the bottom pipe to be brought out easily enough. One set of weights on the top board gives the pressure equally on both gases. If not clear to you, I will explain any details at any time.—INVICTA.

[56104.]—**Gasoline Gas-Engine.**—There are so many minor matters involved that a sketch or two would not demonstrate all necessary. I will, therefore, refer the querist to the Blue Books of two patents—viz., No. 4,342 of 1875, and No. 1,933 of 1879. The first of these contains the simplest form of admission and exhaust valves possible, and is a thoroughly efficient one as well. The latter embodies the simplest form of firing arrangement in my opinion possible. The perusal of these two specifications will also give the querist information of a most valuable nature. And the two books can be bought for 6d. each. If you ask my opinion generally I should recommend a horizontal engine, not a vertical. As to sizes, I should, for the size you name, use a 6in. cylinder and 14in. stroke. As it is impossible for me to know what other particulars you require, I would suggest your embodying them in another query, and I will do all I can to help you.—INVICTA.

[56105.]—**Lever Fusee.**—I have often "scraped" out the turns of fusee by setting fusee in turns, and holding a properly-shaped cutter on rest, work the fusee towards you and press cutter to meet. It needs long practice to do it at all, and then it is only "scraped." I would advise "O. C. T." to send it to a watch jobber, where he will get it cut for 6d.—ANNIE.

[56106.]—**Gun-Barrel Browning.**—I think I omitted, in writing at first, to say that for twist barrels of all kinds the mixture should be put on very light; but especially in your case, where the figuring is delicate. My way is: A small quantity of mixture in a saucer, dip sponge in, then squeeze with fingers, so as to get nearly all the mixture back into the saucer, and have your sponge merely damped. Try again, and if you don't succeed, let me know, and I will give you one or two of Mr. Greener's recipes, which ("Greener on Gunnery") he says give good results. But the mixture I have given is really one of the (if not the) best. I note it is also in Mr. G.'s book, though I, and many others I presume, used it before I ever heard of the book. I must apologise to those readers of the "E. M." who are interested for my omission; but in any case it is most difficult, if not impossible, to convey to others in writing even the simplest process.—ARMOURER.

[56108.]—**Microscopic Staining.**—In addition to the address I gave last week, I might mention that aniline dyes may be obtained from Mr. Chas. Collins, 157, Great Portland-street, London, W., and from Mr. William West, 15, Horton-lane, Bradford.—G. L. M.

[56111.]—**A Legal Question.**—The board responsible for the maintenance of the roads in its district must keep these roads in repair, and the putting up of tressels in daylight to divert the traffic from a part needing repair to a part newly repaired is no obstruction. Generally speaking, without knowing more of the circumstances, I, as a lawyer, would not advise "G. C. C." to raise an action against the board in the event of an accident occurring to a carriage caused by the presence of the tressels.—B.Sc, Plymouth.

[56112.]—**Testing for Arsenic in Wall-Paper.**—The following, in answer to "J. K.," I should recommend as a test for As. A hydrogen bottle, fitted with a tube bent at right angles, and terminating in a jet, is supplied with zinc and dilute sulphuric acid, both of which should be free from arsenic. When the air has been all expelled, a light may be applied to the jet, the flame of which should not stain a surface of white porcelain brought in contact with it. This condition being fulfilled, the substance to be tested may be introduced into the hydrogen bottle, and after a short time the jet re-lighted and again tested with the white porcelain; if arsenic be present, a brilliant black metallic film will appear on the porcelain. If the delivery tube is heated to a red heat, the gas will be decomposed, and arsenic deposited as a metallic ring inside the tube behind the heated portion. This test—called Marsh's test—depends on the fact that nascent hydrogen combines with arsenic, forming therewith arseniuretted hydrogen. Should this explanation not be clear enough, I shall be happy to afford any further information.—J. KEAN.

[56118.]—**American Gas-Bags.**—See my reply more fully to "Oxygen's" query. I think the only new points you mention would be for one, the kind of cloth, or rather mackintosh. This should be a make having two or three layers of rubber between layers of linen cloth; and can be bought at any indiarubber warehouse of size. At the same shop you can buy the rubber cement for the lap-joint. The only other point, I think, is the size. For a dissolving lantern I should have the boards, say, 40in. by 30in., and the flexible sides of, say, 2ft. 3in., or 2ft. 4in. high. If any other points are not fully explained to your mind, I will reply to a query and make the same clear at any time.—INVICTA.

[56119.]—**Magnitude of Small Stars.**—From "Star Gazer's" reply, I fear my query has the fault of being misleading. What I want is a formula for ascertaining the light-grasping power of any given o.g. For example, to find the smallest star which a good 5in. o.g. ought to show: if there is such a formula, to whose magnitude scale does it apply—viz., Argelander, Sm. or H.?—H. A.

[56124.]—**L. B. and S. C. Engines.**—The following are all the dimensions I can give you of the "Terriers":—Cylinders, 15 by 20; six-coupled wheels, 3ft. 10in; weight on leaders, 8 tons 8 cwt.; on drivers, 8 tons 12 cwt.; on trailers, 8 tons 6 cwt.; total, 25 tons 6 cwt. All have the Westinghouse brake.—W. B. P.

[56124.]—**L. B. and S. C. Engines.**—The chief dimensions of the "Terriers" are:—Diameter of wheel, 3ft. 11½in.; cylinder, 13 × 20. Total wheel base, 12ft. Boiler: length, 7ft. 10in.; diameter, 3ft. 6in. Firebox (inside): length at bottom, 3ft. 5in.; at top, 3ft. 1in.; breadth at bottom, 2ft. 11in.; at top, 2ft. 9in.; height, 4ft. Firegrate area, 10·3sq. ft. 125 tubes, length, 8ft. 3¼in.; diameter outside, 1¾in. Heating surface tubes, 473; firebox, 55 sq. ft.; top of chimney from rails, 11ft. 3in.; weight in working order, 24 tons 12cwt.; capacity of tank, 500 gals.; bunker holds 10cwt. of coal. Description, and full dimensions, in *Engineer* for February 28, 1873.—B. LOCKHART.

[56126.]—**Chemical Examination, London University.**—If "Londoniensis," has not time to study for his matriculation exam., he had better postpone it. To my thinking, it is only an insult to the readers of "Ours" to ask them to assist him in "cramming."—B.Sc., Plymouth.

[56129.]—**Legal.**—(1) The money in bank in the joint names of A., B., and C. can be drawn by a majority, that is any two of the three. (2) B. is not actionable, and, consequently (3) incurs no punishment.—B.Sc., Plymouth.

[56134.]—**Taps and Dies.**—It is not practicable with a screw-plate, to cut threads that will fit without shake in holes cut by taps made from the same screw plate. A little pair of stocks and dies are what you want.—INVICTA.

[56135.]—**Value of Gas Liquor.**—Gas liquor of the usual strength—viz., 5 degrees Twaddel, contains 2·55 per cent. of ammonia, and it requires about 10½ tons, or, say, 2,300 gallons of liquor, at the above strength to make a ton of sulphate of ammonia. The present price is from 8s. to 9s. per ton (220 gallons).—STUD. INST. C.E.

[56135.]—**Gas.**—The liquor may be of any strength, to be found by using a hydrometer, known as Twaddel's. The process is very simple. For commerce it should not be less than 8oz. strength. 18lb. to 20lb. of sulphate are produced from a ton of cannel coal, or about 30gal. of liquor of 5 strength. One ton of liquor = 200gal. should yield about 1cwt. of sulphate, worth about £15 to £20 per ton. Liquor is worth now about 8d. per ounce strength per ton, that is at, say, 8° 8 × 8 = 64 = 5s. 4d.; but liquor is at present very cheap.—R. HANNEN, F.S.I.

[56136.]—**Composition of Gas-Lime.**—The following is an analysis of the above by the late Dr. Voelcker:—

*Composition of Gas-Lime (dried at* 212° *Fahr.).*

| | |
|---|---|
| Water of combination and a little organic matter | 7·24 |
| Oxides of iron and alumina, with traces of phosphoric acid | 2·40 |
| Sulphate of lime (gypsum) | 4·64 |
| Sulphite of lime | 15·19 |
| Carbonate of lime | 49 40 |
| Caustic lime | 18·23 |
| Magnesia and alkalies | 2 53 |
| Insoluble silicious matter | 0·28 |
| | 100·00 |

If the above is not what "Sulphur" requires, and he will advertise in the Address Column, I will try and assist him.—STUD. INST. C.E.

[56137.]—**Tracing Paper.**—"Jod" must be very hard to please if he cannot make a suitable tracing paper with Canada balsam and turpentine—using everything of the best. However, as he is not satisfied, let him try a solution of best beeswax in turpentine, brushing over both sides of the paper, and hanging the sheets up to dry for a few days, where they will be free from dust. Some use a solution of gum mastic in turpentine.—N. E. CHILD.

[56143.]—**Hermit Crabs.**—Hermit crabs usually feed on molluscs and most of the animal refuse of the seashore. Increase of size renders it necessary for hermit crabs to leave their old shells and seek new ones, and this may explain why yours creep out of their shells and die.—BOBADIL.

[56143.]—**Hermit Crabs.**—They are not very easy to keep. Keep them in a shallow basin with water constantly changed. I have generally found them eat small pieces of raw meat greedily; but they will not eat anything the first three or four days after they come from the sea. You will not manage to keep them in good health for many months.—R. A. R. BENNETT.

[56144.]—**Sea-Anemones.**—They are, I think, a variety of the Daisy Anemone (*Sagartia bellis*). You can find them out if you will refer to "A History of the British Sea-Anemones and Corals" ("Actinologia Britannica," by P. H. Gosse) under the head of "Daisy Anemones." As a general rule they live on the rocks, and not amongst the sand, &c. I have some in my aquarium which live in stones with a long hole in them, at the top of which the Daisy expands its disk. They are fine specimens if they are as much as 1½in. across.—R. A. R. BENNETT, Oxford.

[56146.]—**Spiral Springs.**—Yes, there is a special wire made for spiral springs in Bessemer; it should be about ·070 carbon in small sizes; but why not buy them?—you will find it the cheapest, and get a better spring. It is in the hardening where you get wrong. You will have to heat them regular, or you will not get a good spring. I should get a bit of flat iron, lay it in your fire, get it a good heat, then lay on your springs; lift iron and springs together, drop in oil. In tempering, get a bit of wire, put it through the springs, roll it about till tempered. If you cannot get them to stand your test write to me; I can supply you with them. See sixpenny sale column.—JAMES PARISH.

[56148.]—**The Thermal Unit in Relation to Time.**—This question is very like the style of Twisden's questions in theoretical mechanics, in that it contains about four queries under the disguise of one, but it does not resemble the said gentleman's questions in clearness. Take the case of carbon or sulphur, "Equivolt," and say exactly what you wish to know. At present I can only guess that you want some information about calorific powers and intensity.—WM. JOHN GREY, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[56150].—**Time Required.**—It would take a constant 12¼ft. head, or equivalent pressure, above 4ft. 2in. from top of the tank to fill it in 18 min., and the top portion of the tank would be filled in 6·84 min.—G. PINNINGTON.

[56150.]—**Time Required.**—Supposing, the 4in. supply-pipe is 100ft. long, and has a head of 5ft. It should then deliver $2356{\cdot}2 \times {\cdot}3333^2 \times$

$$\sqrt{\frac{{\cdot}3333 \times 5}{100 + 50 \times {\cdot}3333}} = 31 \text{ cubic feet per minute.}$$

The capacity of the receiver below the inlet pipe is 113 cubic feet. Then 113 ÷ 31 = 3¾ minutes required to fill this portion. The whole receiver contains 163 cubic feet, requiring 18 minutes in filling; then 18 − 3¾ = 14 minutes occupied in filling the upper 4ft. of the receiver, representing a space of 50 cubic feet. I think your receiver, under the conditions stated above, would fill in much less than 18 minutes. At any rate, you can oblige the "E. M." with the result of your experiment.—YAMA.

[56151.]—**Boring Lathe Heads.**—To "INVICTA."—I am sorry this has been overlooked by me, and tender my sincere apologies to "Uncas" for the delay. The way I should do it is as follows: First, file up and true the underside of the headstock so that it is perfectly true; this, then, gives us a base to work from. Now we must proceed next according to whether or not the castings are cored out for the spindle; if they are cast with a cored hole, it will increase our difficulties. And I will take the most difficult way as the illustration. We now fill up the hole or holes, if both ends are cast through, with a piece of the hardest wood we can find; and then, placing the headstock on the planed bed of the 2¼in. centre lathe with a scribing block we carefully find and locate the exact centre where the mandrel should run. Having marked this off on our wood plug, which should be smoothed off and well chalked to make our marks clear, we ascertain the external size of the bush in which the mandrel is to run. And having ascertained this, we strike off a circle on both sides, on the cast iron itself, and mark the circle by centre punch marks. A second circle, 1-16th or 3-32in. larger, again should be struck and centre-punched also. Now we must see what tools are available. We want a Morse twist drill, say ⅜in. diameter, and having marked off on the wood plug a ⅜in. circle, and another one a trifle larger, we fix the drill in the lathe and bore carefully through the wood plug. Previous to boring we, of course, very carefully set the work true and square on the lathe bed. Having got the first hole drilled, if we have done the work carefully, the drill will show by the larger circle that it has not run sideways at all, this being the use of the second circle. Now we bore the plug in the back centre in the same way. What we now want is a cutter bar, turned down in the front part to the exact size of the Morse drill—viz., ⅜in., and with a cutter 1-16th smaller than the finished hole, bore out the wood plug and the cast iron at the same time, the bar being carried in the wood plug in the back end of the casting serving as a guide. Next we must get either a rose-bit or a milling cutter, and, securing it to our cutter bar, take another cut through the already trued-up hole, taking it smoothly out to the full-finished size. We now bore the back centre, using the front-bored hole as a guide; and when this is got out to size our difficulties are over. Supposing the headstock is cast solid, the job is easier far, as then it means drilling a hole through both sides, so as to come exactly in the scribed lines; and the cast iron, of course, makes a far better guide bush for the bar than the hard wood plug. With care a first-rate job can be made in either way. I trust this will enable you to do what you desire.—INVICTA.

[56152.]—**Tempering Steel.**—What you should do is to first heat the tools up to a blood red, or a little more, according to the class and quality of the steel, then plunge vertically in water; you will now find (or should do) that you cannot file them. Next you temper them as follows: Brighten on the grindstone one or more faces of the tools, then hold them, if small, over a gas flame or over the coke fire, holding the thickest end next the heat, and you will see the colour come and change. You must then cool off quickly in water when the right colour shows. For turning tools for iron I use the tool dead hard or very nearly so, whilst for wood-cutting tools a full straw colour is right. You have apparently been trying to harden and temper at one operation; but this is not possible, unless you want the tools dead hard.—INVICTA.

[56155.]—**Dry Rot—Borer**—This query should not be headed "Dry Rot," as that has nothing to do with the holes bored in his furniture complained of by F. Search. They are made by insects of the genus *Ptinus*, the commonest of which in this country is the *Anobium striatum*. Benzole kills them, and cyanide of potassium is certain death to all the insect tribe; but very great care must be taken in its use, as it is one of the most virulent poisons we possess.—B.Sc., Plymouth.

[56156.]—**Chemical Action in a Chromate Cell.**—On being heated with strong sulphuric acid, potassic dichromate is decomposed with evolution of oxygen, thus—

$$\underset{295}{K_2Cr_2O_7} + \underset{392}{4H_2SO_4} = \underset{393}{Cr_2(SO_4)_3} + \underset{174}{K_2SO_4}$$
$$+ \underset{48}{3O} + \underset{72}{4H_2O} \qquad 687.$$

If the sulphuric acid be dilute and cold, there is a tendency to this reaction, which, however, does not actually occur unless some substance capable of taking up the liberated oxygen is also present. In the chromate cell the $SO_4$ of a molecule of acid combines with some zinc, forming $OZnSO_4$. The liberated hydrogen displaces the hydrogen of the next molecule, and the displaced hydrogen of that molecule turns out the hydrogen of the next one, and so on, until the carbon plate is reached. Here the hydrogen has no $H_2SO_4$ upon which to act; it therefore conspires with the acid to break up the chromate molecule, and we have the reaction—

$$\underset{295}{K_2Cr_2O_7} + \underset{392}{4H_2SO_4} + \underset{6}{3H_2} = \underset{393}{Cr_2(SO_4)_3}$$
$$+ \underset{174}{K_2SO_4} + \underset{126}{7H_2O} \qquad 693$$

The change is rendered evident by the gradual alteration of colour, from the orange red of chromium acting as an acid, to the dark purple of chromium acting as a base. The solution finally contains potassium chrome alum; but I do not think it would pay for recovery.—WM. JOHN GREY, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[56156.]—**Chemical Action in the Bichromate Battery.**—If querist can refer to p. 17, Vol. XXXVII., he will find an answer to his query. It appears that the zinc dissolves in the acid and liberates hydrogen, which reduces the potassium bichromate, thus:—$K_2Cr_2O_7 + 4H_2SO_4 + 3H_2 = K_2SO_4 + Cr_2(SO_4)_3 + 7H_2O$. Zinc sulphate, potassium sulphate, and chromium sulphate are thus formed, and the pot. and chrom. sulphates crystallise together with 24 molecules of water and form "chrome alum." The solution does not become black, but very dark green, which is the colour of the chromium sulphate formed. I don't think any practical use can be made of the used-up liquor unless the salts can be separated, which wouldn't be worth the trouble.—R. A. R. BENNETT.

[56163.]—**Mandrel.**—F. Shakespear has bent the nose of his lathe mandrel, showing that it is not hard-tempered, and he can bend it right again as I did mine last week, by the careful use of a hammer.—B.Sc., Plymouth.

[56167.]—**Developer.**—This is a very good developer, and not particularly "slow" if used correctly. You do not develop your plates long enough. You should go on not only till "the detail, &c., are fairly discernible," but till they have come out distinctly and then disappeared again. If the picture has come up very distinct, and then gradually lost itself in a kind of haze, when that plate has been through the fixing operation it will be a good one. From your saying they are "covered by a greyish mist," I should think you have a slight fog on your plates. Look out for a pinhole somewhere in your camera. Fry's plates are very good when properly managed; but I cannot help fancying that Marion's "Britannia" plates are easier for an amateur—at least, that is my experience. Try the sodic sulphite developer, and most likely all will come right. I do not see why a c.d.v. should take a shorter time than a cabinet if the developer is the same strength. If you do not succeed now, write again.—R. A. R. BENNETT.

[56167.]—**Developer for Dry Plates.**—"Jay Pea's" difficulty most likely arises from the fact of his diluted ammonia having lost its power. Remember what is called liquid ammonia is water holding the gas in solution. I was constantly troubled with the failure of developer to work properly till I gave up the common plan of mixing ammonia with a stock solution of developer. I commenced the plan of mixing the ammonia as wanted from a considerable bulk, and since then have found the developer work with much more regularity. I shall be glad to send "Jay Pea" the formula I use. A picture should, if properly exposed, be developed complete in five or six minutes. If you are a long time developing your picture, it will be little good. It will lack brilliance, and be slow printing.—A. PUMPHREY.

[56170.]—**Microscopical.**—It depends on the user. Myself I cannot see so clearly in a binocular as in a monocular. Try "Practical Microscopy," by G. Davis; "The Microscopist," by J. H. Withes; or "How to work with the Microscope," by Beale.—E. A. TINDALL.

[56170.]—**Microscopical.**—I should most strongly advise Mr. Barnett to use a single microscope for general work, and also for delicate work. A binocular is troublesome to work with, and is also very expensive. By a *single* microscope I do not mean a *simple* microscope; but a compound instrument with one tube. For beginners, I can recommend "Common Objects of the Microscope," by the Rev. J. G. Wood (Routledge and Sons), or "The Microscope," by the Hon. Mrs. Ward (Groombridge and Sons). A beginner might also read an article in the *Journal of Microscopy* for January, 1885, by Mr. Latham, on "The Microscope, and How to Use It."—Enal.

[56170.]—**Microscopical.**—H. T. Barnett is sure to get opposing opinions to his query. Microscopists may be divided into two schools—those who make microscopes, condensers, test plates, and diatoms their hobby, and who think that a month is well spent in resolving whether or not a diatom valve is sunk, or level with the surface: men of this school generally go in for binoculars. The other school are those who use the microscope as means to an end—namely, knowledge with a view to benefiting the human race, such are Pasteur, Virchow, Recklinghausen, Koch, Klein, &c., &c.: men of this school invariably use the single plain microscope; so do analysts, and also the large class of microscopists who use the instrument for trade purposes, such as brewers, calico printers, &c. I do not know of any better books in the English language than those of Carpenter or Beale; but if you can read French, you will find Ranvier's "Traitè Technique d'Histologie" very useful.—B.Sc., Plymouth.

[56171.]—**Gas-Engine.**—I would not advise a vertical engine at all. The horizontal, in my opinion, is far better. Clerk's engine is a horizontal, not vertical, one. I must, I think, draw your attention to the cost you will be involved in in patterns, &c., for making one engine, and I fear it would never pay you; in fact, commercially, it would be far cheaper to buy a second-hand engine than make one for yourself. If you decide to go on and do not mind the expense, I will do my best to help you; but you are entering on an expensive experiment. I wish to place the matter honestly before you now. If you proceed you cannot then blame me for involving you in a large outlay. Let me also know what horse-power, about, you want—not nominal, but actual. It is, of course, quite on the cards that an engine specially designed might not work perfectly satisfactorily, because other patentees would have to be kept clear of, and the way is now pretty well closed against any more successful new gas-engines without infringing previous patents.—Invicta.

[56175.] — **Books on Herbal Medicine.** — "W. M." will find Culpeper's as good as any; but as all the useful herbs now come from America, perhaps some one will tell him whether there are any books published there which will suit him. Let him read Lescher's "Elements of Pharmacy" and Squire's "Companion to the Pharmacopœia" —unless, indeed, he wants to set up as a "Herbalist." If that is his object, of course, "sorry I spoke."—N. E. Child.

[56177.]—**Earthenware.**—Try a slip composed of 4 parts of ordinary whiteware potter's ball clay and 1 part of dried ground flint under the glaze; if that presents any difficulties in the way of cracking or peeling, add a little plaster of Paris and sand.—Pottery Tech.

[56177.]—**Earthenware.**—In all the potteries I am acquainted with white clay is used for producing white earthenware, and the idea of colouring earthenware white would be treated as a joke.—B.Sc., Plymouth.

[56179.]—**Bort.**—In answer to "Carbon," I would say that "Carbon" ought to know more than I do as to the nature of bort and carbonado, seeing that carbon is the base of each. Bort is diamond gem splinters, or impure diamond; carbonado is the same material as diamond, but not crystallised. Save for, or by reason of, difficult processes, which some even doubt to this day, neither diamond gem nor bort (impure diamond) nor carbonado can be manufactured. I should say that both are Nature's products, and, practically speaking, cannot be manufactured.—Z. Y. X.

[56183.]—**Force and Motion.**—The rope with a horse pulling at each end will be strained equal to the pull of the strongest of the two horses only. With a piece of cord suspend, say, 1cwt. to a Salter's spring balance attached to a nail in the wall. The spring will represent one of the horses, the weight the other horse; the index fingers will point to 112lb., and this is the strain on the cord, spring, and the nail. Respecting steam-engines, the pressures on the piston and its cylinder cover are in equilibrium under all conditions.—Yama.

[56183.]—**Force and Motion.**—Suppose one end of the rope was fastened to a wall, and a horse pulled at the other with a force of 120lb., clearly the strain on the rope would be 120lb. If the reaction of the wall is replaced by a horse pulling at the other end with a force of the same magnitude, the effect on the rope will not be varied. Similar reasoning applies to the case of the piston and cylinder cover.—Wm. John Grey, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[56185.]—**Astro. O.G's.**—In oblique refraction light is separated into colours. Any small portion of a convex lens is a prism, so that the focussed rays are seen to have the prismatic colours, and, therefore, an image is fringed with these colours, and is also indistinct, as they are not focussed at a point; but the degree in which this takes place is independent of the focal length of the lens, and so long as the aperture is the same, the degree of colour is the same. Hence, by increasing the focal length, the edge of colour remains the same, while the image is magnified by a given eyepiece in proportion. And so the edge of colour may be reduced to a minimum, and be practically made invisible by increasing the focal length. Hall, in 1729, conceived the idea of an achromatic lens; Dollond, in 1758, brought it to perfection. This principle enabled the opticians to dispense with the great length of their telescopes. Compare a modern telescope with the 150ft. one of Hevelius's, and the old method of correction for chromatism is obvious. I do not know off-hand what size telescope Cassini used; but I venture to think this explanation will account for the object of your wonder.—E. A. Tindall.

[56186.]—**Gum for Micro. Slides.**—What is the querist's difficulty? Do the labels came off the glass again after being fastened on with the gum he uses? If so, use a gum made of gum arabic ½oz., powdered gum tragacanth ½oz., water 1½oz., acetic acid 20 drops, and they will come off no more. —R. A. R. Bennett.

[56196.]—**Gas Holder.**—Tape soaked in a mixture of boiled oil and red lead laid along the joint, and the plates riveted, is the material used now, I believe, by the principal gas-holder makers. If not to be used at once, it is better to soak in boiled oil alone, as the red lead cracks if allowed to dry. —Stud. Inst. C.E.

[56196.]—**Gas Holder.**—Tape, saturated with red lead and oil, is now generally used in the best class of work. Ordinary string was formerly used, and is now sometimes; but the tape makes the best and soundest joint.—W. M.

[56200.]—**Diamond Carat.**—The word "carat" is derived from the name of a plant, the seeds of which were used for weights. It is 3·17 grains, or ·2054 grams.—Wm. John Grey, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[56200.]—**What is a Diamond Carat?**—151½ English carats go to 1oz.—i.e., 480gr., so one carat = 3·17gr. The French carat is 3·8gr., United States 3·2gr., Dutch 3·0gr. Mr. Emanuel no doubt means "pearl grains," 600 of which go to the oz. —R. P. G.

[56201.]—**Fixing Battery Plates.**—As far as I understand your description, the battery is the shape usually employed. If so, why not use the brass screw clamps, which are made on purpose for fixing the zincs to the board, and can be obtained from any electrical dealer, such as Dale, 26, Ludgate-hill, E.C.?—R. A. R. Bennett.

[56203.]—**Chemical Affinity.**—It is quite impossible to deal with this subject within the limits of a reply; but if the Editor approves, I will send an article next month.—Wm. John Grey, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

# UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

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55669. G.N.R. Locos., 440.
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55875. Cupola Blast.—To "Invicta," 527.
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# QUERIES.

[56207.]—**Clock Repairing.**—I have an eight-day clock which stops: the clockmakers tell me it is worn out. I have looked at it, and the train seems all right, and the holes and pivots as well; the only thing I can see is the face of the pallets seem a little worn. Can any reader suggest anything I can do to make it go? I can see no reason why it should stop. I have looked through back numbers of the "E.M." and see nothing on clock mending, so perhaps a few hints may be useful to others as well as myself.—A Many Years' Subscriber.

[56208.]—**Train Indicator.**—While waiting at a suburban railway station one day, I noticed in the ticket collector's box, which was below the platform, and so placed that he had no view of the platform; an indicator with a dial marked train in on one side, and train out on the other, and a pointer moved from one to the other, according as the train went in, or went out of the station. Could any brother reader tell me how this apparatus works?—Mikros.

[56209.]—**Sunshine Recorder.**—I have seen somewhere a description of a sunshine recorder, invented, I think, by Capt. Abney. I should very much like to make one if it is not patented, and would be obliged to any fellow reader who could give instructions for making and using it. It consists of a box with a curved bottom, on which rests a piece of sensitised paper, on which the sun, shinning through a hole in the lid, traces a black line, but beyond this I know nothing about it.—Mikros.

[56210.]—**Electro-Plating.**—Will any reader inform me how to prevent the crystals forming on the cathode? I have added silver to the solution and fresh cyanide, but without effect. The crystals form on all the edges of the work, and at times some streaks of brown are seen on the work?—One in Trouble.

[56211.]—**Water Pressure.**—Will any reader give a simple rule for finding the height an ordinary fire-hose jet will throw, with a given pressure, at the same level as the jet?—Engineer.

[56212.]—**Dr. Johnson's Opinion of Mechanics.** In his Dictionary he describes a mechanic as a "low person." Can you tell me whether mechanics of the time of Dr. J. were low, according to the present derogatory signification of that term, or does the Doctor mean they were merely persons in a humble or lowly position in society?—C. H.

[56213.]—**Common Red Ware.**—To S. Ablidge. —Will you kindly oblige with the following information about common red ware? Percentage composition of red clay suitable for this ware; mesh of lawn used to sift the slip; is the clay made on a slip kiln? Are the large jowls thrown on the wheel or moulded? Are glossed goods in this class of pottery fired biscuit first, or only one fire? Are seggars used? What is usually time of firing and temperatnre at maximum for biscuit and for gloss?—Pottery Tech.

[56214.]—**Christofle.**—Could anyone tell me what is the composition of a compound metal called christcfle, and often used for imitating silver for spoons and folks, and also the proportion of silver it contains?—Wade.

[56215.]—**Nickel.**—Is it possible to deposit nickel on glass, in the same way as silver? If not, could a film of nickel be deposited on the silver film? — C. L. Tweedale.

[56216.]—**L. and S. W. Express Engines.**— According to the number and dimensions of the tubes in these engines, as given by "Meteor" in English Mechanic of 13th inst., I calculate the heating surface to be 1,001·3 square feet, and not 1,051·13 square feet as quoted by "Meteor." Will "Meteor" (letter 23944) kindly say how this discrepancy comes about?—E. M.

[56217.]—**Solar Eclipses.**—To Mr. Pearson.—I should be glad to learn your interesting method of computing eclipses, but I cannot understand all the steps of your calculation. Will you kindly show me how to find geoc. lat. and long., and also how the diagram is constructed, and what is meant by diff. of decl. and X cos. D? I am likewise puzzled with the last two steps in Element II. You see I want a good deel of instruction, more perhaps than you will find it convenient to give me. —Mx.

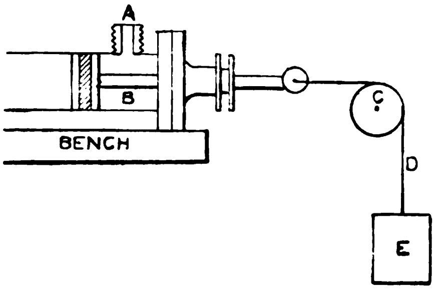
[56218.]—**Electric Clock Dials.**—I want to make a double-dialled drum, size of dials 30in., to be driven by electricity from an ordinary Graham regulator. Wanted to know—best driving action to prevent derangement of hands by wind or other external force, description and size of magnet, what battery, size and number of cells, how often to close circuit, what wheel of regulator to make contact, description of contacts; are platinum contacts necessary or desirable?—A Barbarian.

[56219.]—**Edges of Old Violin Belly Splintering.**—Could any correspondent suggest a kind of varnish or polish that would lie on and adhere, so as to prevent a silk handkerchief being caught by a splinter on the edge of the belly, when rubbing the violin over after use? The splinters are caused by old age, seasoning of the wood, and by wear and tear.—Bumstaal.

[56220.]—**Medical Coil.**—I have bought a coil much out of repair. Both primary and secondary have been taken off; on base board is a little three-way switch arrangement, the lever can be turned on to any of the three studs, but all trace of connections gone; other work all complete. Will some reader tell me how to arrange the secondary with the switch, as I suppose it has been so?—Electric

[56221.]—**Blue Shadow.**—In July, 1883, while travelling on the Rideau Canal, in Canada, the sun being so obscured by haze as to present a coppery appearance, I noticed that the shadows cast on the book I was reading were of a greenish-blue colour—about turquoise blue. The same was noticed by other passengers, so that it was not an optical illusion. Travelling on the railway every evening just after sunset, with a gaslight overhead and light also entering the car windows from the west, the same phenomenon occurs—the shadows of objects held between the gaslight and my newspaper being a decided blue. This disappears when passing through a tunnel, and also gradually diminishes as darkness approaches. I would be pleased to have an explanation.—J. Gayler.

[56222.]—**Testing Pressure Gauges, Safety-Valves, &c.**—Would some correspondent kindly tell me if I am right in the following? The cylinder in sketch is 1in. bore; the boss A on top of the cylinder is to connect to safety valves, &c., to be tested. Now suppose water were forced into the cylinder at B by a force-pump until the piston and rod were forced down, and the weight E lifted by means of the cord D running over the pulley C. Supposing the weight E was exactly 20lb., am I right in supposing the pressure in the cylinder B would be 20lb. on the circular inch, and, of course, on the gauge or safety-valve that was being tested? In the case of a safety-valve the weight might be moved along the lever just till the valve blew off; the lever might then be marked 20lb. at the place where the weight was hanging. I am aware there would be the friction of the piston and the rod, but if the apparatus was well made, that would be very slight—I should think scarcely worth taking into account. If the cylinder B was bored out 1 3-16in., would that make it equivalent to a square inch? An answer to the above questions would oblige—Jack.



[56223.]—**Grinding and Polishing Plate Glass.**—I wish to grind and polish some pieces of plate glass, 6in. by 6in. Should feel obliged if some one would describe the machines used for the purpose; I wish to work them very true.—W. J. B.

[56224.]—**Dynamo.**—To Mr. Bottone and Others.—I want to make a small dynamo to be worked by a 4 man power engine, to light 6 10-c.p. 10 volt incandescent lamps. Will you kindly give me size and weight of wire for armature and field magnets, and oblige—A Constant Reader.

[56225.]—**Spray.**—Requiring to convert a liquid colour into spray, I made an apparatus like this: Two tubes soldered on opposite sides of a tin plate, the top one having nicks in its circumference so as to send jets of air at right angles to a ring of small holes in the plate communicating with the lower tubes, so that the air jets cut across the water jets. But I found that the thing would not act; the water, so far from rising in the tubes, was depressed, and not a particle of spray produced. Why was this?—it ought to have acted.—S. R. Preece.

[56226.]—**Frame Gilding.**—Can any of our correspondents put me in the way to obtain a knowledge of gilding and burnishing for picture frames, called water gilding—this to distinguish it, I believe, from gilding in oils? Please say how frames are prepared in the white, and also frames for regilding? Is there any work published on the subject?—C. C. B.

[56227.]—**Vacuum.**—Could any of your kind readers tell me the best practical means to obtain a nearly perfect vacuum in a vessel, say 1 cubic foot? What would be the pressure outside per square inch? Also, can a vacuum be made at the front of a rigid plate so as to hold another one in front of it which will have to stand a friction of 5lb. per square inch, and if india-rubber could be used as packing between the two plates; if not, what is the best material for packing, or to make a perfect joint between the two plates?—One Who Wants to Know.

[56228.]—**Storage Batteries**—Will some kind reader of "ours" very kindly give directions for making a good simple storage battery, suitable for fairy lamps, that could be charged by six good sized granule cells? An answer to this would greatly oblige—Lux.

[56229.]—**Cholera Bacillus.**—Can any reader of "ours" shortly state, what is the scientific aspect regarding the nature of the above, at the present moment?—F. D.

[56230.]—**Submarine Light.**—Having heard that such lights are in use on the Norwegian coast, for the purpose of attracting the fish, if any of your numerous correspondents could advise me where they can be had, together with directions for use, they will confer a great benefit on fishermen? The electric light could be utilised, but is too costly and cumbrous.—Trawler.

[56231.]—**Dynamo**—To "W. H. E." and others.—I have a small Brush dynamo, A. 11in. diameter, known as a 2,000 c.p. machine, 1,200 rev., 1½ h.p., gives about 10 ampères, 60 volts. It is too small now for my use; 3 arc lamps. I should prefer to have it arranged to give from 4 to 6 volts' for experiments in electro-metallurgy. How would this do? Rewind 4 coils with 6yd. 16 wire and connect to one set of brushes for external work; the other four coils to be used with remaining set of brushes for F. M. only, to be run at 1,600?—Posel.

[56232.]—**Photographing Sunspots.**—I have made a 9in. mirror of 10ft. 9in. focus for the above purpose, and succeeded in taking several fair negatives, showing number and position of spots; but in printing on the usual sensitised paper, unless printed very deep, the delicate spots disappear during toning and fixing. Is there anything better than paper for the purpose? Can any of our astro-photo readers help?—The Optical Bricklayer.

[56233.]—**Intensity Coil.**—I am making an intensity coil, the core of which is 6in. long. I have wound with two layers of No. 16 c.c. wire for primary, and have half a pound of No. 36 s.c. wire for secondary. How many square feet of tinfoil should be used in condenser? What battery power should be used, and what length of spark may I expect?—E. H. J.

[56234.]—**Wimshurst Machine.**—A great deal has been said in "Ours" about the Wimshurst machine, its construction and the length of sparks it is capable of emitting; but nothing (at least nothing has ever caught my eye) concerning its application to the sciences. 1. I would like to know, for instance, to what extent a set of 18in. plates would be applicable to the illumination of vacuum tubes, Crookes' tubes, Plucker tubes; and whether the current generated is strong enough to vapourise metals between carbon points for spectroscopic purposes; and, in a general way, what can be done with the machine in an experimental way? 2. Should the plates be ground on the periphery, and does the efficiency of the machine in any way depend on the thickness of the glass discs; if so, what thickness corresponds to the maximum effect?—Spectrum.

[56235.]—**Medals.**—I have a silver medal. On one side there is Jesus Christ asleep in the boat and some men trying to awake him, and around it is the following inscription; Intempestate Securitas. On the other side there is St. George and the Dragon, with these words: S. Georgivs Eqvitvm Patronvs. Would any reader give me any information respecting the above?—Penwith.

[56236.]—**Boring Mill.**—To "Invicta."—Many thanks to "Invicta" for his prompt answer. What I want at present is simply an idea of your smaller machine to be driven by hand, and bolted on to the front or flange of cylinder. Is boring bar, a screw, or is the head keyed on to it? Also, I want to know how feed is applied to head (with cutters on boring bar) as the head has to travel the whole length of cylinder? Do they generally put in three cutters on head, and do all three cut at once? No. 1 to take first or roughing cut, and No. 3 the finishing cut. An early answer, with sketch, if possible, will be most acceptable to—Hombre.

[56237.]—**Cylinder.**—I have a slide-valve cylinder, 3½in. bore by 6½in. stroke. Will any reader kindly give me a section of slide valve for it, showing lap and lead of valve? The widths of ports are as follows: Steam ports, ¼in. by ⅜in.; exhaust, ½in. by ⅝in.; metal between steam ports and exhaust, 3-16in. Also, what power will it be? Any advice, concerning setting of eccentric of same, will be thankfully received.—J. Gibson.

[56238.]—**New Steam Motor.**—Will "Invicta" kindly send full particulars of his new low-pressure steam motor, with sketch and dimensions, if possible? It seems to be just what I have been looking for—a safe motor up to about ½ horse power.—Safe Steam.

[56239.]—**Filtering Acids.**—Can any reader kindly inform me, what is the best and cheapest media for filtering an acid solution through, in quantities say, of 50 gallons per 24 hours? I have tried sand on the top of cotton wool, but this soon gets filled with precipitate. It is the filtrate I am anxious to obtain, the precipitate is useless.—F. G. S.

[56240.]—**Tug.**—I have a boat 5ft. 6in. over all, 10in. inside greatest beam, and 7½in. deep from floor to deck. I wish to fit it up as a tug. What is the most powerful boiler and engine I can put in her? I am going to make them myself. Would it be well to have cog wheels on the shaft to get a greater speed? I want it for racing with other models—she has fine lines.—F. C. S.

[56241.]—**Lenses.**—To Mr. Nelson.—Perhaps our kind friend, Mr. Nelson, would tell us the size and focus of those two lenses, and their distance apart, which he recommends for making his simple and most excellent condenser (see letter 23938, page 34). Would not a disc of blue glass be an improvement, and ring stops such as are in Swift's and other expensive condensers?—E. B. F.

[56242.]—**Dynamos.**—I want some information as to the method of calculating the E.M.F. of dynamos, from their dimensions and speed of rotation?—Wm. John Grey, F.S.I., Analytical Chemist, Newcastle-on-Tyne.

[56243.]—**Fuses for Projectiles.**—To "Garrison Gunner."—Will "Garrison Gunner" kindly state what fuses are now in use in the service? In connection with the deplorable accident at Shoeburyness, we read of "base" percussion fuses, "with delayed action," to me entire novelties. When I was in the R. A., a few years ago, the fuses we used were the G. S. Pettman, and the Boxer wooden time-fuses for M. L. and B.L.R.O.; also the "E" time, and the "C" percussion for the Armstrong B. L. guns. Are these fuses still in use, and did they ever succeed in making a "concussion" fuse that they used formerly to be so hopeful about?—Ex-Garrison Gunner.

[56244.]—**Skrivanov Battery.**—Will some kind reader tell me how to construct the above battery, and the cost of making and recharging it? I suppose the chloride of silver is the most expensive part.—Accumulator.

[56245.]—**Britannia Company's Foot-Power Circular Saw.**—On page 26 it is stated that a foot-power machine will, from the impetus given to it by the foot, cut 3ft. 8in. of mahogany 1in. thick, after the power (foot of a man) has been withdrawn. Will anyone come forward and say that they have actually seen the facts stated in the above statement? It seems to me so extraordinary that I ask the question. From the drawing the saw only makes, say, fifteen revolutions for each tread, or is the perspective bad?—Z. Y. X.

[56246.]—**Legal.**—B. is in a certain business, and takes a partner, C. B. has a house, used as a private residence, and also as a place of business. He sublets this house to C., taking another house himself, both houses being taken on a lease for several years to suit the partnership. After a few months B. represents to C., that if they dissolve partnership, a much more lucrative business can be taken up by B, who promises to employ C., and take all expenses and risks caused by the change, representing that the house leases are at a premium. The business partnership being cancelled, and B. being unable to pay the rental of C.'s house (the house now being empty and unlet) how should C. proceed? If the landlord takes possession of the house, is the lease thereby cancelled? If C. is unable now to pay anything, but engages in another prosperous business, can the landlord leave the house empty and sue C. for the whole amount of rent due? How should C. proceed to save present expenses and further liabilities? The house is a London one, let on the ordinary seven, fourteen, or twenty-one years lease.—W. H. B.

[56247.]—**Photographing Engravings and Plans.**—To Mr. Lancaster and Others.—With a lens averaging one second exposure for landscaping in sunlight, what would be probable exposure for taking a negative of above? How should the engraving be placed, and should there be any variation of developer to that usual in gelatine plates? I cannot succeed after many attempts.—M. E. N.

[56248.]—**Turning Cast-Iron.**—Will any fellow reader kindly inform me the best sort of tool to use, to take the hard crust off a new lathe-cône, as I want to turn and groove it. Having not turned any before, it seems to take the edge off every tool I use?—Jim.

[56249.]—**Electric Bell.**—I wish to make a single-stroke bell, armature suspended on pivots as in general use for mining gongs, diameter of bell to be 8in., No. of cells, eight Fullers; distance over which it will have to work, 200yds. Give size of cores, quantity and gauge of wire; also as above, but for a 10in. bell, to work over 2,000yds. with 10 Fullers.—Glam.

[56250.]—**Engine Making at Home.**—Referring to page 532, Vol. XL., on Engine Making at Home, would it do for me to make every part half the size, as I find 3ft. too large? And let me know if the bedplate would do if I got it made of mahogany or boxwood, as I think a metal one is rather expensive.—Snooks.

[56251.]—**Australian Vertebrates.**—Would some reader kindly tell me if there is any work published in the British Isles on Australian Vertebrates, or is there any book on Marsupials or Australian Mammals?—Enal.

[56252.]—**Latch Opener.**—Does anybody know whether there is any patent electrical door latch opener, such that it only requires a small battery power (two or three Leclanché) and that when once opened, it may stay open, till a person comes in and shuts the door?—J. K. S.

[56253.]—**Alizarine Oil.**—Used for calico prints. I would like very well to know what would be the best thing to put into this oil for padding the prints before steaming, to improve the red and clear up the white. I believe crystals of tin is a good thing, but does not work well.—A. C. M.

[56254.]—**Netting Square Mesh.**—How can I net so as to produce square mesh?—Anxious.

[56255.]—**Arranging Engine Belting.**—I want to drive a vertical pugmill from a horizontal engine shaft. The diameter of pulley on engine is 1ft. 6in., on pugmill 3ft., with flange on lower side. What should be the distance between the two shafts, and what elevation should the engine pulley have with respect to that of the mill? In what direction should the strap run?—T. M. D.

[56256.]—**Valve Gear.**—Would some of our readers kindly explain the valve gear of a gas-engine? I am anxious to make a model, but am not quite clear about the arrangement of the valve?—A Recent Subscriber.

[56257.]—**Telescope Stand.**—Will someone kindly tell me how I can best make a steady wooden stand for a small refracting telescope, which is about 39in. long, and 2in. diameter? I want the telescope to have altitude and azimuth movements. Please give dimensions, with small sketch if possible.—Omega.

[56258.]—**Reflecting Galvanometer.**—Will someone kindly oblige me with the following details in the construction of a Sir W. Thomson's reflecting galvanometer:—1. Size of coils? 2. Best material for the reels? 3. Amount of wire for each coil? 4. Size of wire? 5. Any peculiarity in winding, insulation, &c.?—Joh.

[56259.]—**Skrivanoff's Dry Battery.**—On page 119, No. 1019, "Starlight" described this battery. I have a small incandescent lamp marked (3·1) which, I presume, means volts, to be used as a scarf pin. Will "Starlight" kindly give dimensions for making one of these batteries that would light the above lamp?—Penwith.

[56260.]—**Wicker.**—A receipt for making a coarse black dye, suitable for basket work before painting; cheapness and quick drying essential, will oblige.—Wicker.

[56261.]—**Selenite.**—I have been recommended to use selenite for hardening my water for brewing purposes. Can any of your readers inform me, what it is chemically composed of, and how many degrees of hardness it would add to my water, if used at the rate of 2lb. for every 25 barrels?—F. E.

[56262.]—**L. and N. W. Tank Engines.**—Why are Webb's double-ended 8-wheeled passenger tanks constantly being turned on the turntable like tender engines? Are not tenders dispensed with partly to avoid turning?—W. B. P.

[56263.]—**G. W. Compound Engine.**—Wanted some particulars of a compound engine, said to have been lately placed on this line? What trains is it running?—W. B. P.

[56264.]—**Mechanics.**—Will any reader kindly solve the following question? Find the horse-power of an engine which will maintain a speed of 20 miles an hour with a train weighing 50 tons, the friction being 10lb. to the ton?—Alpha.

[56265.]—**Lalande-Chaperon Battery.**—To Mr. John E. Chaster.—will you kindly give the particulars of the above? How many cells would be required to light a 20 c.p. lamp? Kindly give the dimensions also.—A Young Electrician.

[56266.]—**Problem—Rolled Iron Joist.**—Will some engineering student oblige?—What safe load, uniformly distributed, will a rolled iron joist, resting on columns, carry, of the following dimensions—viz., 10in. by 4½in., mean thickness, ⅜in.; length of bearing, 15ft.?—Vita.

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It has been found that 17,000 stops are made on the Brighton Railway per twenty-four hours, only about 10,000 of which are regular station stops.

## ANSWERS TO CORRESPONDENTS.

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*\.* *All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

### HINTS TO CORRESPONDENTS.

**1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.**

***\.* Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.**

### GOOD FRIDAY.

THE next number of the ENGLISH MECHANIC will have to go to press some hours earlier in consequence of Good Friday. All advertisements for the next issue must reach the office not later than 5 p.m. on TUESDAY next.

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The following are the initials, &c., of letters to hand up to Wednesday evening, March 25, and unacknowledged elsewhere:—

BATES, HENDY, AND CO.—Pall Mall Electrical Association.—J. Wood.—J. O. White.—Armourer.—J. A. C.—Silex S-adrift.—Student.—Rev. Geo. Bishop.—Arthur Mee.—J. J. Hammond.—C. J. R.—Porcelain.—M. A.—S. Arlidge.—Antares.—$H_2S$.—W. G. P.—E. B. F.—A London Undergraduate.—Valetta.—Jno. M.—S. E. Hunt.—Adams.—J. H.—Invicta.—Annie.

MILLER. (It is doubtful whether a work giving the information you require has been written; but if you send a stamped envelope to the publisher of the *Miller*, Mark-lane, London, E.C., he will forward a list of books which he keeps on sale at his office.)—MILLER, Sowerby Bridge. (We are under the impression that certain books are recommended in the Syllabus; but see previous answer.)—W. E. SMITH. (You would prefer "being answered by post," would you? Well, we do not answer by post, nor reply to such questions as yours, as you will see on referring to Hints Nos. 4 and 5. You will find a description of the battery named by searching the indices.)—BOMBSHELL. (By means of the theodolite, or a small telescope rigged on a stand with an indicating plate.)—B. (Yes, diamonds have been produced artificially by crystallising carbon under the influence of heat and pressure. See pp. 2, 461, Vol. XXX., Nos. 781, 800, for an account of the experiments of Mr. J. B. Hannay, of Glasgow.)—R. V. (The figure of Britannia means the English mark for silver of 11oz. 10dwt. If the "lion's head" is a leopard's head, it is the mark of the London Company, or if it is the "lion's head erased" then the article is of London make, and the metal is standard silver, and cannot be of earlier date than 8 William III. Consult Gee's "Hallmarking of Jewellery," published by Lockwood and Co.)—M. (Fixateur, bandoline, or eau collante consists of any of the vegetable mucilages with a little spirit and perfume. A quarter of an ounce of carrageen moss will make three-quarters of a pint; but if wanted to keep, add one-third of its volume of Eau de Cologne. Quince seed, gum-arabic or tragacanth, malt, and other substances yielding mucilage are used and perfumed in any suitable manner.)—M. P. (Get some white lead and mix with equal parts of turpentine and boiled oil, adding one pound of dryers to every 8lb. of white lead. You can buy the white lead already ground in oil.)—J. W. (The number sent you must have contained something about the subject. There is a diagram in last week's issue which will show you how the wires are arranged, and there is also the index, by the aid of which you can refer to descriptions which will suit you. The primary wire is connected to the secondary, which is smaller, and you can continue adding coils of finer wire, bringing out ends at each junction, so as to get different degrees of power.)—A RECENT SUBSCRIBER. (For so-called automatic or self-acting fountains, see Nos. 459, 582, 801, 967, 973, 974.)—A STUDENT. (Why not procure the Calendar? No limit to age; but how long it takes depends on ability—three years, say. See the indices of back volumes.)—A. C. K. (See p. 476, last volume, and the indices generally.)—J. E. W., Adelaide. (Forney's "Catechism of the Locomotive," published at the *Railroad Gazette* office, 73, Broadway, New York, will suit you, though, of course, it gives only American examples. Dempsey's "Locomotive Engine," published in the "Weale's Series," you will no doubt find at the booksellers in your city.)—OILINE. (See the article on butterine in No. 1030, and look through the indices generally under that head and oleomargarine.)—SUSSEX. (For the manufacture of emery-wheels, see p. 297, No. 845; but perhaps you will find something in this number to suit.)—PAGET. (Directions for making the Wimshurst Influence Machine were given with illustrations on p. 242, last volume. See also the index of Vol. XXXVI., and many replies since that was published. Full as your description is, it does not give any indication of the electrical conditions, for you do not even show the position of the "brushes"—they must touch exactly opposite sectors. The discs should be as close as possible, and should be varnished before the sectors are attached.)—SUPERSTITIOUS. (Why not ask some of the ladies, or the jewellers who sell the rings? They have nothing to do with magnetism.)—W. W. (Indiarubber dissolved in bisulphide of carbon; but for sticking to the tires most people use such cements as Prout's glue, or the special preparations sold by the dealers in cycling requisites.)—A. BROWN. (Why should it corrode? Is it corroded now? The best way will be to keep it thoroughly clean, and dry out carefully after using it.)—SCHWARTZ. (If you will say what is to be understood by "tinning," we may be able to help you. If you mean coating metals with tin, we do not think you will find a "practical treatise," but there are articles in the cyclopædias and in the back volumes.)—J. W. A. (Most likely it was not received. You do not give any idea of what sort of information you require. The details of construction would be found in the technical papers about the time of its completion; but we know of no book giving the "necessary information up to date.")—J. B. (Indiarubber can be dissolved in bisulphide of carbon.)—TINMAN. (The blades of the fan should have very little clearance, and run towards the outlet. It is impossible to say what is the matter from your sketch and description. Perhaps you expected too much.)—G. R. K. (See p. 474, No. 931; but do you think violet would be so extensively used if it were possible to make a black equally as good?)—SCOT. (A calorie is the French thermal unit—the quantity of heat required to raise one kilogramme of water one degree of the centigrade thermometer; it is equivalent to 22 British thermal units.)—JAS. DOUGLAS. (If you procure the catalogue issued by Mr. Fletcher, Museum-street, Warrington, you will see illustrations of the burners and stoves required.)—BOTANIST. (Cyclosis is a term used to denote the circulation within the cells of vegetable tissues. It is best observed, perhaps, in the leaf of Vallisneria spiralis, but can be viewed in Anacharis, Chara, Nitella, or in the common Frog-bit—all aquatic plants.)—JAMES SHAW. (See the articles on photo-mechanical printing processes, pp. 173, 194, 215, 236, last volume; p. 580, No. 961, and the indices generally.)—S. C. S. (Indiarubber stamp-making described in No. 836, p. 94. It has been frequently explained that they cannot be made without apparatus.)—E. M. L. (Egg albumen—see p. 338 last volume, and the indices, for several recipes have been given.)—W. K. (We have heard of it before. If you believe that a few skeins of black silk cured you of lumbago, we have no wish to disturb your belief. Six months seems a long time for so remarkable an "electric belt." We are unable to find the "query.")—ANXIOUS. (Carbon tracing-paper is made by melting together 6 parts of lard and 1 of beeswax, and, as the mixture cools, stirring in sufficient lampblack to give the desired colour. Apply to paper whilst still warm, using as little as possible of the mixture to obtain a good coat.)—H. HARRIS (The question has been recently answered. See p. 547 last volume, and p. 66 last week. You must pay the company a royalty for being allowed to use the instruments, and arrange with the local authorities as to the erection of the wires.)—ANXIOUS, E.B. (We do not know whether it is possible to get rid of "tubicles on the lungs." You had better consult a medical man.)—C. HENRY. (Mercator was a Danish geographer. His maps are laid down on the assumption that the earth is a plane, and have special advantages for sailors. They have straight lines to indicate latitudes and longitudes. See any cyclopædia.)—J. W. A. (You do not appreciate the position. The query is of no interest to anyone but yourself, and the answer must be a gratuitous advertisement. Any large bookseller can help you. See p. 128, No. 551, and Vol. lvi. of the Proceedings of the Institution of Civil Engineers.)—STEAM BOILER. (You can find many recipes in back volumes; but we are afraid you want too much, for such a preparation would be worth patenting. You can keep a good deal of the scale off by filtering and softening the water before pumping into the boiler. Common soda will serve your purpose as well as anything.)—NIX. (Similar queries have been inserted. There is nothing better than plaster of Paris, which will yield as fine an impression as possible, if sufficient pressure is used.)—SELF HELP. (Stoves of the kind can be seen at most ironmongers, and can be bought much cheaper than they can be made.)—W. S. (Merely discs attached to the arbors that would otherwise carry hands. 2. Weale's Series is published by Lockwood and Co., Stationers' Hall-court, E.C. Why should we give the addresses of booksellers who allow a discount?)—MEDIOUS. (Silicated carbon blocks.)—GEO. WHEELER. (No, you must burn and scrape the tar off. 2. If you look under "Terms of Subscription," you will see that the publisher does sell cases for binding, price 1s. 6d. each. It is advisable to order through a bookseller, giving him the numbers of the volumes required.)—T. B. (Messrs. Lockwood and Co., Stationers' Hall-court, E.C., publish a manual of sign-writing under the title of "Letter-painting," price 1s.; but you will find a list of all such books in Calvert's Catalogue, Great Jackson-street, Manchester.)—A SUBSCRIBER'S SISTER. (It is early in the year for an attack of hay-fever. Mr. Gordon, who has closely studied this disease, considers that the exciting cause is due to the irritation of the air-passages by the odoriferous particles arising from the *Anthoxantum odoratum* or sweet-scented vernal grass. The best remedy is a change to the seaside for a few weeks. Failing that, the use of a good respirator may be beneficial. Some patients have found relief by washing out the nose with a weak solution of quinine.)—T. W. (You are awkwardly placed; but if you can prove the facts, we should advise you to sue the advertiser in the Manchester County-court for the money paid, and for the expenses you have been put to. We can only interfere where an advertiser fails to supply goods, and not in cases where matters are in dispute.)—NE SUTOR ULTRA CREPIDAM. (The discussion to which you object was started—as many readers know—by a correspondent who is a clergyman of the Church of England, so that we think religion is in little danger. Some of your objections we share ourselves; but we do not think we are called upon to stop a controversy when it is naturally raised, as in the present instance, although, of course, it cannot be continued very long, to the exclusion of more practical matter.)

**Dr. Carter Moffat's Ammoniaphone** (Harness' Patent). This excellent invention for strengthening and improving the voice, and for curing ASTHMA, BRONCHITIS, and all pulmonary affections, of which a full description, illustrated by a sectional view of the instrument, appeared in the ENGLISH MECHANIC for Dec. 26th, has been secured by the Medical Battery Co., 205, Regent-street, London, W. Its efficacy is vouched for by the highest medical, scientific, and social authorities, and Dr. Carter Moffat attends daily at 205, Regent-street, London, W., to demonstrate its extraordinary utility. Residents at a distance should write for "The History of the Ammoniaphone," sent post free to any address. Dr. Carter Moffat's Ammoniaphone will be sent post free to any address on receipt of P.O.O. or cheque value 21s., and payable to C. B. HARNESS, The Medical Battery Co., 205, Regent-street, London, W.—[ADVT.]

## CHESS.

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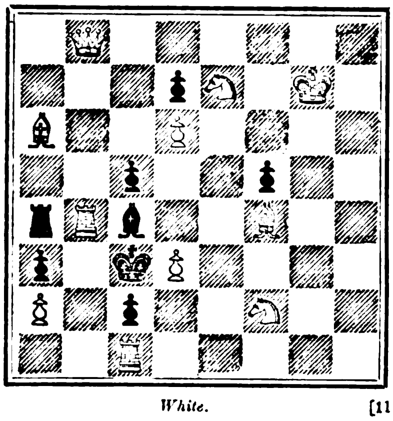
ALL Communications for this department must be addressed to J. PIERCE, Llandwrog, Carnavon.

### PROBLEM DCCCCXXXII.—By J. PIERCE.

*Black.*



*White.* [11+8

**White to play and mate in two moves.**

SOLUTION TO 930.

| *White.* | *Black.* |
|---|---|
| 1. Q-Q B 2 | 1. Anything |
| 2. Q or Kt mates. | |

(Four variations.)

The K B should be at K R 3, to avoid a second solution.

### NOTICES TO CORRESPONDENTS

CORRECT solutions to 929, by W. Brice, Penge; R. A. Bennett, E. Stanley Follwell, J. E. Piper, R. Holster Raymond, Capt. V. S. Pochin, and S. L. Chivers.

To 930 by Rev. W. Anderson (Old Romney), Raymond, Edith Hughes, R. A. Bennett, W. T. Bayne, S. L. Chivers, J. E. Piper, E. Stanley Follwell, and V. S. Pochin.

A THIRD problem received from Respice Finem.

TOURNEY games received from G. H. Mainwaring (2), J. Russell, Rev. Dr. Healy, and C. W. Last.

J. CULMER.—A dual consists in a second solution after the first move on the part of Black in any of the variations.

E. S. FOLLWELL.—There is only one solution competition for two and three movers together. Why not try at both?

EDITH HUGHES.—There is no mate in your solution of 929 if 1 $\frac{\quad}{R \times R}$.

THE first Tourney Problem will be published in the next number, and the Solution Competition will then begin; all variations which lead to different solutions must be given. Additional marks will be scored if duals or second solutions are discovered.

THE following is at present the score among the first six competitors in Correspondence Game Tourney:—

| | Won. | Lost. | Played. |
|---|---|---|---|
| Vincent | 9½ | 0 | 10 |
| Nash | 9 | 1 | 11 |
| Russell | 9½ | 1 | 11 |
| Bourn | 8½ | 2 | 12 |
| Blake | 7½ | 1 | 9 |
| Chatto | 7 | 0 | 8 |

The total number of games to be played is fifteen.

**Every Workman** connected with the Building Trades requiring a Situation should advertise in "THE BUILDING NEWS," published every FRIDAY, price Fourpence, at 332, Strand, London, W.C.

"THE BUILDING NEWS" is the Principal Journal representing Architects and Builders, and has the largest circulation of any Professional Journal in the kingdom.

Every Workman should insist on seeing "THE BUILDING NEWS" every week at his Club or Coffee House. He will find more "Lists of Tenders" for new work in it every week than in any similar paper, and can thus judge where work is likely to be had. He is also specially invited to make use of "Intercommunication" if he wants to know anything about his trade; to write to the Editor if he has any suggestions to make, and to advertise in the paper when he wants work.

The charge for Advertisements for Situations is One Shilling for Twenty-four Words, and Sixpence for every Eight Words after

## CHARGES FOR ADVERTISING.

| | s. | d. |
|---|---|---|
| Thirty Words .. .. .. .. .. .. .. | 2 | 6 |
| Every additional eight words.. .. .. .. | 0 | 6 |

Front Page Advertisements Five Shillings for the first 40 words, afterwards 3d. per line. Paragraph Advertisements One Shilling per line. No front page or paragraph advertisement inserted for less than Five Shillings. Reduced terms for series of more than 6 insertions may be ascertained on application to the Publisher.

ADVERTISEMENTS in EXCHANGE COLUMN—for

| | s. | d. |
|---|---|---|
| Twenty-four words .. .. .. .. .. .. | 0 | 3 |
| For every succeeding Eight words .. .. .. | 0 | 3 |

ADVERTISEMENTS in the SIXPENNY SALE COLUMN.

| | s. | d. |
|---|---|---|
| Sixteen words .. .. .. .. .. .. | 0 | 6 |
| For every succeeding Eight Words .. .. .. | 0 | 6 |

*\.* It must be borne in mind that no Displayed advertisements can appear in the "Sixpenny Sale Column." All advertisements must be prepaid; no reduction is made on repeated insertions; and in cases where the amount sent exceeds One Shilling, the publisher would be grateful if a P.O.O. could be sent, and not stamps. Stamps, however (preferably halfpenny stamps), may be sent where it is inconvenient to obtain P.O.O's.

The address is included as part of the advertisement, and charged for.

Advertisements must reach the office by 1 p.m. on Wednesday to insure insertion in the following Friday's number.

£6,000 IN PRIZES GIVEN TO SUBSCRIBERS!

EVERY SUBSCRIBER GETS A PRESENT.

This Offer Holds Good until MAY 16th Only.

The proprietors of the well known and popular Weekly Paper, THE GOLDEN ARGOSY, being desirous of introducing their paper into every home where it is not now taken, have decided to give away to those who subscribe before MAY 16th, 1885, £6,000 in Prizes. READ OUR GREAT OFFER:

FOR ONLY TWO SHILLINGS

We will enter your name on our subscription books and prepay THE GOLDEN ARGOSY to you regularly for Three Months (Thirteen Numbers), and send a printed numbered receipt in first copy of the paper, which will entitle the holder to one of the following MAGNIFICENT PRESENTS:

PARTIAL LIST OF PRIZES TO BE GIVEN AWAY:

| | | | | | |
|---|---|---|---|---|---|
| 5 | Cash Presents of £100 each | £500 | 20 | Gents' Solid Gold Alberts, £4 each | £80 |
| 5 | Cash Presents of £50 each | 250 | 20 | Ladies' Gold Necklets, £3 each | 60 |
| 10 | Cash Presents of £20 each | 200 | 10 | Elegant Bicycles, £17 each | 170 |
| 10 | Cash Presents of £10 each | 100 | 5 | Silver Tea Sets, £20 each | 100 |
| 10 | Cash Presents of £5 each | 50 | 50 | Gold Pens and Holders, 8s. each | 20 |
| 3 | Elegant Upright Pianos, £50 each | 150 | 500 | Extension Gold Pencils, 4s. each | 100 |
| 5 | Elegant Cabinet Organs, £20 each | 100 | 500 | Magic Lanterns, 4s. each | 100 |
| 20 | Gents' Solid Gold Watches, £8 each | 160 | 500 | Boys' Pocket Knives, 4s. each | 100 |
| 20 | Ladies' Solid Gold Watches, £5 each | 100 | 500 | Ladies' Pocket Knives, 4s. each | 100 |
| 20 | Beautiful Diamond Rings, £6 each | 120 | 1000 | Oil Pictures, 4s. each | 200 |
| 20 | Gents' Solid Silver Watches, £3 each | 60 | 500 | Solid Gold Rings, 8s. each | 200 |
| 30 | Boys' Silver Watches, £2 each | 60 | 1000 | Autograph Albums, 4s. each | 200 |

And 95,237 OTHER USEFUL AND VALUABLE PRESENTS, RANGING IN VALUE FROM ONE TO FOUR SHILLINGS EACH, making a grand total of 100,000 Presents to be given to the first one hundred thousand subscribers received. Everyone Gets a Present. All of the above Presents will be awarded in a fair and impartial manner, full particulars of which will be given hereafter.

THE GOLDEN ARGOSY Is a Weekly Paper for the Father, the Mother, the Boys and the Girls. It is one of the most Beautiful, Useful, Entertaining, Instructive and Popular Weeklies published. It is Beautifully Illustrated, and its reading matter is all Original, from the pens of noted authors. Its regular subscription price is Two Shillings for Three Months; Four Shillings for Six Months; Eight Shillings for Twelve Months, without present or premium; but in order to secure 100,000 new Subscribers, at once, we make the FOLLOWING LIBERAL OFFER:

FOR TWO SHILLINGS or 26 Stamps, we will send you The Golden Argosy, WEEKLY, for Three Months, and one numbered receipt, good for one present. For Four Shillings, or 52 stamps, we will send THE GOLDEN ARGOSY, weekly, for Six Months, and two numbered receipts, good for two presents. For Eight Shillings, P.O. or cash, we will send THE GOLDEN ARGOSY, weekly, for One Year, and four numbered receipts, good for four presents. Every Subscriber gets a receipt, and is entitled to a present for each receipt. Write your name and address plainly.

YOUR SUBSCRIPTION FREE. If you will Cut this Advertisement Out and show it to your friends, acquaintances and neighbours, and get five to subscribe for three months, and send us Ten Shillings, all at one time, we will send you your subscription Free, and One numbered receipt; get ten to subscribe, send 20s., all at one time, and we will send you Two numbered receipts and the Golden Argosy for Six Months; get twenty to subscribe for three months, send 40s., all at one time, and we will send you the Golden Argosy for One Year, and Four numbered receipts, good for Four Presents. A little work will give you a Subscription Free, and a chance to win one of the most valuable prizes. P.O.O. preferred. SAMPLE COPIES 2d. post paid, or all Newsagents.

NOTICES FROM THE PRESS.

A new candidate for the favour of patrons of periodical literature is the English edition of the "Golden Argosy," a weekly paper whose American edition has for some time past been enormously popular on the other side of the Atlantic. Its contents are interesting, wholesome, and good, without being goody, and the paper seems to have class enough to run upon its own merits. The proprietors, however, announce their intention of giving away among their subscribers, under certain conditions, prizes to the value of £6,000 sterling.—The Referee, London.

We have received the early numbers of the English edition of the "Golden Argosy," a weekly journal containing much that is interesting. The serial stories are ably written, and the paper abounds with matter of a highly entertaining description, while the illustrations, which are numerous, are characterised by refinement and finish. It is exceedingly well printed on rolled paper.—Morning Advertiser, London.

The "Golden Argosy," as a publication, has everything in its favour. It is well and clearly printed on good paper, beautifully illustrated, and not the least of its recommendations is the fact that, the literary matter is of a high order, and makes it fit to circulate in any home.—The Liverpool Weekly Albion.

The "Golded Argosy."—As the subscription is only two shillings per quarter for an excellent illustrated weekly budget of literature, it is not improbable that the number of their subscribers will soon be enormous.—The Lancaster Guardian.

We think the paper ought to become popular. There are three good reasons why it should do so, these being—it is well printed and illustrated, the subscription is only eight shillings a year, and the whole space is occupied with reading matter, there being no advertisements. Happy newspaper property, not to require them!—Whitehall Review, London.

The paper abounds with excellent stories, elevating and pure in tone, and with "funniosities" of every imaginable kind, which cannot fail to be productive of mirth and good humour.—Belfast News-Letter.

WHAT SUBSCRIBERS SAY.

"Received 'Golden Argosy' papers safely; words fail me to express my entire satisfaction of same. I anticipate at least one year's pleasant reading. Shall continue to recommend so valuable a paper, which is not only humorous and witty, but instructive.—Wishing you every success, A. TILLY, Guyde-Dome, France."

"We consider the 'Golden Argosy' a most interesting paper for both old and young, for the latter just entering life, it is invaluable, conveying as it does useful knowledge with good sound advice and high moral teaching.—E. HIBBERT, Elm Villa, New Road, Chatham."

"I enclose 2s. and mean to be a regular subscriber, and wish you success.—J. FINCH, Mold Green, Huddersfield."

"Am well pleased with the 'Golden Argosy;' it is a high class family paper, and worthy of a place in every household.—J. EVERTON, 1, Duncombe Street, Grimsby."

"I must say the 'Golden Argosy' far surpasses my most sanguine expectations, the reading is far above the average weekly journal.—J. R. SHAW, Carrickfergus."

"I enclose 2s. to extend my subscription. I can say it is the 'Golden Argosy' in value.—With best wishes, J. FENTIMAN, 15, Eldon Street, Bury."

"I enclose 6s. to extend our subscriptions. I like the paper very much, and think it very good.—E. MUSGRAVE, Sowerby."

"I am much pleased with your 'Golden Argosy,' and enclose 6s. for the remainder of the year.—C. HALFORD, Dogsthorpe Road, Peterboro'."

"I have received 10 copies of the 'Golden Argosy,' and my sons and daughters are very pleased with it. I enclose 6s. to make up a year's subscription.—Mrs. S. HOWORTH, Mirfield, Yorks."

Hundreds of Testimonials like the above received daily.

LIST OF THE AWARDS will be printed in the "Golden Argosy," and forwarded to all subscribers immediately after MAY 16th. Remit by P.O. or Registered Letter. Address—

THE GOLDEN ARGOSY CO., E. B. LEWIS, Manager, 13a, Salisbury Square, Fleet Street, London, E.C.

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**Printing Presses** from 10s., complete. Instructions to amateur printers, just published, post free 1½d.—ADAMS, Daventry.

**Photo Apparatus,** half-plate, Ross lens, a bargain. —G. V. B., 12, Hereford Gardens, W.

**Bichromate of Potash,** 6½d. per lb.—H. LOFTING, 2, Tournay-road, Walham Green, S.W.

Books.—"**How to Live on Sixpence a Day,**" Post free 3d.—LOFTING, 2, Tournay-road, Walham Green.

"**See-Saw Waltz,**" post free 1s. Also quantity of songs, &c.—LOFTING, 2, Tournay-road, Walham Green.

**Electric Bell,** Battery, Push, 20yds. Wire, carriage free 9s. 6d.—FRANKLIN.

Portable **Bell,** Battery, Push, 20yds. Wire, in stained and polished pine case, carriage free 10s. 6d.—FRANKLIN.

**Wholesale Bell and Battery Maker,** Indicators, Induction Coils, Carbons, Terminals, Wires, &c.—FRANKLIN, Volta Works, 41, Sherman-road, Reading.

**Electrical Battery Apparatus,** polished mahogany case, 8s. 6d.—HOWARD, 290, High Holborn.

52in. D. H. F. "Premier" **Bicycle,** ball bearings, nearly new, £7 10s., very cheap.—HOWARD, 290, High Holborn.

**Tricycle,** "The Merlin," ball bearings, excellent condition, cost £18, price £7 10s., bargain.—HOWARD, 290, High Holborn.

**C. Pilkington,** 32, Sackville-street, Piccadilly, W., Magic Lantern Artist and Photographic Colourist.

Magic Lantern **Photograph Colouring,** finely and artistically done, 14s. per dozen. Special terms to the trade on application.—C. PILKINGTON, 37, Sackville-street, W.

**To Bell Fitters and Others.**—Write for reduced List of Bells, Leclanche Batteries, and Materials for same.

**Bell Fitters' Sundries** supplied. All Goods guaranteed.—JOHN H. HINDLE, Irwell Vale, Helmshore, near Manchester.

Twisting, Reeding, and Fluting **Lathe.** While inventing the spiral lathe my aim has been to make it in as few parts, to lessen the friction, and make it as cheap as possible, so that it may be within the reach of every woodturner. I have done small pillars of stone, coal, and clay. Will some one make an offer for it?—Scott.

Steel **Name Stamps,** 3d. per letter. Figures (set), 2s. 4d. Letters, 6s. 4d., per post.—E. F. Baldwin, Robinswood-hill, Gloucester.

**Name Burn Brands,** 5d. per letter. Indiarubber Name Stamps, 1s. 8d. per post.—E. F. Baldwin, Robinswood-hill, Gloucester.

**Books.**—"Mechanic's Workshop Companion," 5s. 6d.; "Engineer's Machinist's Practical Assistant," 2s. 9d., per post.—E. F. Baldwin, Robinswood-hill, Gloucester.

**New Time.**—Alter your Clocks and Watches. Twelve Sets of Figures, with instructions, 6d.—Wheeler, Preston.

**Water Motors,** for sewing machines, organettes window advertisements, 32s., 42s. List one stamp.—Wheeler.

**Fan Castings.**—Improved Registered Designs; sets 5in., 3s.; 6in., 4s.; 8in., 5s. Drawings, 4d.—Wheeler, Engineer.

**Water Motors.**—Complete one horse-power, £9. Half, £6. Quarter, £4. Eighth, £3.—Thomas Wheeler, Preston.

**Incandescent Carbon Lamps,** low resistance, 3s. each; Fairy Lamps, 3s. 6d.; Platinum Lamps, 1s. 3d., post free.—Todd, 14, Wentworth-road, Manor Park, Essex.

**Incandescent Lamp Holders,** new pattern, best in the trade, 12s. dozen; sample, post free, 1s. 3d.—Todd, as above.

The **Coca Leaf Season** has commenced. The best and safest stimulant. Sample packet 13 stamps.

**Coca, or Cuca Leaves.** Taken out by many of the troops in the Soudan. Bought of Marks and Co.

Hunger Defied.—All Cyclists do, or should, carry **Coca** Leaves. Medical and Scientific opinions included with packet.

Every **Volunteer** certainly should take a packet to Brighton. Coca is a necessity, dinner is not.

The tired and weary **Pedestrian** will be resuscitated as if by magic by chewing a few leaves.

**Coca Leaves.**—Medical and scientific opinions included. Sample packet 13 stamps.—Marks and Co., 17, Newcastle-street, Farringdon-street, E.C.

**Violin,** labelled "Antonius Stradiurius Cremonensis faciebat, Anno 1650," marvellous rich tone, handsomest orchestral solo instrument in England; fine preservation; suit professional; with excellent bow, resin, and superior brass-mounted case. Sacrifice whole lot for 14s. 6d., carriage paid; supposed very valuable. Inspection invited, or send early and secure this genuine bargain.—Thomas Carr, Bandmaster (51), Brightlingsea, Essex.

**The Perfect Pea Trainers** (Patented). Send for price list to Thomson's Seed Warehouses, Horticultural Implement and Beehive Depot, 20, High-street, Birmingham.

Tudsbury and Sons' "High Tension" **Wimshurst** Machines, with their new compound ebonite plates, more powerful than glass, unbreakable. Price, 16in., 65s.; 12in., 48s.; 8in., 30s. List, one stamp.—Edwinstowe, Newark.

**Piano,** a good square for sale, £2 10s. Also a good Banjo, cheap.—Apply, first by letter, to E. Leland, jun., 19, Carlton-road, Mile End, E.

**Gelatines,** for tracing Magic Lantern Slides, 4½d. per doz.—Address, Photo, 182, Trongate, Glasgow.

Fine Astronomical **Telescope,** by Mills, 2¼ o.g., rack adjustment, two eyepieces, brass tripod, £4.—99, City-road.

Large Chemical **Spectroscope,** new, £14. Rhumkorff Coil, and five choice Vacuum Tubes, 35s.—99, City road.

Tisley's **Harmonigraph,** 63s. Elliott's Reflecting Galvanometer, £. Browning's Magnetic Exploder, £3 10s. Astro. Eyepieces.—99, City-road.

**Mesmerism.**—All can mesmerise. Success certain. Never fails. Instructions, 8 stamps.—See below.

**Thought Reading.**—Instructions which will teach anyone to become a thorough thought reader in a few hours, 8d.—Below.

**Clairvoyance,** or Second-Sight.—For 8 stamps will forward instructions which will teach anyone. All three, 13d.—G. Marquis, Allhallowgate, Ripon.

Screw-Cutting Gap **Lathe,** 3in. centre, beautifully finished, 8 guineas. Bargain.—Halls, Howard-street, Yarmouth.

**Engineer's Business** for immediate disposal as a going concern in busy part of Southwark and near the Borough; first-class plant and premises and good connection, and one or two specialities in hand.—Apply to S. S. Bromhead, 97, Newgate-street, E.C.

**Dynamos,** hand or power, lamps, &c.; low prices; bargain. Stamp.—Warne, 39, St. John-street-road, E.C.

**Lathe Heads and T Rest,** for woodturner, 30s. Launch Engines, Boilers, and Propellers.—Chennall, Eastville, Bristol.

**Bicycle,** 52in., Haynes and Jefferies' "Coventry." Excellent condition. Cash price, £3 15s.—D. Blagrove, High-street, Lewes.

**Slide-Rest** for 2½in. Lathe, in good order, cheap, 12s. 6d.—J. Brooks, West-street, Alford, Lincolnshire.

Your **Photograph Copied** equalling original, mounted on best cards. Six, 2s. Twelve, 3s.—C. W. Bickle, Stoke, Devonport.

Splendid 12in. polished Steel **Fret Frame,** 1s. 6d. free. Twenty assorted Fretwork Patterns, 7d.—C. W. Bickle, Stoke, Devonport.

Beginner's **Bicycle,** 48, "Ariel," rubber treadles, lamp, gong. Going order. Offers.—Betts, 120, Gwydir-street, Cambridge.

**Elastic Stockings** for Varicose Veins.—W. Smith and Sons, 37, Breck-road, Liverpool. None made in London.

Artistic Hand-painted **Plaques,** ½ inch, velvet frames, 7s. 6d. the pair.—Studio, 34, Denmark-road, Manchester.

**Electric Motor.**—All parts and full instructions for making a real working model, 1s. 3d., free.—Theobald.

Double **Opera Glass,** lenses, metal parts, covering, and instructions for making good glass, free, 1s. 3d.—Theobald.

**Electric Bell,** Gong, Core, Wire, and all parts, and instructions for making, free, 1s. 3d.—Theobald.

**Pantographs,** full size, for mechanically enlarging maps, plans, designs, photographs, &c., with instructions, 1s. 2d., free.—Theobald.

Leclanché, Daniell's, and Bichromate **Batteries,** 1s. 3d. each, free.—Theobald, 11, South-street, Greenwich, London, S.E.

**Cat Gut.**—Gut Hooks and Eyes for lathes and machinery.—James Bellairs, Regent-street, Leicester.

**Bellairs' Gas Stoves,** 1s. 3d., 2s. 3d., 3s. 3s., for boiling. Breakfast stoves, 8s., 11s., 14s. 6d. Send for lists.

Cookson's superior Brass **Engine Castings.** Best and cheapest in the trade, horizontal, ¾ bore, 1½ inch stroke, with guide bars, 3s.

One inch Bore, 2in. Stroke, 4s. 6d.; with guide bars, 5s.; with steam ports made, same price; boring cylinders, 6d.; ¾ do., 4d. extra.

**Engines,** Boilers, and separate parts. Send stamp for list.—S. Cookson, Rovenscliff-road, Kidsgrove, Staffordshire.

New Half-Plate Folding **Camera,** rising front, side screw adjustment, two double slides, £2.—W. Saunders, Dickleburgh, Norfolk.

**Lathe,** 5in. screw-cutting, 5ft. bed, complete, little used, £17 10s.—John Middleton, 16, Hope street, Glasgow.

**Lathe** for sale, back-geared, 5in. centres, compound slide-rest, &c.—John Middleton, 16, Hope-street, Glasgow.

The Simplified **Pentagraph.**—Will enable anyone without a knowledge of drawing to copy and enlarge photographs, pictures, or drawings. Sent free on receipt of 9d. stamps.—Phillips, Optician, 126, Chatsworth-road, Lower Clapton.

**Mandrel Drawn Tube,** brass or German silver, large or small quantities.—James Wilson, Manufacturer of Fishing-rod Mountings, &c., 63, Argyle-street, Glasgow.

**Microscope Objectives,** best quality, to be sold cheap. A 3in., 1in., 1-6th, ¼th, 1-12th water immersion.—E. S., 105, Myddleton-road, Hornsey.

**Cyanotype Paper,** 4d. per sheet, specimen free.—Humphries, Photographer, 5, Esher villas, Shadwell-road, Holloway, London.

Magnificent machine-head **Guitar,** inlaid, equal new, very handsome. Free for 9s. 6d.—Thomas Carr, Brightlingsea, Essex.

**Lathes** and separate parts, rough or finished, or with machine work done. See revised list.—W. R. Smelt.

**Turning,** Boring, Screw-cutting, Planing, Patterns, Forgings, &c. Best workmanship at reasonable prices. Estimates free.—W. R. Smelt.

**Models** of Machinery and Mechanical Movements for Inventors and Manufacturers to scale or otherwise. Estimates free.—W. R. Smelt.

Revised **Lathe List** 1 stamp.—W. R. Smelt, Engineer, 7, Goldsmith's-row, Gough-square, E.C.

Compound **Slide-Rest** and best self-centring chucks, cheap. State requirements.—John Middleton, 16, Hope-street, Glasgow.

**Edward W. Drury,** Hull, Glass Bottle and Cork Manufacturer, Importer of Chemicals, Caramel, Glucoses, Tinned Wire.

**Microscopic Glass Slides,** smooth edge, 5s. per gross.—H. Howard, 7, Chichester-terrace, Shepherd's Bush, W.

Thin covers 3s. per ounce; **Cells,** smooth edge, 14s. per gross; troughs, media, &c.—H. Howard.

**Marine Glue,** Canada Balsam, and all preparations, 6d. per bottle.—H. Howard, as above.

**Amberine.**—Recipe for the best non-alcoholic drink 1s.—H. Parkinson, 7, Chichester-terrace, Shepherd's Bush, W.

Warming, Cheering, Invigorating.—**Amberine,** the best drink. Recipe, 1s. stamps.—H. Parkinson, as above.

**Medical Coils,** very powerful, with battery, complete, carriage free, 2s. 9d. Marvels of cheapness. See below.

**Batteries,** Bichromate, 1s. each, carriage free, 1s. 3d., very powerful, for working coils, motors, &c.—See below.

**Batteries,** Daniell, 1s. each, carriage free, 1s. 3d. very useful for electroplating, &c.—See below.

**Batteries,** Leclanché, 1s. each, carriage free, 1s. 3d., sealed, constant and powerful, for electric bells.—See below.

**Electric Bells,** 7s. 6d., complete set, comprising powerful plated bell, battery, push, line wire.—See below.

**Electro-Plating Apparatus,** 2s. 6d., carriage free, 2s. 9d. Complete apparatus and instructions for amateurs.—See below.

**Toy Gas Motor,** carriage free, 1s. 9d., fit any gas burner, gives brilliant revolving light.—See below.

**Shocking Coil Parts,** 1s., carriage free, the complete set, with instructions for amateurs.—See below.

**Flying Rattle Snakes,** free, 1s. 7d., create roars of laughter and great consternation; made of rubber tissue, blow out 4ft. long, and give forth blood-curdling screams if stroked the wrong way.

**Electric Bells,** 1s., post free, 1s. 3d., all the parts and full instructions for amateurs to construct.

**New Price List,** containing all electrical sundries at really economical prices, free, one stamp.—See below.

**Covered Wire,** silk and cotton, cheapest in the trade. See list.—Economical Electric Supply Co.

For all the above articles, address—Manager, M Department, Economical Electric Supply Co., Wood Green, London.

**Formulas Worked Out** for winding Dynamos from 10 c.-p. to 500 c.-p., 8 stamps each.—H. Jones.

**Dynamo Castings,** 100 c.-p., cog armature, Gramme fields, 9s. a set. Motors with patent armature, 3s. a set.—H. Jones.

**Dynamos,** patent improvements, No. 2,122. 70 c.-p. machines, £5. 32 volts, 7 ampères.—H. Jones.

**Dynamos,** best small machines in the trade, and cheapest double-covered Wires to 20 gauge, 1s. 8d. lb.—H. Jones.

**Dynamos** for Home Lighting.—5 lights, or arc of 500 c.-p. Price £6 10s., approval. Warranted.

**Dynamo Castings,** with laminated armatures, 8 c.-p., 5s.; 16, 5s. 6d.; 20, 6s. 6d.; 30, 7s. each.—H. Jones.

**Dynamo,** laminated armatures, no heating, ventilating; 70 c.-p., 16s. a set; finished, £5. Warranted.—H. Jones.

**Dynamo Machines Repaired.** Motors, with wire, 5s. 6d.—H. Jones, 48, High-street, Lambeth, S.E.

**Universal Trade and Amateur Supply.**—Lecture requisites; light, heat, air, water, geology, engineering, chemistry, photography, &c. Wholesale and export.—Caplatzi.

Frictional and **Induction Machines,** Plates Cylinders, Stands, Conductors, Glass, Vulcanite. Hundreds of Lecture Accessories; their Parts.

**Coils.**—Experimental, Resistance, Medical, Dynamo, Bell, Telegraph, Galvanometer, and other purposes. Vacuum Tubes.

**Batteries.**—Thousands Lighting, Experimenting, Medical, Depositing. The Universal Four-cell Case, 18s. Convenient, durable, and economical.

**Coil-making.**—Sets of Parts and Instructions to size; 5, 10, 20s. The brass, woodwork, reels, wire, separate, cheap.

**Dynamos,** Arc and Glow Lamps, Electric Lanterns, Castings. 10 kinds of Motors, Leads, Armatures, Dynamometers.

**Wires.**—Cheapest Stores. New and second-hand. Great reduction in price. Paraffin, Vulcanite, Reels, Brasswork, Cores, various.

**Astronomy.**—"Society's Monthlies," number good Stands, Tubing, Clock Racks, Circles, O.G.'s, Eyepieces, Finders, Prisms; other parts.

**Transit,** 2¼in., by Cary, with circles; good 2, 2½, 3 Telescopes. Several reflectors; great variety of Terrestrials.

**Lenses,** Prisms, Specula, Object-Glasses, Eyepieces, Finders, Cells, Tubing, Racks, Hooks, Joints, Optical Glass, Tools, in quantities.

**Machinery.**—Several good Lathes, Litho, Printing, Stamping Presses, Flatting Mills, Wheel-cutting Engines, Swiss Mandrels, Wire Covering Machines.

**Model Engines** to 2 H.P. Great number of 1, 2, 3in. stroke ones; good boilers, cylinders, gauges, wheels, cocks, pumps, boats.

**Lathes.**—Overhead, Ornamental, 20; Brassfinisher's, 7; Amateur's 3in., 5; Combination, with Fret and Circular Saws, £4.

**Wheels.**—Fly, Lathe, Saw, Engine, Dynamo, Gearing, Pulley, Clock Movements, Large Springs, Bearings, Shafting, Standards, various.

**Screws and Bolts** for Machinists, Model Makers, 60 sizes. Sample 50, 1s., 2s. Screw Plates, Taps, Chasers, Stocks.

**Magic Lanterns,** Slides, Microscopes, Kaleidoscopes. Oil and Lime Burners. Retorts, Bags, Bottles, Condensers, Lamp Reflectors, Lantern Bodies.

**Photography.**—Triplet, Symmetrical, and cheap lenses, Best Stands, Printing Necessaries, double backs, 2 tons of Negatives.

**Slides.**—Superior, painted, comic and effects, Scientific, immense selection. Skilled exhibitors for town and the provinces very moderate.

**Prisms,** Nicols, right-angle, Spectroscope, Camera Lucida, Obscura, Bisulphide, Achromatising, Cylindrical Lenses, Polarising Plates, various.

**Presents.**—50 Microscopes, 100 Accessories, Objects, Cabinets, Powers, Condensers, Stands, Books, exceptionally low prices—2s.-£10.

**Chemistry.**—Fittings-up of complete Laboratories, Copper Troughs, Gasholders, Stills, Baths, Porcelain. Many Balances, Platinum, 2 thirds price.

**Purchases** and Valuations. Fair trade Value. Cash by return, or best selling market indicated. Particulars first.

**Hire.**—Occasional Lecturers and Bazaars will receive good terms, many facilities, with Apparatus of all kinds.—Caplatzi.

New Catalogue, 2d. **Caplatzi,** Science Depot, Hire and Exchange, Chenies-street, Tottenham-court-road, near British Museum.

**Launch Gas Engine.**—Enclose 3 stamps for litho and particulars. A. Dorrington, West Gorton, Manchester.

Half horse-power Horizontal **Engine Castings,** ports in cylinder, 12s. 6d. Drawing, 18 stamps.—A. Dorrington, West Gorton, Manchester.

The Amateur's **Gas Engine.** Simple and compact. Castings, 42s. Drawing, 5s. Litho, 3 stamps.—A. Dorrington, West Gorton, Manchester.

Double Cylinder **Gas Engine,** impulse twice every revolution. Castings, 90s. Litho, 3 stamps.—A. Dorrington, West Gorton, Manchester.

The Amateur's **Drilling Machine.** Castings, 3s. 9d. Forgings, 3s. Drawing, 8 stamps.—A. Dorrington, West Gorton, Manchester.

No. 2 **Drill,** self-acting feed motion. Castings, 7s. 6d. Forgings, 5s. Drawing, 18 stamps.—A. Dorrington, West Gorton, Manchester.

**Launch Engine Castings.**—2in. Cylinder, 12s. 6d., 3in., 26s.; 4in., 5 s.; 7in., 70s. Litho, 3 stamps.—A. Dorrington, West Gorton, Manchester.

3 or 4 jaw **Chuck Castings,** 3s. Forgings, 1s. 2d. Drawing, 6 stamps.—A. Dorrington, West Gorton, Manchester.

**Working Plans,** Lines, and Details of Canoes, Launches, Tugs, &c. State requirements.—A. Dorrington, West Gorton, Manchester.

Enclose Stamp for **List** of Castings and Working Drawings.—A. Dorrington, West Gorton, Manchester.

**Battery,** bichromate, highest electrical efficiency. Contains 10 per cent. more chromic acid than potash bichromate. Lee's new double Bichrome. Soluble in own weight water. 7d. 1lb., 7lb. sample parcels. 6½d. lb. in 56lb. lots.—R. A. Lee.

**Wire,** double cotton-covered, No. 8 to 18, highest conductivity. 2s. per parcels post, 1lb., free. Ditto, 18 to 22, 2s. 3d.—R. A. Lee.

Chaster's **Electro-Motor** (Registered), as described in English Mechanic, Nos. 1026, 1027, 1029, and 1041. Price £4.—R. A. Lee.

Chaster's **Electro-Motor.**—By special permit, R. A. Lee supplies carburetted annealed castings of above, 8s. 6d. set.

Chaster's **Electro-Motor,** planed, bored, and turned throughout, including wire and all materials; price £2.—R. A. Lee.

**Dynamo Machine,** 20-light, continuous working, patent disc armature, low speed, requires ½-h. to drive, £15.—R. A. Lee.

**Electro-Motors,** Batteries, Dynamos. For Lee's other electrical specialities, see advertisements last week.—R. A. Lee, 76, High Holborn, London.

## Wanted.

Old Microscopes, by Adams, Amici, Baker, Dollond, B. Martin, Pritchard (Goring's "Engiscope"), Varley, and other old makers.—J. Mayall, Junior, 224, Regent-street, London, W.

Agency Wanted, for any saleable goods, iron and brass fittings preferred. Good connections. References given.—Address, D., 222A, City-road, London, E.C.

Deer Horns Wanted.—M. Day, Hook and Handle Manufacturer, 56, Driffield-road, Old Ford, London.

Birmingham Goods.—Jewellery, Watches, Clocks, Hardware, Harmoniums, Furniture. Agents wanted. Wholesale catalogues, 500 Illustrations free.—Henry May, Merchant, Birmingham.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
*FRIDAY, APRIL* 3, 1885.

## FAC-SIMILE TELEGRAPHY.

ON p. 69, Vol. XXXIX., we gave an account of a rather remarkable system of multiplex telegraphy, then recently devised by Mr. Patrick B. Delany, of New York. In this system, which has since become widely known as the synchronous multiplex, a rotating disc is employed at each end of a single line, and the two discs rotating synchronously connect the line with one set of instruments after the other, so that a large number of messages can be sent forwards and backwards over the one line at the same time. No two transmitting instruments are practically in electric circuit with the line at any one instant, but so rapidly is the "line" taken away and brought back again, that the operator does not notice that he has temporarily been out of circuit. The system has been in practical work for some months between the cities of Boston (Mass.), and Providence (R.I.), a distance of about fifty miles—the apparatus being arranged to work from a single circuit up to seventy-two separate and distinct circuits over the one wire. Two line wires have been erected, in case of accident and for experimental purposes; but it is possible to work with six fast or twelve slow Morse operators, or with thirty-six or seventy-two printing circuits. We need scarcely say that many little difficulties were discovered in actual working, and sundry details needed attention; but the system was soon demonstrated to be a practical success, and is now placed on a commercial basis. The synchronous rotation of the discs, upon which the whole system depends, is maintained and regulated on the "tuning-fork" plan, and experience has shown that when the synchronism has been destroyed by intentional or accidental interruptions, or by breaks in the line wire, the discs at the opposite ends have automatically run into synchronism within 90 seconds without the intervention in any way of the operators at the different stations. Mr. Delany having great ideas of what can be done with this principle of synchronous telegraphy, had the second line wire erected between Boston and Providence for purposes of experiment, and it was not long before he demonstrated the possibility of applying automatic repeaters in connection with his system. Thus, the instruments being arranged for six circuits, the order was as follows: A message started at No. 1 Morse key in Boston was received by the relay at Providence and sent away on circuit No. 2, at the Boston station of which it was again received by a relay and returned to Providence, to be repeated again on No. 3 circuit, and so until it had covered 300 miles, and was finally read at the receiving instrument of No. 6 circuit in Boston. The relays are, of course, worked by local batteries, and, incredible as the results may seem, not a few skilled telegraphists would have believed it impossible to connect the receiving instrument of No. 6 circuit in Boston with the transmitting instrument of No. 1 circuit in the same city, and so compel the message to keep on going over the several circuits until some part of the apparatus failed or the batteries broke down. The original signal keeps passing from city to city without the intervention of any operator, and it was observed by timing the intervals of its return that it passed between Boston and Providence 1,800 times in one minute. The signal actually timed—a dot—was kept passing and repassing for five minutes, in which period it covered a distance of 450,000 miles. It will be understood that the greater part of that period of time was taken up by the movements of the armatures of the receiving relays and the levers of the transmitting instruments; but it is surely a remarkable experiment! Mr. Delany, however, had a far more important idea in training, and from a preliminary announcement by Prof. E. J. Houston, we imagine that Mr. Delany has succeeded in accomplishing what he aimed at, for the *Journal* of the Franklin Institute for March appears with an illustration of fac-simile messages, sketches, &c., sent by means of a crude experimental apparatus over one wire. Fac-simile telegraphy has been accomplished before, notably with Cowper's writing telegraph; but when a single wire only was employed the time was so prolonged, and the uncertainty of reproduction so great, that the system had little chance of being commercially successful. If we interpret Prof. Houston's brief announcement aright, Mr. Delany is on the high road to success, and will shortly give us a method of telegraphing handwriting, sketches, maps, plans—in fact, almost anything—with speed and, what is of perhaps of more importance, with certainty of correct reproduction, for, according to the statement published, by means of the Delany synchronous system, an area of twelve square inches can be covered in one minute. The specimen message reproduced as an engraving, by Prof. Houston, consists of a groundwork of rather coarse lines, which are thickened here and there where the current has passed, and letters, sketches, and other pictures appear in what are known as broken or rotten lines. Although these lines are comparatively so coarse, Prof. Houston ventures to express the opinion that with more carefully-prepared apparatus Mr. Delany will be able to transmit portraits and other work of the kind equal in fineness to an ordinary woodcut; he says, in fact, that he has no doubt it can be done with more carefully-prepared apparatus; but as no details of the process are at present available, it would be well to await further particulars before pronouncing an opinion one way or the other. The system has the great advantage that it is available for telegraphing in all languages, for it is as easy to produce Chinese characters as the simple Roman letters; but it is quite another thing to telegraph a portrait with all the fineness of even an ordinary woodcut, and we are afraid that it will be a long time before fac-simile telegraphing will reach that degree of perfection. As a sketch, however, no matter how crude, often conveys by a few lines much more than hundreds of words, it is evident that any really practical method of transmitting telegraph messages in fac-simile will find a wide sphere of usefulness. So much has already been done in that connection, especially in reproducing handwriting, that the early discovery of some comparatively easy method of transmitting lines and dots in absolutely accurate fac-simile may be confidently anticipated; but not a few rather more enthusiastic believers in progress firmly hold to the idea that what is known as tele-photography will be accomplished before the end of the present century. Some of our readers will no doubt remember that in Vol. XXXIII. pp. 158, 180, we gave an account of some experiments with what is called the selenium cell, which possesses the peculiar property of enormously varying its electrical resistance under the influence of light, and just as Graham Bell anticipates much in the future from the photophone, so others see in this remarkable property of selenium a possible means of transmitting photographs by telegraph. At the last meeting of the American Association for the Advancement of Science, Mr. C. E. Fritts described an improved method of making selenium cells, and hinted at, rather than suggested, their employment in several branches of electrical science. Some of these cells have been placed in the hands of Professor Grylls Adams, Dr. Werner Siemens, and Dr. G. F. Barker, and we may shortly expect to hear more about them. In the selenium cells which have been previously brought under the notice of the scientific public, the two parts of the selenium, at which the current enters and leaves the cell, have been in substantially the same electrical condition; the paths of the current and of the light have been transverse to each other, so that the two forces have partially neutralised each other in their action upon the selenium. In Mr. Fritts's form of cell we find a radical departure from former methods of employing selenium, for he uses very thin plates, and polarises them, so that the opposite faces have different electrical properties. That is done by melting the selenium upon a plate of metal with which it will form a chemical combination sufficient, at least, to cause the selenium to adhere and give a good electrical contact. To assist in effecting this object, the selenium, during the progress of melting and crystallising, is compressed between its metal plate and another plate, of steel or other substance with which it does not combine, and thus is formed a sheet of granular selenium, uniformly polarised throughout, and having its two surfaces in opposite phases as regards molecular arrangement. The non-adherent plate being removed after the selenium has cooled, the surface of the latter is covered with a transparent conductor of electricity, such as a thin film of gold leaf, platinum, or silver, and the advantage of this arrangement consists in the fact that it enables one to apply the current and the light to the selenium in the same plane or general direction, instead of transversely, so that both influences can be brought into similar action, or can be made to oppose each other, according to the effect desired. Previous to the experiments of Mr. Fritts, the most sensitive selenium cell was one made by Dr. Werner Siemens, which was about 15 times as conductive in the sunlight as in the dark; but by the new system devised by Mr. Fritts, selenium cells have been made which exhibit the extraordinary difference in resistance between light and dark expressed by the term "337·5 times," or under the joint influence of light and electricity, more than 99 per cent. of the resistance disappears temporarily. All the cells made by Mr. Fritts do not exhibit so remarkable a difference as that, but they are all vastly superior to anything hitherto achieved. He finds that to obtain these maximum results it is necessary to protect the cells from light when not in use, and to send the current in at the gold-plated face, for when the current and the light both act through the gold in conjunction, their forces are united, and every atom of the selenium being affected by the light, the full effect is obtained. The cells improve by use, but should be kept cool; and it is curious that the kind of battery employed has a remarkable effect upon the sensitiveness of the cells. For instance, cells which had their sensitiveness largely reduced when the bichromate battery is employed, became extremely sensitive with the Leclanché—a simple fact which suggests the truly scientific thought that if one battery current destroys sensitiveness, another may increase it. Hitherto Mr. Fritts has found no better battery than the Leclanché, but selenium exhibits some very peculiar properties in this respect, which will require the careful attention of the investigator. Mr. Fritts divides his cells into two classes—the L B. cell, in which the resistance becomes greater as the battery power increases—that is, "Like the Battery power," and the U.B. cell, one in which the resistance becomes greater as the strength of current decreases—that is "Unlike the

Battery power." These changes are not due to heating of the conductor or of the selenium, but appear to be caused by some peculiar property of the selenium, for the cells when first made have two states or conditions—very low and very high resistance. When very low Mr. Fritts has stimulated them by sending intermittent or alternating currents through them, and has made them become very sensitive to light; but some cells have been laid aside as intractable, because, although it was possible to stimulate them into a high degree of sensitiveness, they would not stop there, but dropped into the insensitive state. Hundreds of cells were thrown aside as worthless until Mr. Fritts became acquainted with this dual state, as he calls it; but now he expects to utilise them all for some purpose or another. The most peculiar point in this connection is the very wide range of resistance of the cells in the two states; in the low state it may be a few ohms or a few hundredths of an ohm, in the high state it is sometimes millions of ohms, and the change is effected instantly—a very interesting problem both for the electrician and the physicist. These selenium cells can be used as current generators, as they form a photo-electric dry couple or battery, but should be protected from overheating by the alum-water cell or other means. The current is then constant and of considerable E.M.F., and the cells can be arranged in series or in multiple arc as with any other battery. The current appears directly light is thrown upon the cells, and ceases as quickly when the light is shut off, the strength varying with the amount of light and the extent of surface lighted,—the intensity of the light being of no apparent importance in producing the change, though it undoubtedly has some effect on the intensity of action of the cell. It is curious, too, that the power of producing current is independent of the sensitiveness of the selenium cells to light, for, according to Mr. Fritts, some of his best current generating cells are only moderately sensitive to light, and some of the most sensitive will generate scarcely any current at all; but it is remarkable that the cells exhibit a constant resistance in sunlight for months, allowing for differences in temperature, &c. The sensitiveness to light is increased by what is called "proper usage," and that is shown not by a lowered resistance under the influence of light, but by an increased resistance in the dark. "Proper usage," however, is, in this connection, an undefined phrase, for so little is really known about these selenium cells that even Mr. Fritts himself cannot undertake to explain all the phenomena he has witnessed. He has, however, drawn attention in a very practical way to the amazing peculiarities of selenium cells, and has set on foot investigations which may prove extraordinarily prolific in inventions, for we have said enough to show that here we have a practically unworked field of investigation, which, in one direction, promises to yield all we need towards perfecting a system of fac-simile telegraphy.

## IMPROVEMENTS IN THE MANUFACTURE OF SODIUM.

ONE of the latest, if not the last, of the patents taken out by Mr. Sidney Gilchrist Thomas —whose untimely death was recently announced —was in connection with the manufacture of sodium, and, like all his inventions, it is of a promising nature. The reduction of sodium from carbonate of soda is at present effected by heating the latter with carbon in small wrought-iron retorts heated externally. These retorts are very rapidly destroyed, and their renewal is very costly, while the heating of the mixture is inefficient. Instead of these externally-heated retorts, Mr. Thomas placed the mixture of carbonate of soda and carbon in a retort or tube which may be of wrought or even cast-iron, lined with a thick lining of highly-fired magnesia or lime, or fritted dolomite, or other refractory material unacted upon by sodium, such as carbon or graphite. Instead of firing these retorts externally, he heated the mixture by passing into the interior of the tube reducing gases free, or as free as possible, from oxygen or carbonic acid, water-gas prepared from coke being preferred. These gases are first heated to a very high temperature by passing through regenerative stoves, preferably of firebrick, such as those of Siemens or Cowper, but on a small scale, which have been intensely heated by burning in them water gas or other gases. A sufficient number and area of regenerative chambers is provided to enable a steady temperature to be maintained by their alternate use. In this way the reduction of the sodium is more completely effected, and the cost of the retorts very greatly reduced. The operation may be rendered almost continuous by constantly introducing fresh quantities of sodic carbonate and carbon into the retort by means of a closed hopper. The tubes or retorts are, of course, of much larger diameter than those now employed. The reducing gases, which will consist chiefly of hydrogen or carbonic oxide, are subjected, after passing through the retorts, to rapid cooling, by passing through an artificially-cooled condensing chamber, which may be cooled by the circulation of water in pipes or otherwise, and the sodium vapour which is carried over is there condensed. The gases must be either forced through the retorts by pressure or by an exhaust. Potassium may obviously be manufactured in a similar way.

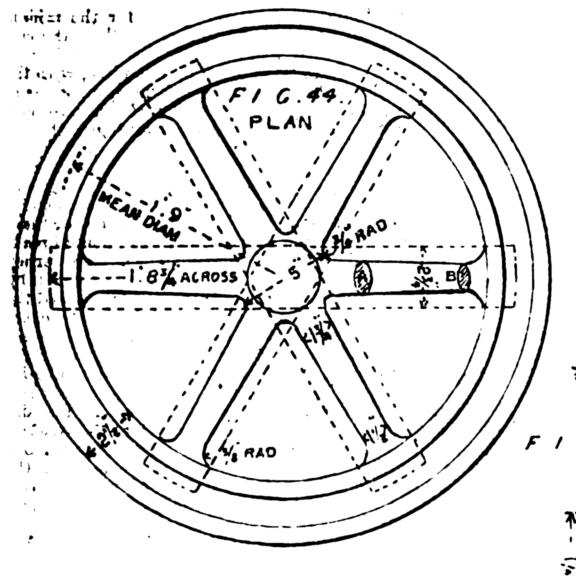
## RECENT IMPROVEMENTS IN ELECTRIC BATTERIES.

AMONGST recent patents connected with batteries, it is noticeable that the "improvements" consist mostly in the arrangements of the elements, though in a few cases new or hitherto unused substances are employed, either as excitants or electrodes. We have made a few notes on these, and taking them in numerical order, we first notice an improved "primo-secondary battery" (1100) by G. G. André. In this the negative element consists of a wooden core with a bottom flange, on which is wrapped lead, either in sheet or wire. That is surrounded by highly-burnt coke, in the granular form, mixed with peroxide of lead, and the whole inclosed in a porous envelope, such as two thicknesses of canvas, which may be nitrated to make it acid-proof. The positive element is either zinc, iron, or lead. The idea is that when the peroxide has been reduced to protoxide, the negative elements can be removed, taken to the charging-station, and there have the protoxide reconverted into peroxide by the current from a dynamo. The exciting liquid may also be taken to the station, when a sufficient quantity has been obtained, and have the zinc it holds in solution deposited by the same charging current. The improvements patented by Mr. Lyte (1278) also refer to a lead cell. At the bottom of a glass jar he places a box of sheet lead or antimonial lead about one inch in depth, and containing peroxide of lead. This is the negative element. To this box is attached a thick wire of lead, insulated from the positive element by means of an indiarubber or guttapercha tube, and extending from the box (to the exterior of which it is fastened) nearly to the top of the jar. The positive element consists of a thick zinc wire coiled in the form of a flat spiral. The positive element passes up through a cover with which the jar is provided, being enveloped where it passes through the cover with a short length of indiarubber tubing for insulation, and provided with a terminal above the cover. A wire from the negative element also passes through a hole in the cover and forms the other terminal.

Mr. Tribe (2078) patents the use of nitro-cellulose in the construction of containers, receptacles, frames or supports, for the active elements of batteries. Messrs. Lundy and Bottomley (2234) patent the use of chlorides of magnesium and manganese as excitants. The chlorides hitherto employed — ammonium, potassium, silver, sodium, and zinc—act prejudicially on the electrodes and other parts of the battery; but owing to the deliquescent properties of the chlorides of magnesium and manganese, they can be employed as excitants with beneficial results. Another feature of this invention consists in using either chloride of magnesium or chloride of manganese, or both, in combination with each other, or with chloride of zinc in solution, or in combination with any other compatible chloride or chlorides; or in solution with any compatible salt or salts, such as sulphate of sodium, sulphate of magnesium, or sulphate of potassium.

Improvements in the construction and working appliances of batteries have been patented by Mr. Emmens and the United Patents Corporation (2750), and consist of the employment preferably of cells of a rectangular form, in each of which is placed one or more porous pots, resting either on the bottom of the cell or on one or more chocks, so as to admit of free circulation of the outer fluid. The porous pots are covered by lids with sides sufficiently deep to form a water seal in the outer fluid when the cell is charged, and thus they prevent the escape of noxious fumes when a fume-emitting-dehydrogenising fluid is used in the porous pots. The inventors furthermore provide the lids with discharge tubes or nozzles for causing the fumes to pass off in any required direction. The tops of the lids are extended lengthwise so as to rest in notches made in the sides of the containing cells. The negative electrodes consist of plates of carbon or other suitable material, and they or their poles are carried through the lids. The positive electrodes consist of plates of zinc or other suitable material, and are provided with hooks or clips which hang on strips of metal affixed to the sides of the lids, and in electrical connection with each other. The positive terminals are made in the shape of small cups, which are partly filled with mercury or amalgam, and the connections between the different cells of a battery are effected by means of spring clips of brass attached to copper strips carrying a projecting stud at the other end, the clips being pressed down over the hooks of the positive electrodes, and the stud dipping into the cups of the positive terminals. Excellent contact is thus secured, and can be made or broken without the trouble of screwing and unscrewing nuts.

The next is one that has already been briefly noticed, and is entitled a "new electric couple" by the patentee, Dr. Prizbram (3,770). In an impermeable vessel, such as a glass jar, he places two cells concentrically one within the other. These cells are to be made of a material which is little liable to corrosion by acids or alkalies, and is possessed of a restrained permeability. There are thus two outer ring-shaped chambers and an inner or central cylindrical chamber. The outermost ring chamber contains an alkaline solution of any desired density or concentration, and also the electrode or electrodes, by the immersion of which electricity is generated—preferably a plate of zinc conveniently bent to fit the chamber, and carrying the negative terminal. The intermediate annular chamber is filled with water, which may be slightly acidulated, or a small quantity of alkaline solution (soda or potash) may be added to the same: but these additions are not indispensable. The central cylindrical chamber contains nitric acid, or any other compound which is rich in oxygen and easily parts with a part thereof, and the other electrode destined to gather the electricity generated; it is preferably made of carbon, and carries the positive terminal. Thermo-electric piles do not appear to attract much attention from patentees, for we have been able to find one only, and that from Vienna. It has been patented on behalf of Messrs. Lautemack, Kolm, and Laske (4158), and consists in giving to the electrodes a well-insulated core of elastic metal, which may either be the negative electrode or a neutral metal. Graphite is used preferably, to form the insulating layer, but clay, porcelain, glass, or asbestos may be used. If the core is the negative electrode, it runs through the whole length of the positive metal, and has a pole wire cast on one end, while the other end of both metals carries a piece of neutral plate, which is to be heated. If the core is formed of a neutral metal it may be wholly inclosed in the positive electrode, and the negative electrode will then act as heat receiver. We are afraid there is not much to hope for from the thermo-electric piles. In an improved secondary battery, patented by E. Jones (6068) each electrode in a pair is a counterpart of the other, and each is formed entirely of metallic lead so disposed as to present a very large extent of surface to the action of the exciting fluid in the battery. This large surface of metallic lead is obtained by forming the electrode with a number of strips, ribbons, or wires of metallic lead, arranged in rows and in-



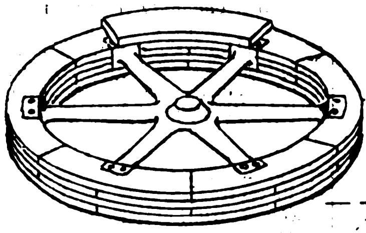


FIG. 42.

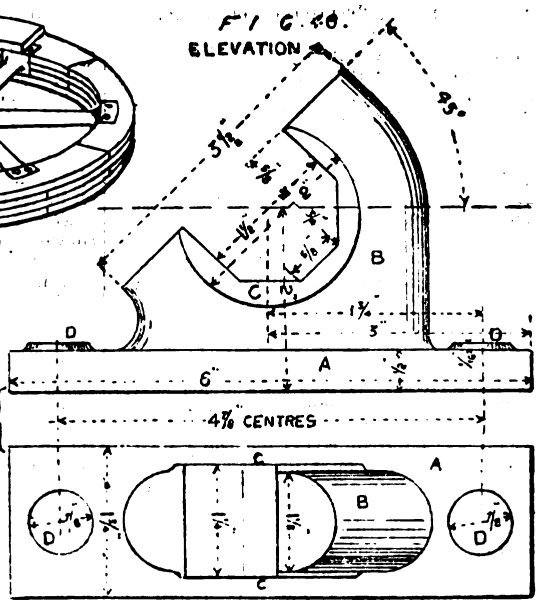


FIG. 46.

SECTION A.B.

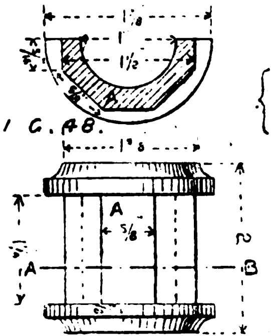
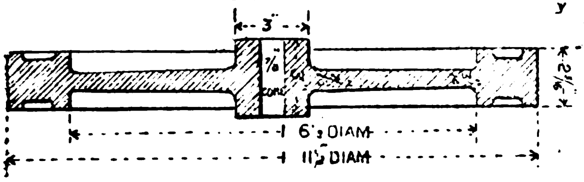


FIG. 48.

FIG. 41. SECTION



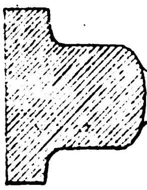


FIG. 45.

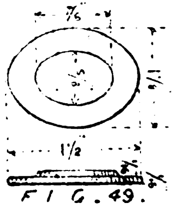
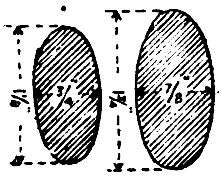
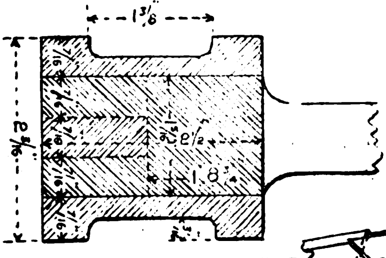


FIG. 49.

FIG. 44.



ENLARGED SECTION B. ENLARGED SECTION A.



ENLARGED SECTION OF BUILT UP RING WITH CORE

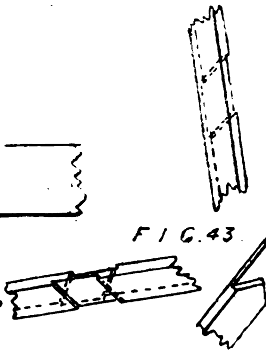


FIG. 43.

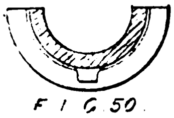


FIG. 50.

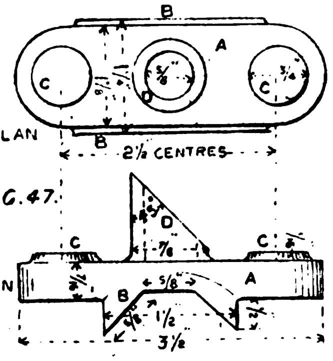


FIG. 47.

tegrally united with a base or wall of similar material, and preferably at right angles thereto. The two electrodes for every pair have their projecting strips, ribbons, or wires, so arranged that when in their proper relative position, the bases or walls will be opposite and parallel, the one with the other, and the rows of strips, ribbons, or wires projecting from one plate or base will interlock or alternate with those on the other plate or base, and will leave room for the insertion between them of insulating plates of glass or other suitable material.

C. Baudel patents improvements in batteries, in which the circulation of the exciting liquid is the chief feature. The battery is composed of any number of superposed elements of, say, zinc and carbon, separated by indiarubber of sufficient thickness to form a kind of chamber containing the exciting liquid. The latter flows into the outer vessel by gravity, and passing upwards through each "chamber" by means of holes in the plates, is drawn off at the top. The arrangement constitutes the invention (12374). In another patent (14476) the novelty consists in the employment of the different materials. It is the invention of J. Cerfaux, of Brussels. The materials are said to form a new combination: they are mercury, sulphate of copper, peroxide of manganese in grains, sulphate of zinc, peroxide of manganese, granulated and in powder, with crushed carbon from retorts, the whole covered with a layer of lead. Another part of the novelty of the invention also consists in the employment of a long lead wire inside the porous pot, formed into a spiral at the bottom of the pot, and successively traversing all the above-named materials downwards and upwards. This lead wire thus forms two rods stopping level with the porous pot, and it holds "magnetically" the different materials contained in the porous pot. So far as our search has extended through the patents of 1884, we cannot say that we have found anything very promising in the way of new batteries.

## ENGINE-MAKING AT HOME.—IV.

### The Flywheel and Bearings.

I ALLUDED in my first article to the difficulty of setting out a small engine by the rules applicable to those of larger dimensions apart from the assistance to be derived from the trained eye accustomed to note and apportion due relations of parts. The flywheel now furnishes a case in point. If we take one of the best-known rules for the weight of a flywheel rim, viz.:—

$$W = \frac{P S}{45 D}$$

Where—

W = weight of rim in cwts.
D = mean diameter of rim in feet.
P = total average pressure on piston in lbs.
S = stroke in feet

We shall find that our rim comes out at 1ft. 9in. mean diameter and 33·8lb. average pressure:—

$$\frac{33 \cdot 8 \times 8 \cdot 2 \ (= \text{piston area}) \times \cdot 502 = \text{stroke}}{45 \times 1 \cdot 75} = 201\text{lb.}$$

While with an average pressure of 48·3lb. we get—

$$\frac{48 \cdot 3 \times 8 \cdot 2 \times \cdot 502}{45 \times 1 \cdot 75} = 280\text{lb.}$$

These are excessive weights for so small an engine. Further, this rule takes no account of the rate of piston speed, which should have an important bearing on our conclusions, since a slow-running engine would require a greater reserve of power than a quick-running one; neither does it take account of the work to be done, whether intermittent or otherwise, really the most important consideration of all.* And if we take another rule which does embody the rate of speed:

$$W = \frac{\cdot 6366 \, P S C}{D} \left( \frac{N}{60} \right)$$

where—

P = pressure on piston in tons.
S = stroke of engine in feet.
D = mean diameter of rim in feet.
N = number of revolutions per minute.
C = constant = four for ordinary engines.
W = weight of flywheel rim in tons.

And assume a piston speed of 220ft., or = 10 revs. per minute, and a pressure as before o 33·8lb., we get 340·9lb. in our rim.

Under these circumstances the best way is to consider what kind of work the engine will be required to perform, and to proportion the wheel accordingly. I have drawn a wheel, Fig. 41, which I consider of good proportions for an engine doing variable work. The weight of its rim is 84¼lb. Arms and boss bring the weight of the casting up to 102lb.; but the weight of the rim alone is taken into account, since the arms do not materially influence the momentum. In a very light engine the weight might be reduced with advantage, either by diminishing the diameter to 16in. or 18in., and maintaining the same section, or by retaining the diameter, and reducing the metal. For driving purposes the width of the rim might be increased on the outer face, the inner metal being lessened, as shown Fig. 45.

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* The mechanical energy stored up in a flywheel can be properly calculated only in relation to the precise nature of the work of the engine. The amount of work produced by a single half-stroke is estimated, together with the limits of variation in the quantities of power absorbed by the machinery driven thereby, and the weight of the flywheel is so calculated that its *vis viva* shall equalise those variations, so that the factors necessary for an exact estimate are the piston speed, the average pressure, the stroke, the variation from the mean velocity, the force of gravity, and the friction of the axle. The power stored up in the rim is made to exceed that which is given out by one half-stroke of the engine by from three or four to six times, according to circumstances. For a clear statement of the theory of the flywheel, together with formula based thereon, and appropriate examples in calculation, see Baker's "Mathematical Theory of the Steam Engine," published by Crosby Lockwood, pp. 37—41, in the 7th edition.

This is a small fly-wheel, hence no moulder would care about the trouble of making it in cores—the method adopted in large fly-wheels, neither should we like to see so small a wheel with wrought-iron arms. So we go in for a pattern, and decide on arms having an oval section, as being more elegant in appearance than those of rectangular form.

There is no way of making a pattern of this kind strong enough for moulder's usage, except by building it up in segments, Fig. 42. The ends of these segments are plumb one over the other in their alternate layers like the joints in masonry, and a ring built up thus is stronger than if made in any other way. The greater the number of thicknesses used in building up, the stronger the pattern, but the courses need not all be of the same thickness, so that their number and thickness may depend upon what stuff we happen to have by us. If we have to buy, we shall purchase stuff that will plane up to $\frac{7}{16}$in. thick; $\frac{1}{2}$in. board will do this, if a thick board be selected. This will make a strong ring in five courses.

But, again, if we make the arms simply to drop within the ring, we have a very weak mode of attachment indeed, and short grain besides in the hollows. Hence we determine to fit the arms to some little distance into the rim. This must be done, however, while the rim is yet partly built up, so that we want to determine on a certain thickness of stuff out of which the hollows are to be cut, such thickness to bear reference to the segmental thicknesses. If we have, as we suppose, five sets of segments—these divided between $2\frac{3}{16}$in. thickness will finish to $\frac{7}{16}$in.—then we settle that our arm stuff shall be $\frac{7}{16}$in. × 3 = $1\frac{6}{16}$in. thick, which will leave one clear segment on each side. So we proceed in this way:—

For five sets of segments, saw out, at six to the circle, 30 segments about $\frac{3}{8}$in. wider than the finished width, and $\frac{1}{2}$in. longer than the sixth part of the circle. Level a wooden face chuck, and glue one ring of segments upon it, with slips of paper intervening, but extending only about an inch to each side of the end joints of the segments. These paper slips are to permit of ready detachment of the ring from the plate after it is turned, the paper parting in two readily without splintering the wood. Upon this first set glue three others in succession, facing the surface of each set in the lathe after the glue has dried, and chalking over the surface so obtained for the proper fitting of the segments in the set to come next above. When the fourth course is glued on leave it for awhile while the arms are being prepared.

Get out three pieces of stuff $20\frac{3}{4}$in. by $2\frac{1}{4}$in. by $\frac{7}{8}$in., all finished sizes, and lock together with joints, as shown in Fig. 43. The views are self-explanatory, and the thickness of each middle web is one-third of $\frac{7}{8}$in., and the angles of the rebated edges are at 60° with the edges of the stuff. Put together temporarily, mark a 5in. circle in the middle, and from that 5in. circle, working from both sides of the stuff, bevel each arm-piece to $\frac{3}{4}$in. thick at the ends. The $\frac{7}{8}$in. and $\frac{3}{4}$in. thicknesses represent the conjugate diameters of the elliptical sections next the boss and the rim respectively. To make up the ends to the $1\frac{6}{16}$in. thickness necessary for letting in to the rim, we must glue a slip of wood on each face $2\frac{1}{4}$ by about 2in. by $\frac{9}{32}$. Now mark the shape of the arms, Fig. 41, plan, on the stuff so prepared, take apart and work to shape, cutting the edges square in the first place, afterwards cutting the elliptical forms at each end respectively (Fig 44), using a chisel and templets, and working the intermediate portion straight along with a small thumb-plane and bull-nose. Glue the arms together finally, and complete then the $\frac{3}{4}$in. hollows around the central boss.

Returning to the ring, which has dried in the interval, turn the inner portion to 1ft. $6\frac{1}{2}$in. diameter, Fig. 41, and laying the arms centrally upon the face, scribe around their ends, and cut down six recesses to those lines $1\frac{5}{16}$in. deep. Into these recesses glue and screw the arms finally, Fig. 42, and over them glue the last course of segments, one only of the final course being shown in the figure. Then turn the outside of the wheel, and also the inner edge of the course last glued on, and remove from the face-plate. The radii of the arms next the rim are then completed with gouge and penknife. All that now remains is to turn two bosses with hollows as shown in Fig. 41, and to screw them upon each side of the arms. One boss has to receive a print on its centre, $\frac{7}{8}$in. in diameter.

The bearing block for the crank shaft is shown in Fig. 46, its cap in Fig. 47, and the brass in Fig. 48, and all dimensions are given therein. I have given the diameter of the shaft as $1\frac{1}{8}$in., which is $\frac{1}{8}$in. over the size given by the rule which makes the shaft = the bore of the cylinder × ·33. The pattern, of course, has boring allowance. No portions are left loose for moulding. The block moulds with its flat faces up and down as it lies on the sheet. The cap moulds with oil cup downwards, and the brass with its hollow working face down. But they are so small that enough taper for moulding may be given by glass-papering.

The bearing block is made in six pieces: the foot A, the block B; two facings. C C, for the shoulders of the brasses; and two bosses, D D, for the hold-down bolts. All are glued and bradded together simply, and the hole is cut out in the pattern for the reception of the brass.

The cap is made in four pieces, consisting of the plate A, out of which the portion which clips the brass is cut; the facing B B for the shoulders of the brasses, the bosses C C for the tightening bolts, and the oil cup D. The latter is glued upon a face-plate with a paper joint, turned and bored, cut to the angle of 45°, removed and glued in position. An oil-cap cover, Fig. 49, is also made.

The brass, Fig. 48, consists of three pieces, the centre, A, being squared to $1\frac{1}{4}$in., and cut to fit tightly into the bearing block. If so fitted, it will come out a trifle larger in the casting, so that a little easing with the file will make it fit without much labour.

The flanges B B are turned, and fastened to the central block, and the 1in. semicircular hole worked through.

Brasses are now commonly fitted by turning, as being cheaper than filing; and a stud, Fig. 50, prevents them from slipping with the revolution of the shaft. But the old-fashioned way is easier in this instance.

## LOCOMOTIVES ON THE BRIGHTON LINE.

THE following is the substance of a paper read by Mr. W. Stroudley, M.Inst.C E., at a recent meeting of the Institution of Civil Engineers. It will be seen that it refers to several very important points, but it may be stated that the figures referring to evaporation and coal consumption require verification because they are so exceptional.

The author, on his appointment to the London, Brighton, and South Coast Railway, in 1870, had to consider what kind of locomotive engine and rolling stock would best meet the requirements of the service; as, owing to the great increase and complication of the lines and traffic, the original primitive engines and rolling stock were not able to do so. He, therefore, in the same year, designed a large goods engine, class "C," arranging the details so that they would enable him to construct the several classes illustrated, all the principal parts being interchangeable. Having had long experience with both outside and inside-cylinder engines, he adopted inside cylinders, but placed the crank pins for the outside rods on the same side of the axle as the inside crank, the outside pin, however, having a shorter stroke; and he thus obtained the advantages of both systems. He adopted the method of putting the coupled wheels in front, instead of at the back as usual, which permitted the use of small trailing wheels, lightly weighted, and a short outside-coupling rod for the fast running engines, and also a much larger boiler than could be obtained when the coupled wheels were at the back. The author adopted a somewhat high centre of gravity, believing that it made the engine travel more easily upon the road, and more safely at high speeds; the slight rolling motion, caused by the irregularities of the road, having a much less disturbing influence than the violent lateral oscillation peculiar to engines with a low centre of gravity. The high centre of gravity also threw the greatest weight upon the outside or guiding wheel when passing round curves; and this relieved the inner wheels, and enabled them to slip readily. The author used six wheels in preference to a bogie for these engines, to avoid complication and unnecessary weight. The engines were very light for their power. Spiral springs were used for the middle axle, and these had a greater range than the end ones for the same weight. The two cylinders of the large engines were cast in one piece, with the valves placed below, giving lightness, closeness of centres, and easy exhaust and steam passages. The crank axle was the only disadvantage left in an inside cylinder, inside framed engine, and, when this was of good proportions, it offered but a small objection. Owing, however, to the narrow gauge of the rails in this country, the crank axle could not be made so strong as it ought to be, or there would be no reason why a crank axle should break. When the flanges of the driving wheels were turned down thin, so as to avoid the side shock given by crossings and check-rails, there only remained the strain of the steam upon the pistons to cause breakage; the action of this was precisely the same as the methods used by the late Sir William Fairbairn in testing to destruction the model tube for the Menai Bridge, by letting a heavy weight rest upon it suddenly at frequent intervals. The deflection, if sufficient, caused a crack at the weakest place, which gradually extended until fracture took place. This was precisely what occurred in the axle; the crack invariably commencing on the side of the axle opposite to that to which the steam was applied.

The author, after thirty years' experience, believed that the separate parts of locomotives, including tires, axles, piston-rods, side-rods, bolts, cotters, and carriage and wagon axles, broke from the same cause; they did not break when carefully designed and made with proper materials and workmanship. As the crank axle could not be made of the proper strength, it was well to consider how to avoid, as far as possible, risk of accident by its failure. By making the axle-boxes and horn blocks deep and strong, giving large flat surfaces against the boss of the wheel and the outside of the crank arm the driving-wheel was kept in position after the axle was broken, if the fracture occurred in the usual place—namely, through the inside web, near the crank pin, or through the centre part where it joined the inside web. An axle broken in this manner would run safely over any part of the road, except at a through crossing, where the guiding-rail was lost, and the flange was liable to take the wrong side of the next point; this, however, had not happened in the author's experience. The author had always hooped the larger cranks, and had for some time hooped every new crank in the same proportion as adopted on the Great Northern Railway, thus reducing the risk to a minimum. The engines had been arranged that part of the exhaust steam might be turned into the tender or tanks, so that the feed-water might be heated. This was a special advantage in a tank engine, by increasing the total quantity of water; it also kept the water supply of greater purity, and it relieved the boiler of a certain amount of duty in heating the water from the ordinary temperature to that which feed-water required. The feed-pumps had been designed to meet the requirements of pumping hot feed-water. The proportions of the valve-gear gave an admission of 78 per cent. of steam in full gear, which could be reduced to 12 per cent. with excellent results; and as at high speeds the steam was never exhausted, the temperature of the cylinder was maintained and as much steam was locked up in the cylinders as raised the pressure at the end of the stroke to near that in the steam chest. This made the engine run very smoothly at high speeds, and turned what would otherwise be an extravagant coal burner into an economical machine. And for the same reason the compounding of fast passenger or frequent-stopping locomotives was not likely to show much, if any, economy over a well-designed simple engine. The case was different, however, in heavy goods engines, working with a late cut-off most of the time, and where the conditions approximated closely to those of a land or marine engine with a constant load. The back pressure observed in the diagrams of high speed locomotives was not therefore a defect, but an advantage, and the author accordingly used small steamports and short travel of slide-valve. These remarks as to back pressure did not apply to the pressure in the exhaust pipes, where it should be as small as possible, but only to the back pressure in the cylinder. The latter was greatest at high speeds, when a small volume of steam was passing through the cylinders, and small power was required, and least when working full power with the smallest expansion. All the passenger engines and many of the goods engines were fitted with the Westinghouse automatic air-brake, as were also the whole of the carriages. This brake gave entire satisfaction, and complete control of the trains. The author took considerable pains with the fittings and details when it was first introduced, and arranged the gear for the engines, so that the brake acted upon each wheel independently, allowing the springs freedom to act; or it acted upon the front of all the wheels, as in the tank engines, the brake of which was moved by hand as well as by the air pressure. The Westinghouse air-pump had been fitted with a plunger at the bottom end of the rod, $1\frac{3}{4}$in. in diameter, and this pumped water into the boilers of the goods engines when they were in sidings or were delayed by signals. For the express and large goods engines, the greatest possible amount of heating surface had been provided: the fire-box was capacious, with small tubes of considerable length in proportion to their diameter, little or no flame being generated with the coal used, and a very small amount of soot. The fuel which was found cheapest to consume in this locality was smokeless coal from South Wales, mixed with a small quantity of bituminous coal from Derbyshire. The boilers were made of the best Yorkshire iron with plates having planed edges: holes were drilled after the plates had been bent; the joints were butt-joints, and they were hand riveted. The construction of the ash-pan and its dampers, perforated plates, water-supply, and the arrangement of fire-bars, brick arch, fire-door, and deflector, was shown. The indicator diagrams, taken by one of the Crosby Steam-Gauge and Valve Company's indicators, at various speeds, and under varying conditions of gradient, afforded a fair idea of the working capabilities of these engines, the economical value of which was best shown by quoting the consumption of fuel for the half-year ending the 30th of June, 1884, when the average of the whole of the engines on this line was 29·74lb. per engine mile, including the coal used in raising steam. A great number of careful tests had been made of the amount of coal required to raise steam in the engines from cold water, and also from the partially heated water when the boiler had not been emptied, and this amounted on an average to about 3lb. per mile run. Some doubt had been expressed as to the value of heating feed-water by the exhaust steam. The author, therefore, had a number of tests made with the ordinary heating apparatus removed, and water fed to the boilers by the feed pumps, and in one series by a Borland's injector. The amount of power required to work the pumps was inappreciable; and the heated feed-water brought about reduction in the consumption of fuel to the extent of over 2¼lb. per train mile. It had also been found that heating the feed-water by direct contact of the steam did not, on this railway, injuriously affect the boiler plates. With a view to ascertain what was the amount of power required to haul a train from Brighton to London, a complete set of 49 diagrams was taken from the engine "Gladstone" working an express train of twenty-three vehicles, the total weight of train and engine being 335 tons 14 cwt. A section of the line was given, and clearly illustrated the result, giving the horse-power at about every mile, the speed, and the gradient. The temperature of the gases in the smoke-box was taken at frequent intervals; also the degree of vacuum in the fire-box and in the smoke-box, and the quantity of water used out of the tender. To the latter had to be added the water condensed from the exhaust, which from experiments the author estimated at 20 per cent. This gave an evaporation of 12·95lb. of water per 1lb. of coal, and 1lb. of coal would convey one ton weight of the train 13½ miles, at an average speed of 43·38 miles per hour over the Brighton Railway, the rate of consumption being 2·03lb. of coal per horse-power per hour.

## DR. KLEIN ON CHOLERA.

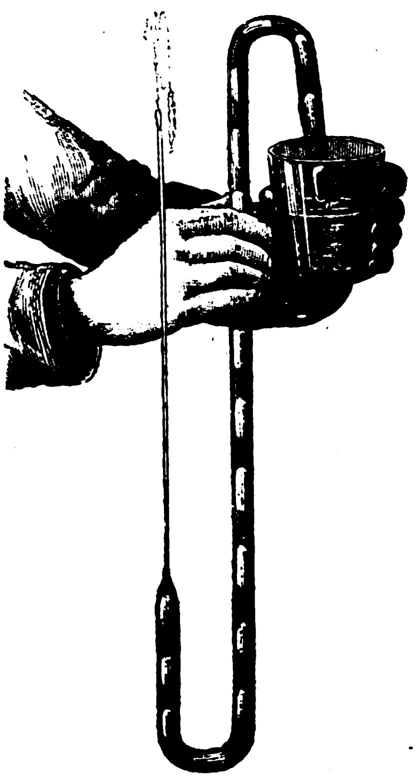
At a recent meeting of the Abernethian Society of St. Bartholomew's Hospital, Dr. Klein briefly reviewed the accepted theories as to the ætiology of cholera, and stated the views concerning it which he had been led to adopt since his visit to India. His speech is of importance as embodying the conclusions of the Indian Commission of Inquiry into this disease. Two main theories are held with regard to cholera—the one, supported by a large section of the Indian medical staff, being that cholera is non-infectious and non-communicable; the other, upheld by European authorities, that it is both infectious and communicable. In support of the former theory may be quoted the numerous cases of sporadic cholera which occur, and the fact that when troops are attacked in a military cantonment and are at once marched out into camp no new cases occur other than those which are already incubating. Lastly, in many places in India, in spite of all conditions favourable to the spread of the disease by choleraic evacuations, as a rule only sporadic cases occur. In support of its communicability and infectiousness it is unquestionable that when an outbreak of cholera has occurred it has in most instances been introduced from a district where cholera was rife, as instanced by the late outbreak at Marseilles, which was shown to have been introduced from Egypt. Some have maintained that it may be conveyed by winds; against this may be adduced the fact that epidemics have occurred in Malta without any occurring at the same time in Gozo. Now, Gozo is nearer to Egypt than Malta, and yet no epidemic at Malta has ever been preceded by an epidemic at Gozo. The upholders of the theory of infectiveness are divided into two schools—the contagionists, who consider that the disease is directly communicable from the sick to the healthy, and that the virus is contained in the discharges from the alimentary canal; and the localists, who believe that the evacuations contain a germ which is capable of elaborating the virus under suitable conditions of climate and soil. Against the contagionists' view must be considered especially these facts—that it is very rare for attendants to be attacked early, and that they only succumb at a late period of the epidemic, and that cholera patients are treated in the general wards of a large hospital in Calcutta, and yet no cases of contagion have occurred. Dr. Koch, in studying this disease, found that the lower part of the small intestine of patients who died from cholera swarmed with peculiar bacilli (comma bacilli), which passed out with the evacuations, and which he considered were capable of manufacturing the cholera virus when introduced into the small intestine of an unhealthy patient. He also believes that this bacillus is destroyed by the acid secretion of the stomach of a healthy person, and, further, that this bacillus is destroyed by drying; and hence that this disease could not be propagated by soiled linen after this had been dried. The German Commission believes these bacilli to be the cause of the disease. Dr. Klein, by a series of experiments, has proved that these comma bacilli are not destroyed by an acid solution of the same strength as that of the gastric juice: but that, on the contrary, they thrive after having been immersed in such a solution. Further, that though these bacilli, in common with all germs (except spores of bacilli), are destroyed by thorough and scientific drying, still soiled linen never becomes thoroughly dry. Klein thinks that even the location of these bacilli in the lower part of the small intestine should not of itself suggest suspicion, inasmuch as bacilli and micrococci in great numbers are contained in it even in health, and the more because this locality is not the exclusive seat of the disease. More conclusive evidence, however, was collected by him in India. For instance, three of the houses situate in a fashionable street in Calcutta contained in all eight cases of cholera. Leading out of the square was a narrow lane to a large water tank, around which was built a squalid rookery. The water of this tank was used in the rookery for all purposes, and contained the comma bacillus. Now, the houses in the square were not supplied with water from the tank, and yet eight cases of cholera occurred in the square, while none were found in the rookery, which was inhabited by about 200 families. The English Cholera Commission has also found a bacillus apparently identical with the comma bacillus in the intestines of children and adults suffering from diarrhœa. Dr. Lewis, of Netley, has found the same in the saliva of healthy persons. With regard to the evacuations containing the virus, Klein found that in India the public-built wells were universally contaminated by sewage, and that the water, though nominally not used for drinking purposes, for expediency was generally so used, and especially at night time. Again at Benares, a large sewer opens into the Ganges at a spot where the pilgrims and natives perform their religious ablutions, these including especially the washing out of the mouth with the river water. In spite of this, only sporadic cases of cholera occur. Dr. Klein has been led to the conclusion with regard to the cholera—that Koch's bacillus cannot be the cholera germ.

## THE OCHOROWICZ LOUD-SPEAKING TELEPHONE.

In this instrument, which is stated by M. Hospitalier, in *L'Electricien*, to be the most powerful he has heard, the inventor has sought to transmit to a distance speech, as well as vocal and instrumental music, with such clearness that an opera, for instance, may be heard by several people some distance from one another, and without having to bring the receiver to their ears. The system comprises a microphonic transmitter of new and special construction, and of a magnetic and receiving telephone, the magnet of which is a solid steel cylinder with a slot down the length of its surface 5 or 6mm. (1¼in.) wide, with two soft iron cores 3 or 4mm. in diameter about the middle, and carrying coils. The latter are inclosed in a kind of flat box, formed of two thin iron plates, one at the top opposite the cores (as in ordinary telephones) and the other at the bottom, screwed to the middle of the magnet. The lower plate is pierced with two holes of a larger diameter than the soft iron cores which traverse it, so as to move freely without touching, these two circular and parallel plates being connected together at their outer edges by a metal crown. In this way, the two plates are only fixed by a point, that which connects the lower plate with the magnet; they form a kind of vibrating box very mobile and elastic, which contains the coils. When the undulating current, modulated by the transmitter, passes through them, it modifies the flow of force inside, increasing or diminishing it. The box closed by the two plates contracts or expands under the influence of these variations of intensity, vibrating throughout its whole substance, thus accounting for the remarkable power of this telephone. It is also capable of acting as a magnetic transmitter, and permits of speaking and hearing in the same manner for a certain distance; but in this case the effect is considerably less marked than with the microphonic transmitter.

## EXPERIMENTS WITH THE SIPHON.

The following description of some interesting experiments with the siphon is sent by Prof. G. M. Clayberg, teacher of physics in the West Division High School, Chicago, to the *Scientific American*. Some very instructive experiments may be performed in the following manner:—Take a piece of ordinary glass tubing about 5mm. (·2in.) in internal diameter and one metre (39·4in.) long. Fifteen centimetres (6in.) from one end bend it to an angle of 100°, and 5 centimetres (2in.) farther to an angle of 90°. Draw out the other end to a point, and grind off the point so as to leave a hole about one millimetre (·04in.) in diameter. Twelve centimetres (4¾in.) from this end bend it twice at right angles in the same plane as the bend at the other end. Grind off the large end obliquely. When finished, the siphon will be as in the illustration. Place the large end in a vessel of water in which a little aniline red has been dissolved, and support the apparatus high enough so that the whole siphon can be seen by all the class. Start the water, and of course it will run. Lift the siphon so that the opening of the large end is partly out of the liquid, and you will have the beautiful appearance of a succession of spaces filled alternately with the coloured liquid and with air. The length of these spaces can easily be regulated by raising or lowering the siphon a very little. Again lift the siphon entirely out of the liquid until fifteen or twenty centimetres of air have entered, and then lower it into the liquid again. The long bubble of air will pass slowly down the long vertical part of the tube and then up the short and pointed arm until it reaches the small opening, when it will rush out with great velocity. The rapid escape of the air gives the liquid behind it great velocity, and when it reaches the small opening at the end of the tube it is suddenly checked, producing considerable pressure—pressure enough to throw a few drops of the liquid 10ft. or 15ft. high, easily seen when the drops strike the ceiling of the class-room. This sudden arrest of the velocity of the flowing liquid illustrates the principle of action of the hydraulic ram.



## DO PLANTS VARY WHEN PROPAGATED BY CUTTINGS?[*]

On reading what is said about "seed" potatoes in last week's *Press*, I notice the assertion is made that "seed" taken from the most productive hills gave a larger yield of tubers than that taken from the least productive. I am inclined to believe that further experimennts will show that this increased productiveness will not continue to hold, because the reason for the greater or less yield was probably only an accident of circumstances, especially favourable conditions of the set made to form the hill, or by being highly fertilised, or some such cause that gave it this temporary advantage; and that the chances are all against any permanent improvement being made by such selections. The potato is said to have been introduced into Europe in 1584. If the original tubers had had the highest cultivation that the skill of man could give, it is exceedingly doubtful if 300 years of culture would have changed them in the slightest degree if propagation had been solely from the tubers and not from seed proper. I base this opinion on a very extended experience in the cultivation of plants from cuttings. Strawberry plants taken from any well-known kind, such as Sharpless, for example, from strong, vigorous, growing plants will certainly give better results than from weak plants of the same kind, planted in the same soil. But if the progeny of the strong and the weak plants are again taken and replanted, the difference between the two would hardly be perceptible after they had been growing together under the same conditions. Every now and then we hear of varieties of fruits or flowers, said to be degenerating, that are propagated from cuttings, grafts, or roots. I believe there is no such thing as permanent degeneration of any fruit, flower, or vegetable that is raised from cuttings, grafts, or roots. The Jargonelle pear, the Ribston Pippin apple, the Hamburg grape, or the Keen's Seedling strawberry of the English gardens are found to look just as good, and as bad, under different conditions of culture as they were fifty or one hundred years ago, and that any change, either better or worse, is only an accident of circumstances, and temporary. For be it remembered that when a plant is raised from cuttings as in the grape vine, grafts as in a pear, or layers as in a strawberry, or pieces of the root as in a potato, such parts are not seed proper, but are merely parts of the same individual first called into existence. The Early Rose potato, introduced nearly a quarter of a century ago, is just as good to-day, under proper cultivation, as when first introduced, but is certainly no better. It is often to be found, of course, under unfavourable circumstances, and then may be supposed to have degenerated; but when it is shown under other circumstances to be as fine as when first introduced, how can the assertion of permanent degeneracy be admitted?

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[*] By Peter Henderson, in the *Philadelphia Press*.

Permanent improvement, in my opinion, in varieties, can only be made by the selection of the fittest specimens that have been raised from seed proper. Here we have, as in the Early Rose potato, the Sharpless strawberry, and the Concord grape, varieties that have shot ahead of their fellows, having merits that the general public recognise, but all the art of man cannot further improve these so that their "progeny" (to use a convenient, though, perhaps, not a strictly correct term) will be permanently better or worse than when first called into existence. It is a very common error, when a luxuriant crop of anything is seen growing under specially good culture, to imagine that cuttings, roots, or seeds from such plants must necessarily give similar results when the same conditions to grow such crops well are not present. Not long ago Boston was famed for its rosebuds, and even experienced florists paid double price for stock from such plants, only to find that in their hands these plants would not produce Boston rosebuds. Now the case is changed. Madison, N.J., as a whole, beats Boston in rose culture, and the demand has changed from Boston to Madison, and, of course, with the same results; for, if the purchasers of Madison roses cannot give Madison culture, there will be no Madison rosebuds. While we admit the advantage of a healthy stock, and even, perhaps, the value of a change of stock, what I claim is that no culture will permanently change the variety from the normal condition, and that the only advance that can be made is by selecting the best specimens, hybridising these from their seed, again selecting, and so on forward. To be sure, we have in rare instances what are known as "sports" by gardeners, or what Darwin has called "bud variation," which may be improvements on the original variety or the reverse; but culture, good or bad, has nothing to do with such anomalous cases. Again and again we see it asserted as a matter for wonder that the wild celery of English marshes or the wild carrot of the hedge rows have attained their present high condition by "cultivation." If cultivation means that man has through generations "selected the fittest" of these again and again, taking always the flower of the flock, so as to have attained the present perfection, then that is true; but if by "cutivation" is meant that "domestication" by high culture, manuring, &c., in a garden or a field, has caused such results, then, in my humble opinion, it is not true.

# A NEW DEVELOPER CONTAINING SULPHITE OF AMMONIA, WITH A NOTE ON THE LIME DEVELOPER.*

I HAVE fully recognised the value of the potash developer for rapid plates and short exposures; but notwithstanding this, I now advocate a fresh developer containing ammonia and sulphite of ammonium, this developer having proved excellent with almost all kinds of commercial plates.

A.—Dissolve 10 parts of pyrogallol, and 25 to 30 parts of sulphite of ammonium, in 100 parts of water.

B.—Dissolve 5 parts of bromide of ammonium in 150 parts of water, and add 50 parts of liquid ammonia.

The working developer is made by mixing 100 cubic centimetres of water, 4c.cm. of the pyrogallic solution A, and 4c.cm. of the alkaline solution B. Development takes place very quickly, and if it is desired to make the reaction slower, more water (50c.cm. extra) is added. This leads to the production of softer pictures. If, on the other hand, more vigorous images are required, a few drops of a 10 per cent. solution of ammonium bromide must be added. The ammonium sulphite developer gives very well-modelled, brilliant negatives, in which the high-lights are well rendered, and the deep shadows are full of modelling, while the negatives have an agreeable dark-brownish tint. The ammonium sulphite makes the aqueous solution of pyrogallol more permanent than when the sodium sulphite is used, and there is but little liability to to fog with it. *A Developer with Lime Water.*—Pyrogallic acid and lime water were first recommended by Davanne for collodio-bromide emulsion, and this developer can also be used with gelatine emulsion plates. As lime is but slightly soluble in water, it is convenient to make a 10 per cent. solution of sugar in water, and to saturate this with slaked lime. The pyro-lime developer becomes violet and brown in use, also becomes turbid; while the developed images produced are so thin that I do not think very much of this developer.

# STAINING TISSUES FOR PHOTOGRAPHY.†

By George A. Piersol, M.D.

SATISFACTORY results in photographing histological tissues depend largely upon two conditions. 1. Having a section so thin and even that little more than a single layer of cells is included. 2. Having such thin section properly stained—especially sufficiently differentiated. Regarding the first condition, but little difficulty is experienced in these days of sliding microtomes, whose advent has marked a new era in section cutting. The successful completion of the second condition for photography is not always as readily accomplished. By most workers probably the stains ordinarily employed and valued for general use are borax-carmine and hematoxylin; of the two the latter is usually the more highly prized—the simple manipulations required and the unsurpassed results justly giving hematoxylin a recognised pre-eminence. These sections stained with borax-carmine (properly used) yield often excellent negatives; in their strata the red colour being sufficiently non-actinic to give a vigorous contrast on the plate. In well differentiated carmine staining, however, little else than cells is coloured, and frequently delicate details of the connective-tissues are wanting on account of their transparency. Hematoxylin stainings in very thin sections, while all that can be desired under the microscope, are usually very disappointing when photographed; the delicate layer of tissue offers almost no actinic contrast when monochromatic sunlight is obtained by the ammonio-sulphate of copper cell. Since hematoxylin is so extensively employed in all lines of work, a ready modification of this staining to meet the needs of photography is of advantage. While especially intended for nervous tissues the modified use furnishes specimens of all organs admirably adapted for photography. No especial formula for hematoxylin is needed, using one which is capable of staining deeply and giving standard results. In the usual course of work the sections are stained; a very few thin ones, however, are allowed to remain in the solution, after those for ordinary preparation, until they are of an intense dark purple, when they are transferred, one by one, to a capsule containing a solution composed of the following constituents:—

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|---|---|
| Borax | 1·0 |
| Potassium ferricyanide | 2·5 |
| Water | 100·0 |

In this they are kept moving until the intense colour is gradually discharged, and the purple tint is replaced by a bronze-yellow, shading to saffron. Before the sections reach the latter colour they should be washed in water; the further usual steps in mounting are then completed. Sections so stained, and mounted in balsam, will be found to possess all the differentiation given by hematoxylin, with a change from the purplish blue colour to the subdued tones of brown—a substitution often most pleasing and grateful to the eye.

# CRITICAL METHODS OF DETECTING ERRORS IN PLANE SURFACES.

By John A. Brashear.*

FOR a number of years I have been practically interested in the subject of the production of plane and curved surfaces, particularly for optical purposes—*i.e.*, in the production of such surfaces, free if possible from all traces of error—and it will be pleasant to me if I shall be able to add to the interest of this association by giving you some of my own practical experience, and may I trust that it will be an incentive to all engaged in kindred work to do that work well. In the production of a perfectly plane surface there are many difficulties to contend with, and it will not be possible in the limits of this paper to discuss the methods of eliminating errors when found, but I must content myself with giving a description of various methods of detecting existing errors in the surfaces that are being worked, whether, for instance, it be an error of concavity, convexity, periodic or local error. A very excellent method was devised by the celebrated Ross, which is frequently used at the present time, and those eminent workers, the Clarks of Cambridge, use a modification of the Ross method which in their hands is productive of the very highest results. The device is very simple, consisting of a telescope in which the aberrations have been well corrected, so that the focal plane of the objective is as sharp as possible. This telescope is first directed to a distant object, preferably a celestial one, and focussed for parallel rays. The surface to be tested is now placed so that the reflected image of the same object, whatever it may be, can be observed by the same telescope. It is evident that if the surface be a true plane, its action upon the beam of light that comes from the object will be simply to change its direction, but not disturb or change it any other way, hence the reflected image of the object should be seen by the telescope without in any way changing the original focus. If, however, the supposed plane surface proves to be convex, the image will not be sharply defined in the telescope until the eyepiece is moved away from the object-glass, while if the converse is the case, and the supposed plane is concave, the eyepiece must now be moved towards the objective in order to obtain a sharp image, and the amount of convexity or concavity may be known by the change in the focal plane. If the surface has periodic or irregular errors, no sharp image can be obtained, no matter how much the eyepiece may be moved in or out. This test may be made still more delicate by using the observing telescope at as low an angle as possible, thereby bringing out with still greater effect any error that may exist in the surface under examination, and is the plan generally used by Alvan Clark and Sons. Another and very excellent method is that illustrated in Fig. 1, in which a second telescope, *b*, is introduced. In place of the eyepiece of this second telescope, a diaphragm is introduced, in which a number of small holes are drilled, as in Fig. 1, *x*, or a slit is cut similar to the slit used in a spectroscope, as shown at *y*, same figure. The telescope *a* is now focussed very accurately on a celestial or other very distant object, and the focus marked. The object-glass of the telescope *b* is now placed against and "square" with the object-glass of telescope *a*, and on looking through telescope *a* an image of the diaphragm with its holes or the slit is seen. This diaphragm must now be moved until a sharp image is seen in telescope *a*. The two telescopes are now mounted as in Fig. 1, and the plate to be tested placed in front of the two telescopes as at *c*. It is evident, as in the former case, that if the surface is a true plane the reflected image of the holes or slit thrown upon it by the telescope *b* will be seen sharply defined in the telescope *a*. If any error of convexity exists in the plate, the focal plane is disturbed and the eyepiece must be moved out. If the plate is concave it must be moved in to obtain a sharp image. Irregular errors in the plate or surface will produce a blurred or indistinct image, and, as in the first instance, no amount of focussing will help matters. These methods are both good, but are not satisfactory in the highest degree, and two or three important factors bar the way to the very best results. One is that the aberrations of the telescopes must be perfectly corrected, a very difficult matter of itself, and requiring the highest skill of the optician. Another, the fact that the human eye will accommodate itself to small distances when setting the focus of the observing telescope. I have frequently made experiments to find out how much this accommodation was in my own case and found it to amount to as much as 1-40th of an inch. This is, no doubt, partly the fault of the telescopes themselves, but, unless the eye is rigorously educated in this work, it is apt to accommodate itself to a small amount, and will invariably do so if there is a preconceived notion or bias in the direction of the accommodation. Talking with Prof. C. A. Young a few months since on this subject, he remarked that he noticed that the eye grew more exact in its demands as it grew older, in regard to the focal point. A third and very serious objection to the second method is caused by diffraction from the edges of the holes or the slit. Let me explain this briefly. When light falls upon a slit, such as we have here, it is turned out of its course; as the slit has two edges, and the light that falls on either side is deflected both right and left, the rays that cross from the right side of the slit towards the left, and from the left side of the slit towards the right, produce interference of the wave lengths, and when perfect interference occurs dark lines are seen. You can have a very pretty illustration of this by cutting a fine slit in a card and holding it several inches from the eye, when the dark lines caused by total extinction of the light by interference may be seen. If now you look towards the edge of a gas or lamp flame you will see a series of coloured bands that bring out the phenomenon of partial interference. This experiment shows the difficulty in obtaining a perfect focus of the holes or the slit in the diaphragm, as the interferences fringes are always more or less annoying. Notwithstanding these defects of the two systems I have mentioned, in the hands of the practical workmen they are productive of very good results, and very many excellent surfaces have been made by their use, and we are not justified in ignoring them, because they are the stepping stones to lead us on to better ones. In my early work, Dr. Draper suggested a very excellent plan for testing a flat surface, which I will briefly describe. It is a well-known truth that if an artificial star is placed in the exact centre of curvature of a truly spherical mirror, and an eyepiece be used to examine the image close beside the source of light, the star will be sharply defined and will bear very high magnification. If the eyepiece is now drawn towards the observer the star disc begins to expand, and if the mirror be a truly spherical one the expanded disc will be equally illuminated, except the outer edge, which usually shows two or more dark rings due to diffraction, as already explained. Now if we push the eyepiece towards the mirror the same distance on the opposite side of the true focal plane, precisely the same appearance will be noted in the expanded star disc. If we now place our plane surface anywhere in the path of the rays from the great mirror we should have identically the same phenomena repeated. Of course it is presumed and is necessary that the plane mirror shall be much less in area than the spherical mirror, else the beam of light from the artificial star will be shut off; yet I may here say that any one part of a truly spherical mirror will act just as well as the whole surface, there being, of course, a loss of light according to the area of the mirror shut off. I might go on to elaborate this method to show how it may be made still more exact, but as it will come under the discussion of spherical surfaces I will leave it for the present. Unfortunately for this process, it demands a large truly spherical surface, which is just as difficult of attainment as any form of regular surface. We come now to an instrument that does not depend upon optical means for detecting errors of surface, namely, the spherometer, which, as the name would indicate, means sphere-measurer, but it is about as well adapted for plane as it is for spherical work, and Prof. Harkness has been using one for some time past in determining the errors of the plane mirrors used in the transit of Venus photographic instruments. At the meeting of the American Association of Science in Philadelphia there was quite a discussion as to the relative merits of the spherometer test and another form which I shall presently mention, Prof. Harkness claiming that he could, by the use of the spherometer, detect errors bordering closely on one-five hundred thousandth of an inch. Some physicists express doubt on this, but Prof. Harkness has, no doubt, worked with very sensitive instruments and over very small areas at one time. I have not had occasion to use this instrument in my own work, as a more simple, delicate, and efficient method was at my command, but for the measurement of convex surfaces I know of nothing that can take its place. I will briefly describe the method of using it. The usual form of the instrument is shown in Fig. 2. *a* is a steel screw working in the nut of the stout tripod frame *b*. *c c c* are three legs with carefully prepared points; *d* is a divided standard to read the whole number of revolutions of the screw *a*, the edge of which also serves the purpose of a pointer to read off the division on the top of the milled head *e*. Still further refinement may be had by placing a vernier here. To measure a plane or curved surface with this instrument, a perfect plane, or perfect spherical surface of known radius, must be used to determine the zero point of the division. Taking for granted that we have this standard plate, the spherometer is placed upon it and the readings of the divided head and indicator *d* noted when the point of the screw *a* just touches the surface *f*. Herein, however, lies the great difficulty in using this instrument, *i.e.*, to know the exact instant of contact of the point of screw *a* on the surface *f*. Many devices have been added to the spherometer to make it as sensitive as possible, such as the contact level, the electric contact, and the compound lever contact. The latter is probably the best, and is made essentially, as in Fig. 3. I am indebted for this plan to Dr. Alfred Mayer. As in the previous figure, *a* is the screw, this screw is bored out and a central steel pin turned to fit, resting on a shoulder at *c*. The end *d* projects below the screw *a*, and the end *e* projects above the milled head, and the knife edge or pivot point rests against the lever *f*, which, in turn, rests against the long lever *g*, the point *h* of which moves along the division at *j*. It is evident that if the point of the pin just touches the plate no movement of the index lever *g* will be seen; but if any pressure be applied, the lever will move through a multiplied arc, owing to the short fulcri of the two levers. Notwithstanding all these precautions, we must also take into account the flexure of the material, the elasticity of the points of contact, and other idiosyncrasies, and you can readily see that in an instrument so delicate practice alone will bring about the very best results. Dr. Alfred Mayer's method of getting over the great difficulty of knowing when all four points are in contact is quite simple. The standard plate is set on the box *g*, Fig. 2, which acts as a resonator. The screw *a* is brought down until it touches the plate. When the pressure of the screw is enough to lift off either or all of the legs, and the plate is gently tapped with the finger, a rattle is heard, which is the tell-tale of imperfect contact of all the points. The screw is now reversed gently and slowly until the moment the rattle ceases. and then the reading is taken. Here the sense of hearing is brought into play. This is also the case when the electric contact is used. This is so arranged that the instant of touching of the point of screw *a*, completes the electric circuit in which an electro-magnet of short thick wire is placed. At the moment of contact, or perhaps a little before contact, the bell rings, and the turning of the screw must be instantly stopped. Here are several elements that must be remembered. First, it takes time to set the bell ringing, time for the sound to pass to the ear, time for the sensation to be carried to the brain, time for the brain to send word to the hand to cease turning the screw, and, if you please, it takes time for the hand to stop. You may say, of what use are such refinements? I may reply, what use is there in trying to do anything the very best it can be done? If our investigation of Nature's profound mysteries can be partially solved with good instrumental means, what is the result if we have better ones placed in our hands, and what, we ask, if the best are given to the physicist. We have only to compare the telescope of Galileo, the prism of Newton, the pile of Volta, and what was done with them, to the marvellous work of the telescope, spectroscope, and dynamo of to-day. But I must proceed. It will be recognised that in working with the spherometer only the points in actual contact can be measured at one time, for you may see by Fig. 4 that the four points, *a a a a*, may all be normal to a true plane, and yet errors of depression, as at *c*, or elevation, as at *b*, exist between them, so that the instrument must be used over every available part of the surface if it is to be tested rigorously. As to how exact this method is, I cannot say from actual experience, as in my work I have had recourse to other methods that I shall describe. I have already quoted you the words of Prof. Harkness. Dr. Hastings, whose practical as well as theoretical knowledge is of the most critical character, tells me that he considers it quite easy to measure to 1-80000th of an inch with the ordinary form of instrument. Here is a very fine spherometer that Dr. Hastings works with from time to time, and which he calls his standard spherometer. It is delicately made, its screw being 50 to the inch, or more exactly 0·01998 inch, or within 2-100000th of being 1-50th of an inch pitch. The principal screw has a point, which is itself an independent screw, that was put in to investigate the errors of the main screw, but it was found that the error of this screw was not as much as ·00001 of an inch. The head is divided into 200 parts, and by estimation can be read to 1-100000th of an inch. Its constants are known, and it may be understood that it would not do to handle it very roughly. I could dwell here longer on this fascinating subject, but must haste; I may add that if this spherometer is placed on a plate of glass, and exact contact obtained, and then removed and the hand held over the plate without touching it, the difference in the temperature of the glass and that of the hand would be sufficient to distort the surface enough to be readily recognised by the spherometer when replaced. Anyone desiring to investigate this subject further will find it fully discussed in that splendid series of papers by Dr. Alfred Mayer on the minute measurements of modern science, published in *Scientific American* Supplements, to which I was indebted years ago for most valuable information, as well as to most encouraging words from Prof. Thurston, whom you all so well and favourably know. I now invite

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* By Dr. Joseph Maria Eder in the *Photographic News.*

† Extracted from a paper in the *American Monthly Microscopical Journal.*

* Extracted from a paper read before the Engineers' Society of Western Pennsylvania.

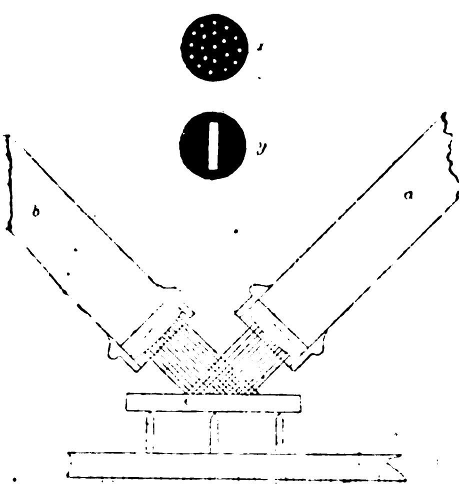

FIG. 1.

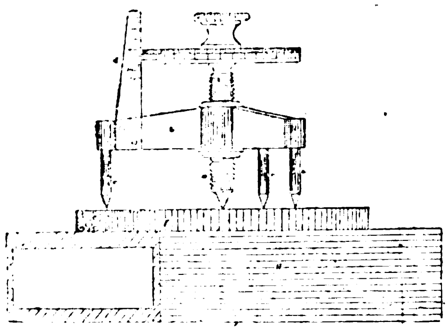

FIG. 2.

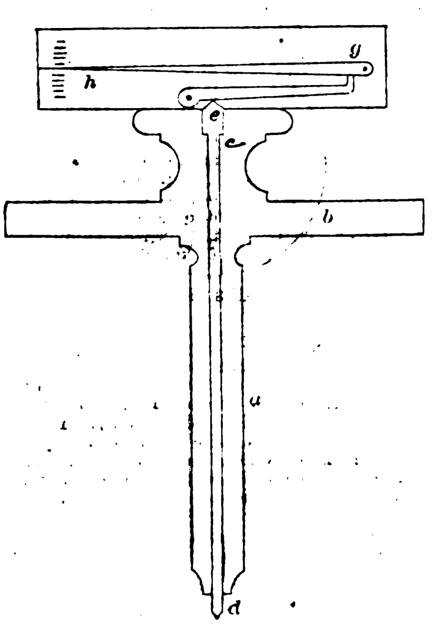

FIG. 3.

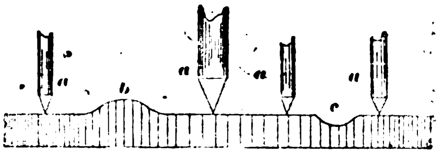

FIG. 4.

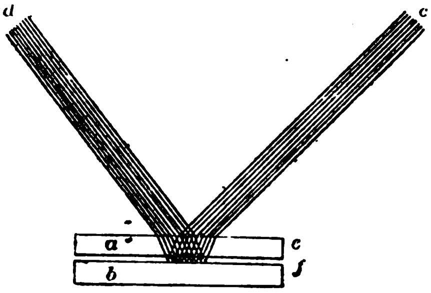

Fig. 5.

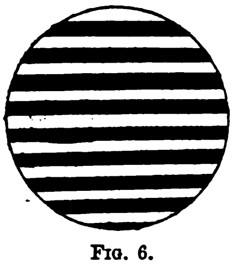

Fig. 6.

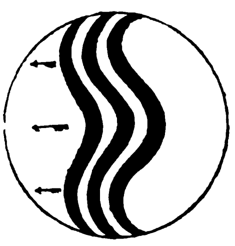

Fig. 7.

your attention to the method for testing the flat surfaces on which Prof. Rowland rules the beautiful diffraction gratings now so well known over the scientific world, as also other plane surfaces for Heliostats, &c. I am now approaching the border land of what may be called the abstruse in science, in which I humbly acknowledge it would take a vast volume to contain all I don't know, yet I hope to make plain to you this most beautiful and accurate method, and for fear I may forget to give due credit, I will say that I am indebted to Dr. Hastings for it, with whom it was an original discovery, though he told me he afterwards found it had been in use by Steinheil, the celebrated optician of Munich. The principle was discovered by the immortal Newton, and it shows how much can be made of the ordinary phenomena seen in our every day life when placed in the hands of the investigator. We have all seen the beautiful play of colours on the soap bubble, or when the drop of oil spreads over the surface of the water. Place a lens of long curvature on a piece of plain polished glass, and looking at it obliquely, a black central spot is seen with rings of various width and colour surrounding it. If the lens is a true curve, and the glass beneath it a true plane, these rings of colour will be perfectly concentric and arranged in regular decreasing intervals. This apparatus is known as Newton's colour glass, because he not only measured the phenomena, but established the laws of the appearances presented. I will now endeavour to explain the general principle by which this phenomena is utilised in the testing of plane surfaces. Suppose that we place on the lower plate lenses of constantly increasing curvature until that curvature becomes nil, or in other words a true plane. The rings of colour will constantly increase in width as the curvature of the lens increases, until at last one colour alone is seen over the whole surface, provided, however, the same angle of observation be maintained, and provided further that the film of air between the glasses is of absolutely the same relative thickness throughout. I say the film of air, for I presume that it would be utterly impossible to exclude particles of dust so that absolute contact could take place. Early physicists maintained that absolute molecular contact was impossible, and that the central separation of the glasses in Newton's experiment was 1-250000 of an inch; but Sir Wm. Thomson has shown that the separation was caused by shreds or particles of dust. However, if this separation is equal throughout, we have the phenomena as described; but if the dust particles are thicker under one side than the other, our phenomena will change to broad parallel bands, as in Fig. 6; the broader the bands the nearer the absolute parallelism of the plates. In Fig. 5 let *a* and *b* represent the two plates we are testing. Rays of white light, *c*, falling upon the upper surface of plate *a*, are partially reflected off in the direction of rays *d*, but as these rays do not concern us now, I have not sketched them. Part of the light passes on through the upper plate, where it is bent out of its course somewhat, and falling upon the lower surface of the upper plate, some of this light is again reflected towards the eye at *d*. As some of the light passes through the upper plate, and passing through the film of air between the plates, falling on the upper surface of the lower one, this in turn is reflected, but as the light that falls on this surface has had to traverse the film of air twice, it is retarded by a certain number of half or whole wave-lengths, and the beautiful phenomena of interference take place, some of the colours of white light being obliterated while others come to the eye. When the position of the eye changes the colour is seen to change. I have not time to dwell further on this part of my subject, which is discussed in most advanced works on physics, and especially well described in Dr. Eugene Lommel's work on "The Nature of Light." I remarked that if the two surfaces were perfectly plane there would be one colour seen, or else colours of the first or second order would arrange themselves in broad parallel bands; but this would also take place in plates of slight curvature, for the requirement is, as I said, a film of air of equal thickness throughout. You can see at once that this condition could be obtained in a perfect convex surface fitting a perfect concave of the same radius. Fortunately, we have a check to guard against this error. To produce a perfect plane three surfaces must be worked together unless we have a true plane to commence with; but to make this true plane by this method we must work three together, and if each one comes up to the demands of this most rigorous test, we may rest assured that we have attained a degree of accuracy almost beyond human conception. As it is difficult to see the colours well on metal surfaces, a one-coloured light is used, such as the sodium flame, which gives to the eye in our test, dark and bright bands instead of coloured ones. When these plates are worked and tested upon one another until they all present the same appearance, one may be reserved for a test plate for future use. Here is a small test plate made by the celebrated Steinheil, and here two made by myself, and I may be pardoned in saying that I was much gratified to find the coincidence so nearly perfect that the limiting error is much less than ·00001 of an inch. My assistant, with but a few months' experience, has made quite as accurate plates. It is necessary, of course, to have a glass plate to test the metal plates, as the upper plate must be transparent. So far we have been dealing with perfect surfaces. Let us now see what shall occur in surfaces that are not plane.

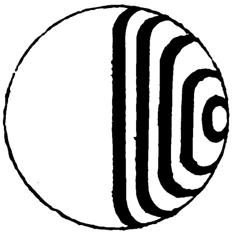

Fig. 8.

Suppose we now have our perfect test-plate, and it is laid on a plate that has a compound error—say, depressed at centre and edge and high between these points. If this error is regular the central bands arrange themselves as in Fig. 7. You may now ask, How are we to know what sort of surface we have? A ready solution is at hand. The bands always travel in the direction of the thickest film of air, hence, on lowering the eye, if the convex edge of the bands travel in the direction of the arrow, we are absolutely certain that that part of the surface being tested is convex, while if, as in the central part of the bands, the concave edges advance, we know that part is hollow or too low. Furthermore, any small error will be rigorously detected, with astonishing clearness, and one of the grandest qualities of this test is the absence of "personal equation," for, given a perfect test-plate, it won't lie, neither will it exaggerate. I say won't lie, but I must guard this by saying that the plates must coincide absolutely in temperature, and the touch of the finger, the heat of the hand, or any disturbance whatever will vitiate the results of this lovely process; but more of that at a future time. If our surface is plane to within a short distance of the edge and is there overcorrected, or convex, the test shows it as in Fig. 8. If the whole surface is regularly convex, then concentric rings of a breadth determined by the approach to a perfect plane are seen. If concave, a similar phenomenon is exhibited, except in the case of the convex the broader rings are near the centre, while in the concave they are nearer the edge. In lowering the eye while observing the plates, the rings of the convex plate will advance outward, those of the concave inward. It may be asked by the mechanician, Can this method be used for testing our surface plates? I answer, that I have found the scraped surface of iron bright enough to test by sodium light. My assistant in the machine work scraped three 8in. plates that were tested by this method, and found to be very excellent, though it must be very evident that a single cut of the scraper would change the spot over which it passed so much as to entirely change the appearance there; but I found I could use the test to get the general outline of the surface under process of correction. These iron plates I would say are simply used for preliminary formation of polishers. I may have something to say on the question of surface plates in the future, as I have made some interesting studies on the subject. I must now bring this paper to a close, although I had intended including some interesting studies of curved surfaces. There is, however, matter enough in that subject of itself, especially when we connect it with the idiosyncrasies of the material we have to deal with, a vital part of the subject that I have not touched upon in the present paper. You may now inquire how critical is this "colour test." To answer this, I fear I shall trench upon forbidden grounds, but I call to my help the words of one of our best American physicists, and I quote from a letter in which he says by combined calculation and experiment I have found the limiting error for white light to be 1-50000000 of an inch, and for Na or sodium light about fifty times greater, or less than 1-800000 of an inch. Dr. Alfred Mayer estimated and demonstrated by actual experiment that the smallest black spot on a white ground visible to the naked eye is about 1-800th of an inch at the distance of normal vision—namely, 10in., and that a line, which, of course, has the element of extension 1-5000th of an inch in thickness could be seen. In our delicate "colour test" we may decrease the diameter of our black spot a thousand times and still its perception is possible by the aid of our monochromatic light, and we may diminish our line ten thousand times, yet find it just perceivable on the border land of our test by white light. Do not presume I am so foolish as to even think that the human hand directed by the human brain can ever work the material at his command to such a high standard of exactness. No; from the very nature of the material we have to work with, we are forbidden even to hope for such an achievement, and could it be possible that through some stroke of good fortune we could attain this high ideal, it would be but for a moment, as from the very nature of our environment it would be but an ignis fatuus. There is, however, to the earnest mind a delight in having a high model of excellence, for as our model is, so will our work approximate, and although we may go on approximating our ideal for ever, we can never hope to reach that which has been set for us by the great Master Workman.

**A Clear Shellac Varnish.**—A simple mode of of clearing turbid lacquer or solutions (however strong) of shellac in spirits of wine, is to add to the same a quarter of their bulk of commercial "benzine" or refined petroleum spirit. If the mixture be agitated three or four times during the space of an hour and then allowed to stand, it speedily separates into two distinct layers, the upper one is a solution of the fatty or waxy matter in petroleum spirit, the lower is a brilliant alcoholic solution of pure shellac. The petroleum spirit only dissolves to a small extent in the other liquid, and the latter when drawn off is easily freed from it by slightly warming, with gentle agitation. Crude lac of any kind may be caused to give an absolutely clear solution in alcohol if it first be roughly powdered and then washed with warm petroleum spirit once or twice so as to dissolve out all the fatty matter. This latter has the advantage of simplicity, while at the same time the quality of the lac is in no degree injured.—*Southern Coach Maker.*

**Gallium.**—Dr. L. Ehrlich, a German chemist, has succeeded in isolating the metal gallium by an industrial process. A preliminary experiment has yielded 0·6 grains of gallium from 80 kilogrammes of zinc blende. The method followed was a modification of that introduced by M. Lecoq de Beisbaudrau, which by lixiviation of the zinc sulphate resulted in a small quantity of mud containing ferric oxide and gallium. The galliferous alkaline solution was then electrolysed in a platinum capsule and the metal deposited in fine needles. As the melting point of gallium is low, about 30·5 deg. C., and its lustre brighter than that of mercury, it may be found of useful application by-and-by.

# SCIENTIFIC NEWS.

THE death is announced of Prof. Morrison Watson, dean of the medical school and professor of anatomy at Owens College, Manchester. Whilst lecturing last month he broke a bloodvessel in the head, and lingered on unconsciously until last week, when he expired. Dr. Watson was only in his fortieth year. He will be remembered by many as demonstrator of anatomy under Prof. Turner at Edinburgh, but was widely known as a contributor to scientific journals, and as one of the experts engaged on the reports of the voyage of the *Challenger*.

The well-known mineralogist and palæontologist, Prof. Dunker, of Marburg, is dead.

At the next meeting of the Royal Microscopical Society, on the 8th inst., at 8 p.m., the original ruling machine of the late Herr F. A. Nobert will again be exhibited by Mr. J. Mayall, jun. Mr. Mayall informs us that, with a view to clearing up the mystery regarding the production of the diamond ruling-points, he has submitted them to the inspection of Messrs. Wellby, the well-known diamond merchants, of Garrick-street, in order to decide which surfaces were artificially prepared and which cleaved, &c. Messrs. Wellby recommended that an independent examination of the ruling-points should also be made by professional diamond cleavers. Accordingly, Messrs. Nyburg, formerly diamond cleavers of Amsterdam, were requested to undertake the examination. The results of the various examinations will be communicated to the Society by Mr. Mayall.

Dr. Luther, of Düsseldorf, discovered another small planet on the 14th of March. It is of the eleventh magnitude, and will reckon as No. 247, No. 245 being that discovered by Mr. Pogson at Madras on Feb. 6, and observed at Berlin and Vienna on the 9th and 12th of March. No. 246 is the small planet discovered by M. Borrelly, as announced on p. 54. Dr. Palisa has named No. 244, Sita.

The Guarantee Fund in connection with the meeting of the British Association at Aberdeen is now nearly all subscribed, amongst the latest contributions being £50 from the Queen. The nomination as President for the Birmingham meeting in 1886 has been offered to Sir W. Dawson, F.R.S., the principal of M'Gill College, Montreal, and has been accepted.

An ascent of Ben Nevis was made last week by two gentlemen, who found the observers in good health and spirits, although the buildings were almost entirely buried in snow. At the half-yearly meeting of the Scottish Meteorological Society last week, the report of the council was read, in which it was stated that hourly observations had been taken during the winter at the Ben Nevis Observatory, except during some hours of the night between the 21st and 22nd of February, when a severe storm prevented a light being carried outside to read the thermometers. The cost of the erection and maintenance of the observatory to the end of January had been £5,935, or £325 beyond the sum received for the purpose. At the meeting, a paper by Mr. Omond, the superintendent of the observatory, on "The Formation of Snow Crystals from Fog," a common phenomena on the Ben, was read.

A meeting in connection with the Marine Biological Association is to be held at the rooms of the Society of Arts on April 13th. Cambridge has undertaken to raise £500 for the station of the Association, and nearly the whole of this amount has been subscribed. The Association has nearly £6,000 in hand, but requires some £4,000 yet before building.

Some rather alarming statistics were recently given by Mr. W. Whitehead, the President of the Manchester Medical Society, when he stated that the number of deaths from cancer had increased from 4,807 in 1849 to 14.057 in 1882, the last return available. Mr. Whitehead did not compare deaths from cancer with population, but with the total number of deaths, and he found that whereas in 1849 out of the total mortality one death in 90 was due to cancer, in 1882 the proportion was one in 36. These figures do not represent the extent of the increase fully, because formerly fibroids, polypi, &c., were included under the head cancer. In 1882 twice as many females died from cancer as males, and the proportionate increase has been greater amongst women.

Prof. Brown-Séquard read a note on the "Local Action of Cocaine," at a recent meeting of the Société de Biologie of Paris. His experiments show that the drug acts through the medium of the peripheric nerves on the nervous centres, which react by producing an inhibition of sensibility.

On p. 384, No. 1,006, we described a method of making maps in relief patented by Mr. J. de Mendonca Cortez, president of the Banco Lusitano, Lisbon. Maps prepared on his plan have attracted the attention of the War Ministers of France, Germany, and Italy, but they might with advantage be utilised also for the purposes of elementary education.

It was thought that Herr Lenz, who is going out to explore the region of the Congo on behalf of the Geographical Society of Vienna, would also be commissioned to represent the similar societies of Berlin and Munich. It appears, however, that the Berlin Society has determined to send an explorer of its own, and Dr. Fischer will proceed to Zanzibar some time this month, and will journey thence to Uganda and the watershed of the Upper Congo.

At the annual meeting of the Institute of Naval Architects, which was held last week, the president, Lord Ravensworth, stated that the diminution in shipbuilding for all ports during the past year amounted to the equivalent of seven and a half millions sterling, which would account for much of the distress and privation borne by the industrial classes during the past winter. The president, amongst other points, also referred to the increasing use of high-pressure steam, 150lb. being now common, while triple expansion engines, he thought, threatened to oust all others. A number of papers of more or less interest were read, including one by Mr. Thornycroft, on "Guide-Blade Propellers for Shallow Draught Vessels." He considers that the guide-blade propeller will beat the paddle-wheel (stern wheel), as its only defect is a limited power to propel astern.

The technological examinations of the City and Guilds Institute will be held at the different centres on May 20 next. Candidates who cannot arrange to attend at any of the provincial centres can, on application to the director and secretary, be examined at the Cowper-street Schools, London. The programme, containing syllabus of each subject and last year's questions, can be obtained from the secretary, Gresham College, E.C.

Mr. Coxwell, referring to some statements as to the lifting power of hot air and gas in balloons, says that the average specific gravity of coal gas is such as to lift only from 35lb. to 40lb. per 1,000 cubic feet, and to lift 40lb. it must be prepared from a dry coal and be well purified. Even hydrogen cannot be made to lift much more than 60lb. per 1,000 cubic feet.

Vaseline is, it seems, used as a substitute for lard or butter in pastry by some of the confectioners of Paris. M. A. Riche recently presented a report on the subject to the Council of Hygiene of the Department of the Seine, in which he states that however advantageous its use may be to pastry makers, because it has no tendency to become rancid, the employment of vaseline for alimentary purposes ought to be interdicted as injurious to health.

**Compressed Teak for Loom Shuttles.**—The increase in the price of boxwood, largely used in the manufacture of loom shuttles, has directed attention to the possibility of producing some cheaper material equally suitable. It has been found that compressed teak will answer the purpose, and a powerful hydraulic press has just been completed by Sir Joseph Whitworth and Co., of Manchester, for Mr. Robert Pickles, of Burnley, to be used in compressing this class of timber for the manufacture of loom shuttles. The press consists of a strong cast-iron top and bottom and steel cylinder, with a large ram. In the centre of this ram is fitted a smaller ram, with a rectangular head fitting into a die which is placed on the top of the large ram. The timber is put into this die and a pressure of 14 tons per square inch is applied. The pressure is then relieved, and the large ram descends. The top pressure block, which fits the die, is afterwards removed, and the small ram rises and pushes the compressed timber out at the top of the die. The timber thus treated is made very dense, uniform, and close grained, and is capable of taking a very high finish.

# LETTERS TO THE EDITOR.

*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

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*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

### THE MISSING PAIR Σ. 1143.

[24035.]—In the ENGLISH MECHANIC, of Feb. 6, there appeared an interesting letter (23794) by Mr. H. Sadler on "The Missing Pair Σ 1143." I have examined the two stars lettered by him A and B on several occasions with my 7½in. refractor; but have as yet failed to detect a companion to either of them in the position given by Struve. There is, perhaps, not much interest attaching to a negative result of this kind, except as showing that an attempt has been made to solve an interesting question. I shall endeavour to keep the stars under occasional observation. On Feb. 18 I gauged the magnitudes of the two stars thus:—A 8·9, white; B 7·1, ruddy orange.

**George Knott.**

### GRINDING AND POLISHING GLASS SPECULA.

[24036.]—I HAVE directed the amateur in a previous letter to slope the sides of his facets to an angle of from 45° to 55° with the radius of the curve of the face of his polisher. Now this is a very important element towards certainty of results, and therefore success; and to impress its importance on the memory of the amateur, I will explain the results of some of the many experiments I have made to investigate the laws that are brought into action by the various slopes of the sides of the facets.

Now here I must explain to the amateur that one great indication of the face of the polisher being all right is the regular revolution of the polisher; but he will remember that I directed him to put the pushing rollers that are attached to the under-side of the ring that encircles the polisher a little in advance of the middle line, so that at each push the polisher is really pushed a little round in the ring, and thus forced to go round against any accidental cause tending to irregularity. Now, this is all right when all the conditions are as perfect as can be obtained, and they are all well understood and mastered practically; but when we want to try experiments, we have to reduce the strongly controlling conditions, so that the laws we want to discover shall not be overborne in their action, and thus never become visible enough to enable us to study them with certainty. The pushing rollers must, therefore, be put within ⅛in. of the centre line of the push, where they will exert but little influence on the revolution of the polisher in the ring, all the other conditions are the same as those I have explained as necessary to produce the parabola, except the sides of the facets, which we are about to experiment upon. I first wished to try the effect of perpendicular sides upon facets that were narrower than they were thick, as well as upon facets that were broader than they were thick. I therefore made a polisher with the centre facets ½in. square, and the others graduated so that the outer ones were $\frac{3}{16}$in. wide on the edge of the polisher, and all ¼in. thick. Now this amount of graduation, with sloping sides to the facets, will about produce the parabola, the same as though the centre facets were ¾in. square, and the others graduated to ⅜in. at the edge of the polisher. The above polisher that I made to try these experiments with, allowed me a wide range of proportion, varying from the outside facets being thicker than they were wide, to the centre ones, which were double as wide as they were thick. I tried to figure, or rather polish—for figuring was out of the question with such a polisher, for all the regularity of the revolution of the polisher had gone. Now it was jumping round in one direction, then in the opposite direction, then standing still, then moving quietly in the direction of the speculum (the right direction), then it would start off with a jerk in the opposite direction, and thus it kept on during the whole time I experimented with it, which extended over several half-hours' workings. Of course I had not been watching the jerkings backwards and forwards of the polisher many minutes before I began to anticipate the cause—namely, the want of support to the sides of the narrow facets, causing them to bend on one side, and thus either be bent below the general level, and thus give a preponderance of cut somewhere else, or else the bending of the narrow facets on one side, causing one edge to project above the general level; and these raised edges coming in contact with the edge of the speculum would cause points of resistance, and so cause the polisher to be pushed round on these points as centres. Thus, if the point of resistance was one time on the right-hand half of the polisher, then the polisher would be pushed round from right to left; then, perhaps, the point of resistance would be changed to the left-hand half of the polisher; when it would cause the polisher to be pushed round from left to right; and so on, ever varying with the bending, however slight, of the weak facets, first on one side, then on the other, some of the facets even breaking off. Upon examining the facets I find what I expected—viz., that the $\frac{3}{16}$in. wide facets represented in Fig. 1. A, full size, were some bent as shown in B; the face being just slightly below the general level, so as to be out of action, while others were bent, as shown in C; the bite of the rouge having pulled or bent up one side above the general level, only to be caught by the edge of the speculum to be pushed still further out of shape. This disturbance of the shape of the facets decreased as I approached to the centre; those facets that were as broad as thick, as shown in D, were only slightly bent, as in E, while those that were double as broad as thick, were apparently not affected, but stood well; the peculiar effect of their perpendicular sides could not be seen, but was made manifest in another experiment I will describe further on I may just observe that the experiments I describe are by no means all I tried; but they are those that I discovered laws by, or that will show to the amateur the nature of these laws.

Now it is very evident that the narrow facets A B C D E wanted more support on their sides to prevent them yielding sideways. What amount of support is necessary, the amateur will readily understand from the following reasoning: I told him I found those facets whose base was twice their height seemed not to yield sideways, but to maintain their shape. Such a facet is represented in Fig. 2, where it will be seen that the centre perpendicular line A B has the support of an angle of 45° on each side, viz., A C B and A D B; this angle, then, I concluded, was the smallest allowable, so as to be perfectly free from alteration of shape during polishing; in other words, the base of the facet must be not less than double its height. We shall see further on the need of sloping sides even to such proportioned facets.

I next made a polisher with all the facets ½in. square and ¼in. thick, the sides being perpendicular. I polished with this for several half-hours and found, as I expected, the figure of the mirror to be as shown in Fig. 3 with the well-known pecking in, and rise in the centre, clearly indicating that all the facets were acting alike, the same as a solid metal tool; of course, the only thing to be done is to graduate the facets towards the edge, so as to reduce their resistance, and thus proportionately increase the resistance, and therefore wear, on the centre of the mirror, and so to lower the elevation seen in the centre, and thus produce the spherical surface, to be carefully altered into the parabola, when we are parabolising by a carefully conducted further graduation or reduction of the facet towards the edge, and thus slightly increasing the proportionate resistance, and therefore cut of the centre facets, to sink the centre of mirror below the spherical curve to the required amount to produce the parabola; but, of course, this refinement I was not going on to with this polisher, as I was only experimenting upon the effect of various sloping sides to the facets. I may just observe that with every new-made polisher I tried experiments, such as the alteration of shape, allowable before I got to the shape I made the special polisher for, gave me the opportunity of trying; I kept notes of what experiments I wished to try to determine certain points, and these experiments I tried on new polishers, so as to use up their full shape; that allowed me to make the facets of the required form to decide certain doubtful points; otherwise one would have had to be making new polishers for every experiment; thus, during my experiments, I had always some modification to introduce into every new polisher to decide or discover or confirm some supposed law, and thus I often confirmed my previous conclusions over and over again upon new polishers, before I brought them to the shape I specially and finally required them to be. I mention this as a hint to future experimenters, as utilising new-made polishers and saving much time in making polishers, too. I now wanted to decide this question that was among my query notes—viz., Is it the increased area of the larger centre facets in a graduated polisher that wears down the elevation shown in the middle of Fig. 3, or is it the increased resistance of the large centre facets, on account of their increased width of base as compared with their thickness? Now, with the polisher in hand, I had only to graduate the face of the facets, beginning with not toughing the sides of the facets near the centre of the polisher —i.e., leaving them perpendicular and sloping the sides of the facets towards the edge of the polisher, so that the faces of the outside facets should be ⅛in. wide, which graduation, with the ½in. square centre facets, would produce the parabola if the slides were all sloped to an angle of 45°; and, therefore, the above polisher ought to produce the parabola, if the parabola were produced by the alteration of the area merely of the faces of the facets, for, as said before, the area is the same as would produce the parabola if the sides were sloping to an angle of 45°.

I represent in Fig. 4 A one row of facets from centre to edge, to make plain to the amateur the conditions this important experiment was tried under. Now, I polished with this polisher for several half-hours, and not a bit of reduction of the elevation in the centre as shown in Fig. 3 took place; the elevation was, if anything, increased, showing that it was not the increased proportionate area of the centre facets of a graduated polisher that reduces the elevation in the centre of the speculum (Fig. 3), but the increased resistance of the larger facets (with equally sloping sides with the smaller outside facets) over the less resisting, because smaller, outside facets. And further, we learn that the perpendicular sides were no more support than if they had been cut away, leaving the sides to an angle of 45°, and thus reducing the area of the centre facets to the same as the outside, for it will be remembered that with the equally-areaed facets the same figure was produced. The revolution of the polisher was much more regular, however, but not perfectly so. This improved regularity of motion in the polisher was produced by the support afforded by the sloping sides of the outer smaller facets.

FIG. 1.

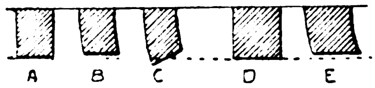


FIG. 2

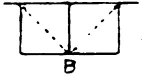


FIG. 3

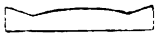


FIG. 4

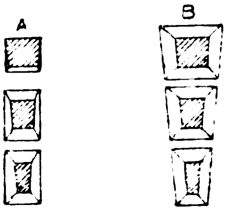


FIG. 5

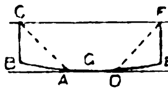
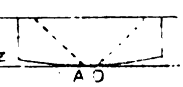


FIG. 6



Now, to still further confirm my increasing convictions and conclusions, that it is the resistance far more than the area that does the parabolising or the sphericalising, if I may so call it, when the mound in the centre of Fig. 3 is reduced to the common spherical curve of the outside part by graduating previous to parabolising, I now proceeded to try the following experiment with the polisher: I filled up the perpendicular sides of the facets with pitch, by melting the end of a stick of it, as we do sealing wax, and letting it drop into the angle adjoining the perpendicular sides till filled up, then melting it thoroughly into all the crevices with the end of a hot iron wire, and finally cutting the superfluous pitch off with my razor to the required 45° angle; thus I added the same support to the centre and intermediate facets as I already had to the outside facets, but leaving the area of the facets unaltered from the last experiment—the altered form of the facets I show in Fig. 4 B. I now proceeded to polish with this polisher, with the certainty of what the result would be, for I had worked the parabola with such a polisher many a time before. Well, after the first half-hour's polishing, the elevation in the centre of Fig. 3 had almost gone, and another half-hour's polishing had completely reduced it to the common spherical curve of the outside parts, conclusively showing that the increased support had given the necessary predominant resistance, and, consequently wear, to the centre facets necessary to increase their cut (by resistance, not increased surface) so as to sink the centre more than the outside, and thus produce the sphere first; when, if the resistance is increased a little more, the parabola will follow. The revolution of the polisher now became pretty regular.

I may here observe that in the previously-described experiments I had made my polisher with ½in. square facets, so as to allow more room in the grooves to experiment upon different angle of sides. But I had better here state that I have found the larger the faces of the facets, in other words, the less the grooves the better the surface of the glass is; therefore, in actually finishing a mirror, I have the centre facets ¾in. square, and graduate the outside to what is needed to produce the parabola.

From other experiments, which would take too much space and time to describe in detail, I find that a facet with a base of ¾in. square, but with perpendicular sides, and consequently with a face ¾ square, has far less cut than a facet on the same sized base, but with sloping sides at 45°, and consequently with an area many times less; in fact with perpendicular-sided centre facets, it is only just possible to reduce the mound shown in Fig. 3, when the outside facets (with sloping sides, of course) are reduced at the edge to nothing on their face. How this comes about the amateur will easily understand from Fig. 5, where it will be seen that as the angles A, B, C, and D, E, F, of the facet have no support, they are easily pushed up by the rouge, which acts like a wedge, the thin end of which, getting in, will push its way beyond the limit of the 45° angle shown by the ends A, D of the dotted lines, aided by the leverage, if I may so describe it, of the pitch from A to B and D to E, so that instead of leaving the polisher in contact from A to D, the pitch at A and D is actually lifted above the surface of the speculum by the wedge of rouge, lifting the surface (the levers, if I may so call them) G B and G E, and thus carrying with them part of the surface from at A and D towards the centre G of the face B G E, and thus reducing the contact surface of the facet to what is shown in Fig. 6, where the part included in the dotted lines shows the really effective part of the facet, leaving an effective surface A D in contact with the speculum less than if the facet (Fig. 5) had its area reduced by having its sides cut to an angle of 45° as shown included in the dotted lines, when the whole of the surface, A D, would have been kept in contact.

I think by this time the amateur will see the reason why I have directed him to have the sides of his facets sloped, and why I have made so much of its importance in my previous letter, knowing as I do how much it conduces to the regularity of the motion of the polisher, and while an angle of 45° will do, I think to be on the safe side an angle of 55° is better, and for the following reasons. I have explained in the first part of this letter how the edge of a square-sided facet is apt to be pulled down or pushed on one side, so that in the former case to increase the local resistance so as to cause the polisher to swing round on it, either backwards or forwards, according as the resisting edge is on the right-hand half or left-hand half of the polisher for the time being. In the latter case the local resistance would be decreased, thus making the preponderance of resistance to be on the opposite side of the polisher. To determine at what angle these causes of irregularity in the motion of the polisher cease to act, I made a polisher with perpendicular-sided facets, then cut their sides to an angle of 10°, then polished, noticing how the polisher moved round, then increased the angle to 15°, and noticed again; I found the jerking of the polisher was reduced with every increase of angle, and thus I proceeded till I got to 45°, when the polisher began to move pretty regularly round. I then went on to 50°, and so on till I reached 70°; but there was little or no improvement beyond 50° angle, so that I came to the conclusion that from 50° to 60° would be perfectly safe; but I believe the greater the angle the better, since the rouge will have, if I may so speak, a better supported lever of surface to resist the thin end of its wedge-like action.

I may here be allowed to call the attention of amateurs to the fact, as bearing on this subject, and corroborating my conclusions, that the late Dr. Lassell used square-sided facets for his polisher, and that he found the tendency to irregularity in the motion of his polisher such that he had to devise a very elaborate system of wheels for his first machine, and pulleys and wheels for his last machine, to control the revolution of the polisher and make it revolve at about the rate he found it would naturally when acting at its best. Now, I believe that the perpendicular sides of his facets had very much to do with the irregularity of the motion of the polisher, and that had he sloped the sides of his facets to an angle of from 45° to 55°, he would have had little or no trouble from irregular motion of his polisher, since the resistance would have been kept equal all over the polisher, thus leaving the combination of motions and resistances to produce, without accidental interference from perpendicular sides, a regular revolution of the polisher.

**H. A. Wassell.**

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## LUNAR OBJECTS.

[24037.]—THE following are notes of lunar features which have been observed, with a comparison of them, as shown on the maps of Neison, Schmidt, Mädler, and Lohrman. On comparing the various maps with the moon we must, I think, come to the conclusion that Schmidt's is by far the most perfect, and that future efforts will be well directed towards rendering it yet more perfect, and clearing up discrepancies between it and others. Schmidt's map being on a larger scale, is likely to show many things omitted by others, but it is not often that we find Neison showing objects that Schmidt omits; yet sometimes this is the case, and it becomes important then to find out by observation which is correct; also, as Schmidt's sections do not overlap, it is sometimes difficult to make sure what he shows at the divisions; perhaps, therefore, it would be useful to direct attention to these parts and to make drawings of them.

On Feb. 4, 1885, I observed a very well-marked cleft, from the middle of the east wall of Theophilus half way to Hypatia. On Mädler's map alone can it be distinguished as a valley marked *x*. It was also seen by me in 1881. A valley which lies from E. to W. of the north wall of Theophilus on its slope is often conspicuous, but does not appear on either of the above maps. On Dec. 6, 1884, its eastern part was seen to be composed of three craters in a row, and one a little way west of them, from which the cleft extended quite to the western edge of the wall, bending a little with the curve of the wall.

On Jan. 5, 1885, I noticed a valley crossing the west wall of Cyrillus obliquely from its crest to the floor. This also is not shown on either map.

The western wall of Catharina is divided in an oblique direction, S.W. and N.E., so forming a valley or chasm. This is shown by Mädler and Lohrman, and best by the latter.

On Feb. 4, 1885, there was seen very plainly a good-sized crater on the S.E. part of the floor of Eudoxus. It is not shown on either map. Schmidt's map cuts through Eudoxus, so that it is not easy to see what he shows. On Feb. 22 a valley was seen between two mountains, which seemed to lie more west than the crater, which was not then visible. This valley is shown by Lohrman and Schmidt. Last August some small hills or craters were seen near the northern wall. There is some discrepancy in the objects shown in the various maps. There is a difference also in the size of the craters A and B, as shown by Neison and Schmidt. The former shows them the same size; but A is really a good deal larger than B, and is thus shown by Sch., Lohr., and Mädler.

On Feb. 5 and other occasions the crossed clefts east of Eudoxus were well seen. At each end of ξ, on its eastern side, lies a small crater. Perhaps there is another crater or a hill on the western side of its southern end. These are not shown by Neison or Sch., but the clefts are well shown by both. The clefts end at the foot of a peculiar shaped mountain on the north. Sch. does not carry them beyond the spot where they cross one another; but I was able to trace them beyond this into the two hollows of the mountain as easily as through any part of their course. Perhaps Mädler shows one cleft and Lohr. both. The latter draws the shape of the mountain best. Neison's two clefts ζ could not be seen; they must either pass through this mountain or lie north of it.

On the north border of Alphonsus I observed a valley on Feb. 6, 1885, at 18h. 13m., which is not shown on either map satisfactorily. Lohr. partly shows it. It was very plainly visible, commencing near the northern end of the principal clefts which cross the floor from N. to S., and passing over the wall of Alphonsus and Ptolemæus, which are here coincident; it ends at the foot of the wall of the latter.

The conspicuous cleft on the south side of Archimedes was seen on Oct. 10, 1884, to be formed of craters. Neison only places the letter δ in its position, and the other maps show nothing there.

Of the very conspicuous valley west of Macrobius, Sch. only shows part of one, nor do they appear on the other maps, though they can be best made out on Lohrman's. There are two long and nearly parallel valleys lying in a N. and S. direction, crossed by one transverse, which is continued over the crest and down the slope of the west wall of Macrobius. South of these, and between Macrobius and C. lies another long valley.

In Littrow, Sch. and Lohr. show nothing, while Mädler and Neison draw a ridge and some small white spots. As it is an uncommon occurrence for Mr. Neison to show more detail than Sch., I watched Littrow for some months, but without seeing the least trace of anything. I had never seen anything previously. On Feb. 2, 1885, however, a small white spot and a narrow white streak were very faintly visible. On the next night they were even less distinct, though just traceable. They were seen again faintly on March 4. The direction of the streak is not exactly that shown by Mädler and Neison; it extends from the crater on the S.E. wall to the brilliant mountain on the N.W. wall. The white spot lies on its southern side. The crater is at the foot of the broad outside slope of the S.E. wall, and is only shown by Mädler and Schmidt. On February 3 a small and well-defined black spot lay on its western side. Another crater, perhaps, lies on the S. wall, further west; but is not shown on the maps. On the same date there was a sharp and narrow line of shadow through the N.E. and the S.W. wall; but not corresponding to one another in direction, though being somewhat in the direction of Mädler's streak. If the streaks are clefts, there may, therefore, be two crossing the floor. A little way south of Littrow lay a large mountain, divided into three portions by two similar short, straight black lines, one of which might have been an extension of the line through the south wall. A large, round spot of shadow lay between it and the wall. It is clear that the objects on the floor and walls of Littrow require to be reobserved, in order to obtain a correct representation, as the maps differ so much.

North-east of Beaumont is a crater rill, which is often visible, though very delicate, ending at the most eastern of the two ridges from Beaumont to Theophilus, which is so rarely visible. I have seen the rill in the years 1881 and 1882, and again in 1884, Aug. 10th, 15h. 30m., and Oct. 8th. It is not the one which Neison mentions as having been seen by Schmidt doubtfully; the position of that, as given in Neison's description, is N.E. of A., while this lies S.E. of that crater. Its north-western end is just south of A., and it extends to the group of craters E. of Beaumont. Almost exactly in its place Schmidt draws four small and separate craters in a row, and a larger separate one at each end of the row. This is plainly the same object; but whenever I have seen it, it has been as a true crater-rill, and extending further than his row of craters. Mädler shows three small craters in a row, nearly in its position; Lohr. shows nothing similar to this.

On the west wall of Franklin Neison draws two conspicuous craters, marked *g*, which are not shown by Schmidt. He also draws one on the N. wall. He does not draw the large crater a little distance from the N. W. wall, near which the cleft passes towards Cepheus, unless the one first mentioned on the N. wall is intended for it. Schmidt shows a conspicuous crater on the S.W. wall, and a smaller one close to it, also a crater on the N.E. wall, and two craters near the junction of Franklin and *f*. These are all omitted by Neison. Schmidt also shows the crater some little distance from the N.W. wall with another, smaller, between it and the cleft. Mädler shows the crater some way from the N.W. wall, and *g* as a large crater. On Lohrman's map the wall at *g* is divided, showing two mountains; but Schmidt gives neither the division nor the peaks. Lohrman draws two other peaks on the west wall, one being in the position of Schmidt's south-western crater. A division in the N. wall is shown by Lohrman and Schmidt only. It is strange that Schmidt does not show *g*, for it is drawn as a large crater by Mädler and Neison. On August 8, 1884, I noticed that it was not visible, nor do I remember seeing it at any other time.

The differences in *f* shown in the various maps are as follows:—Neison and Mädler show a central hill and a ridge from the south wall of Franklin; Lohrman shows the ridge very conspicuously ending in a peak; Schmidt two central hills only. On February 2, 1885, I saw the ridge very distinctly.

The central mountain in Euler, which is very plainly to be seen, and which is shown by Mädler, Lohrman, and Schmidt, is not shown by Neison.

**M. A.**

## CUTTING SCREW-THREADS.

[24038.]—IT is clear from "Vulcan's" last letter that our propositions have got into confusion. At page 560 Mr. Wenham asserted that, in cutting an angular thread of 50°, a revolving V-cutter or V lap-wheel does not give the same-shaped thread as that given by a fixed V-point tool or chaser of the same angle and tilted to the same pitch. I then had to point out that Mr. Wenham had nodded. At page 35 Mr. Wenham, *more suo*, neither justified nor corrected the statement which I had impugned, but produced the usual red herring and went on to argue about "a circular saw," "a square-thread screw of coarse pitch," and "a pair of skew gear wheels." I like red herrings, sometimes, and it is always interesting to study the way in which Mr. Wenham uses them to save himself from the dogs. But what we now say is that Mr. Wenham is wrong, and I ask him either to acknowledge his error or to show where my error is. I may add that Mr. Wenham's proposition is contradicted by Mr. Hines (page 14), and by "Vulcan" (page 35). In practical mechanics the question is one of considerable importance, and there ought to be no fog about its answer.

At page 60 (23973) "Vulcan" now raises a question altogether different, but one which deserves careful consideration. Of course, the cross section of a screw-thread is affected by the angle at which the thread is cut across. The *normal cross section* is made at right angles to the line of the thread, and, for all questions depending upon thread form, it is the section to be regarded. The spiral surfaces of a screw-thread are all ruled surfaces, and are not developable. The only elements which are developable are the spiral elements or the surfaces upon a given *pitch cylinder*. The normal cross-section of the screw-thread is given by a second ruled surface crossing the thread at right angles, and having each transverse radial element to the cylinder on which the thread is cut. Such a section would be given by *one edge* of a square fly-cutter revolving upon an axis parallel to the hypothenusal line which gives the pitch of the thread. The traverse of such revolving cutter-edge would have to describe a spiral surface at right angles to the path of the thread, and radial to the axis of the screw. If the thread were cut without traverse, so as to be an annulus upon the cylinder, and return into itself instead of advancing as a spiral screw-thread, then *the normal section* of the thread would also be its *axial section*, and would be shown in the ordinary diagram of a screw bolt cut by a plane passing through its axis. Our angular thread of 50° pitched to the rate of eight or ten turns to the inch, will have for its axial section a base about as much wider than that of the normal section, as is its secant. If the thread were cut upon a plane surface, the secant of the angle at which the cross-section were made would give the exact length of its base. An annular thread would appear as a ridge normal to the base, and the secant would be 1. An eight per inch thread upon an inch nose would be a hypothenusal ridge at an angle of about 2° 15′ from the normal, and its secant would be 1·0007716. This would make the axial cross-section ·0002in. longer in the base than the normal cross-section—an increment which is negligible, and therefore not before referred to.

In all cases, upon a plane surface, the groove cut will be the counterpart of the cutting plane—this being tilted, so as always to be normal to the line of its traverse. Upon a rotating cylinder the cut is equally a counterpart, but a counterpart modified by the cylindrical curve of the surface upon which it is cut. This modification it is which makes it a screw-thread, and to call the screw-thread "deformed" because of this would be absurd. Nor is this the question raised by Mr. Wenham, who denied the similarity of action between a cutter revolving and a cutter fixed. Instead of the revolving cutter being liable to give a distorted thread, it is the fixed tool which involves that liability, because it is difficult to keep its cut exactly upon the line of centres. This has been well shown by Mr. Hines.

I cannot see what "Vulcan" means by "the angle in a plane of revolution of axis of screw." The normal cross-section of a spiral thread will in all cases be a portion of a spiral surface, and therefore not developable, nor capable of being represented upon a plane except by projection. This spiral surface, or *normal helix*, will be screwed other-handed and to a hypothenusal line whose angle is the complement of the pitch of the thread —i.e., pitched from the axis as much and in the same direction as the thread is pitched from the plane of rotation. Thread-rate in reference to change-wheel calculations is necessarily axial, inasmuch as what we cut is a given number of turns per axial inch of the cylinder. As the line of the *normal helix* is hypothenusal, it will, for a given length of cylinder, always be longer than the axial line. But, for a given number of threads, the normal helix is the shortest possible line. The *stress* borne by a screw-thread is not axial but normal, inasmuch as it is resolved into its components. Therefore, the normal cross-section is the one to which regard should be paid in calculating the strength of thread.

The idea that a more correct form for the lap would be obtained by first cutting a thread by a chaser is a mistake. It is not possible to cut a correct thread by any multiple-point tool. No multiple-point tool can be made as accurately as a single angular point. The multiple points of a cutter wheel can be finished off more accurately than a multiple-pointed chaser; but nothing can equal the accuracy of a single-point tool used as a revolving cutter, or fixed in the slide-rest and traversed under the guidance of change wheels. If all the teeth of a chaser could be ground to equal angles, there would remain the impossibility of getting all their points at equal distances from each other. The result of any failure to make each tooth follow exactly in the track of its predecessors would be to narrow the thread and to deform the groove.

It is always refreshing to see the courage with which Mr. Wenham advances his theories, and the vigour with which he defends them or the skill with which he runs away. If it were possible for anyone to make the readers of the English Mechanic believe that a V-shaped lap or revolving cutter would produce a groove different from that of a V-point tool fixed in the slide rest and set at the same rake, it would be Mr. Wenham, and the more so, because in practical matters we are indebted to him for valued help. **James Edmunds.**

Grafton-street, Bond-street.

### LATHE MANDRELS.

[24039.]—I should like to thank Mr. Wenham, Dr. E., and others, for the interesting matter they have brought before us on this subject, and was much pleased to hear of the cone and key fitting described by Mr. W. Mr. Wenham's letter this week confirms my impression, that whilst Dr. E. is writing of a V-thread, Mr. W. writes of a square one; what he says of the angular difficulty is evidently true of the square thread; but has not, as far as I can see, been proved true of the V-thread of Dr. E. **F. A. M.**

### LATHE MATTERS.

[24040.]—Neither Dr. Edmunds nor myself have ever suggested that "a square thread screw of coarse pitch" can be ground up true by means of a revolving wheel. The contact here would be—not a V-line, but a line and two surfaces, and until two spiral surfaces can be made to coincide with the plane sides of a square-faced grinding wheel, a square screw thead will not allow a counterpart revolving cutter to clear its sides. But there *is* one way in which an extremely true square thread screw of any pitch *can* be finished off by grinding up, and when Mr. Wenham has set himself right on the present question, I shall be very pleased to explain it unless it is done by Dr. Edmunds.

Mr. Wenham seems to imagine that highly-carbonised tool steel is the only "very finest and best quality of cast steel." On the contrary, we now make our taps of a special description of steel which consists of a shell or cylinder of cast steel, which will harden perfectly, and having a core of mild steel which will remain soft, thus securing the advantages of toughness and strength with perfect cutting edges. In some cases, notably in very large mandrels for double-geared lathes, we select a special quality of mild, sound, homogeneous steel such as has already been described by Dr. Edmunds (page 542, No. 1039), and this, of course, we case-harden.

As to the diamond tools for cutting untempered steel, we all know that, as a laboratory experiment, they can be used, and more diamond tools are made to-day than at any previous period, not for turning up hardened steel surfaces, but for trueing up grindstones and emery-wheels, and turning and cutting granite, porphyry, and similar substances, grooving mill-stones, &c., that it is a very old system of turning up hardened traversing mandrels I have distinctly stated, for Cawdron, my great-uncle, who founded the business which I now conduct, regularly used them for the purpose 70 years ago. But the question is, whether, with our modern emery-wheels and other devices, the use of the diamond is a preferable method? None of the ornamental tool-makers use it for their fine hard steel work, and I believe that none of our great engineers do so. Why not, if the method be a practical one? We want accurate and detailed facts upon the subject. Mr. Wenham's correctness may be tested by any reader who has a fine lathe, and who is, as he says, "knowing enough to test its nose with the corner of a file." I venture to say that, but for an accident, the nose of every such lathe will be found to be *soft*, and purposely left so for a reason which is well known to skilled makers. It will be recollected that in a previous letter Mr. Wenham proceeded to show how to soften the nose of a hardened mandrel by means of a hot poker thrust into it, yet, now that I am obliged to differ from him, he endeavours to assail my tools by asserting that if the screw nose is soft they are not good. I need not follow Mr. Wenham about "a screw turned absolutely true, and this truth retained in hardening." It is quite *possible* to arrive at very great accuracy in hardened steel screws, taps, &c.; but such accuracy as Dr. Edmunds requires for his interchangeable mandrel could not be depended upon without grinding up.

"E. J. S." has again favoured us with interesting and suggestive letters; but on these I will write only a few words, for by his letter (23975) he evidently misunderstands what I have stated. He *had* advocated a "long cylinder fit," apparently as a substitute for the Edmunds mandrel face, and I showed that such an arrangement would at the points of entrance wear sufficiently to render it an imperfect system. This has nothing whatever to do with a *taper* fit, which I believe I was the first to introduce as an interchangeable system for lathe centres and drills—in fact, I still continue to supply drills to clients in India, Africa, and Australia, which run perfectly true in spindles sent out a dozen years ago, and this shows that in my manufactory work "to the fraction of the thousandth part of an inch can be produced." I have also always been an advocate for large bearing surfaces, and I was one of the first to apply them.

The suggestion, however, of a second cylinder-fit at the end of the nose is most unpractical. One cylinder-fit, the thickness of a florin, properly placed, as a "stop-surface," will answer every purpose, and its wear in a lifetime will, as I have said, be infinitesimal. To attempt to prevent the "angular variation" by means of a cylinder-fit—single or double, long or short—is a practical absurdity. Nothing of this sort can compete with the wide face of the Edmunds model mandrel-head.

I am so clear that this mandrel-head will be a great improvement in our ornamental lathes, that I am now busy perfecting my patterns and gauges for new model headstocks, which without being more expensive to my clients, will be a great advantage to them. Not only will the chucks, as Mr. Evans says, be absolutely transferable, but we shall get rid of the expense and bother of the old transfer chucks. We also throw overboard the old complicated and unmanageable ornamental lathe-threads, and, as "Z. Y. X." amusingly puts it, "an amateur will be able to go out to spend the evening with a friend and take his chuck with him."

I have to thank Dr. Edmunds for the loan of the models which he exhibited, and for every kindness in reply to my inquiries. **Edward Hines.**

### LAMINATED ARMATURES.

[24041.]—Respecting Mr. H. Harcourt's letter 23933, will *he*, or *they*, kindly each make *their* own statement? One saying I looked at the pieces of iron, a second he filed the sharp corners off, a third he threaded them on the spindle, a fourth he held them on in position, and the united host screwed them up; for, according to H. Harcourt's *neighbour* (F. Walker, in letter 23959*), he states that at least 1in. of compression is required before the laminated discs are screwed sufficiently tight on armature spindle. Now, F. Walker, in letter 23410, Vol. XL., describes a dynamo in which a cross form of laminated armature is used. This armature in question, see Fig. 5, page 136, Vol. XL., will hold little more than half the wire that a Siemens armature of the same dimensions holds—that is, if I may judge from the proportions he gives therein. He further states that he gets on an armature spindle 5½in. in length, 150 discs of sheet iron, the thickness of each being $\frac{1}{20}$th of an inch. In other words, 7½in. thickness of laminations he gets on a spindle 5½in. in length. This is equivalent to compressing the discs about 30 per cent., and by means of a *screw on a ⅜in. spindle*. Hence my suggesting the united co-operation of H. Harcourt and his clique in screwing up this multum-in-parvo laminated armature; that is, supposing the thread and spindle would stand the pressure required. F. Walker has still left unanswered the query 54934, Vol. XL., where "Likervize Walker" asks, "How does Mr. F. Walker get 150 discs, each 1-20th of an inch thick, on to a spindle 5½in. long?" Again referring to above query in No. 1,027 "Cyrax" says, "It is a pity that Mr. F. Walker should have made such a blunder. . . . Mr. F. Walker might explain how he gets 7½in. of discs on to a 5½in. spindle, because that would be news?" If he, in his last letter (23959), refers to the *one inch compression* required for the 7½in. thickness of laminations on spindle, "Likervize Walker," "Cyrax," others, and myself still require to know how they are eventually to be got over the remaining inch—i.e., 2in. of compression in 7½in. length. On the other hand, if he refers to an armature of such a length as required in my motor—viz., 3in.—being made in laminations, he would require originally 80 discs 1-20th of an inch thick each, which, of course, will take up 4in. in length, and these must be squeezed down to 3in. by *means of a screw*. Under these conditions the iron would be compressed lengthways 25 per cent. I trust that no one but F. Walker, unless he has at hand an hydraulic press capable of exerting at least 1,000 tons pressure on the square inch, will attempt such a feat, and, assuming success to attend the effort, where would be the laminations?

After this unfortunate episode one is naturally surprised to see F. Walker in print again, and doing battle for this cross form of armature.

The only part of F. Walker's letter which is at all to the point is the first half of the second paragraph, when he, in trying to defend the armature in question, admits just what I stated—viz., that it is difficult for an amateur to wrap, and holds very little wire.

All who, therefore, contemplate making dynamos or motors, would do well to consider if F. Walker is suited to be their guide, when he himself gets into such terrible pitfalls.

The laminated armature I used, and from which I got such poor results, was that described by F. Walker in No. 1020.

**John E. Chaster,**
Electrical Engineer, Southport.

### VIOLINS.

[24042.]—I have read with much pleasure the two letters on this subject from a "Country Parson." I could have wished to have seen more precise dimensions of the drawings of the Strad. to which he refers, and if "Country Parson" does not object, I would be glad if he would send his address to me under cover to the Editor.

My object in writing on the subject of violins is not to elicit a long correspondence on the merits or distinguishing characteristics of noted old makers. I have at different times read a good deal on this subject, but when we read of this maker adopting a "high" model, or that maker being partial to a "flat" model, it conveys very little real information as to the nature of the curvature used. The curves of the back and belly, both lengthwise and crosswise, should be given in rectangular co-ordinates; the values of $x$ being equal distances on the horizontal line from neck to tail, and the values of $y$ giving the height of the curve at these points. If, as is usual, the entire length be divided into 72 parts, the value of $y$ should be given for every four of these parts. As regards the curve lengthwise, one series of measurements along the centre is sufficient; but for the curves crosswise, they should be taken at three places—across the middle and across the widest part of both top and bottom parts, the places where these lines cut the central line being carefully noted. The thickness of wood at some of the various points should be noted, though it need not be measured for every ordinate; probably for every eight parts of the central line and for every four parts of the cross lines would be sufficient.

A set of these tables for an Amati, a Stradivarius, a Guarnerius, or a Steiner, would enable anyone to plot out the curves and obtain correct templates from them, with a degree of exactitude not to be attained by any other method. Very few persons have the chance to copy a real first-class old violin; and if measurements of such a one exist, it is to be hoped that they will find a place in these pages.

But it may be asked, Why be at all the trouble to imitate exactly an old model, when the chances are that the fiddle will still prove worthless, since, as your correspondent very truly says, "Excellency in violins is not confined to any special form of arching or outline, or to any exact thickness of wood"? To this it may be answered, that while success may be reasonably hoped for by working with good wood on a good model, it is not likely to result from using good wood on a bad model. All that can be done for the violin has been done by the makers above named, and if we depart from the lines they have laid down, it must be a step backwards.

Although the curves in the best violins may not appear alike, it is not improbable that in the best instruments of any one maker, they may still belong to the same family of curves; and even in a "flat" and a "high" model it is not impossible for the curves to be of the same nature, though they differ so much in depth. A surface, the curvature of which is "gentle and easy, and free from any abrupt elevation," seems to indicate that the radius of the curve is governed by a certain law—unwritten, perhaps, but yet known to the eye of the artist. Those who have spent any time in tracing curves from their equations, will be aware how soon the eye is offended when an irregularity of curvature sets in, even in figures of very curious outline.

It would be a difficult, if not an impossible, task to strike out mechanically the governing curves of a violin back or belly, unless it can be proved that they belong to some well-known figure. This is why I have advocated their setting out in rectangular co-ordinates from some known good violins, by which the curve can, of course, be faithfully reproduced; and, also, it can be easily ascertained whether an equation can be deduced which will express the relation between the co-ordinates. I have previously said that the catenary curve seems best adapted for the violin arch, or it may approach nearer a parabola, for in this case these two curves would scarcely be distinguishable. I must, however, leave this and other matters for a subsequent letter. **Orderic Vital.**

[24043.]—In the appendix to Otto's book on "The Violin" there is described "A method for tracing a beautiful model for violin by means of a graduated perpendicular line," in which it is directed that the length of piece of wood intended for the back should be divided into 72 equal parts, in terms of which the description and diagrams are worked out therein. The rise for the back and belly is obtained by cutting a template of hard wood to the arc of a circle, the radius of which equals 216 parts, that is—three times the length of the body of the instrument. I do not know any book in which measurements of a "Strad" violin may be found; but if "Orderic Vital" has not seen the description above referred to, I shall be happy to lend him the book if he will advertise his address. I quite agree with him that age alone does not improve an instrument. An unplayed violin remains stationary as regards quality of tone. **War.**

## A NEW METHOD OF FOMING CRYSTAL MODELS BY PLAITING.

[24044.]—In this letter I propose to consider some of the various forms of "prisms." Fig. 5 is in a form ready for plaiting. As I find the meaning of prefixing — to a number is not quite clear, I substitute the word "under" for it. This is the *right rhombic prism*. It is bounded by six planes, two terminal rhombs, and four lateral planes. Angles of inclination of planes 60° and 120°. Plane angles of terminal rhombs 60° and 120°. Of lateral planes 90°. The tabular right rhombic prism of uric acid is a modification of this.

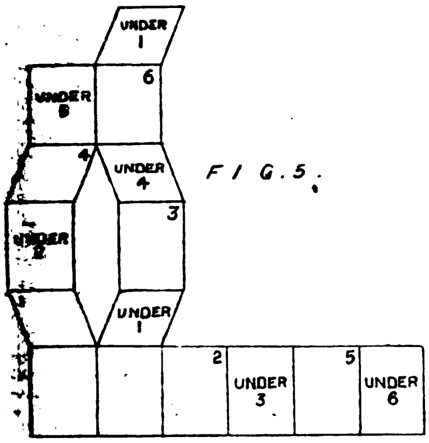

FIG. 5.

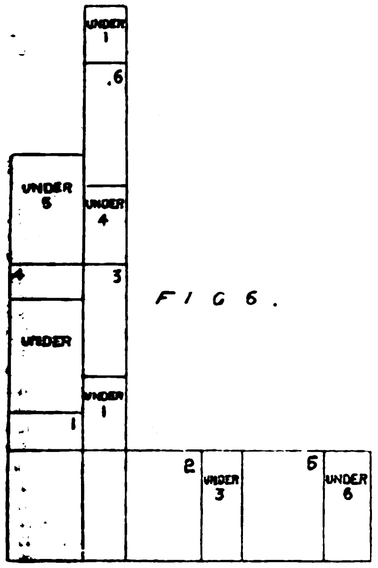

FIG. 6.

The *right rectangular prism* (obtained by plaiting Fig. 6) is bounded by six oblongs of three kinds. Angle of inclination of faces 90°. Plane angles 90°.

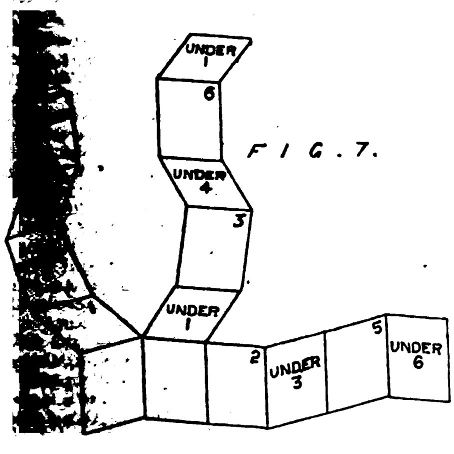

FIG. 7.

The *oblique rhombic prism* (Fig. 7) is the one in which the obliquity of terminal rhombs occurs in direction of their long diagonals. It has 6 faces, two similar and equal terminal rhombs, and four rhomboids. Angles of inclination of faces and plane angles vary. Project a spherical △ on three adjacent sides of crystal. If angles of inclination of planes be A, B, C, and the opposite sides *a*, *b*, *c*. Plane angles are given by the formula—

$$\sin.\ \frac{a}{2} = \left(\frac{-\cos.\ \delta \cos.\ (\delta - a)}{\sin.\ B \sin.\ c}\right)^{\frac{1}{2}}$$

The *oblique rectangular prism* (Fig. 8) is a modification of the last (see table).

Before proceeding with further examples, I had better add the analytical table—the basis of the structure. It will serve to give an outline of the subject. At present I have been explaining it in detail; in my next letter I will endeavour only to add to it the least amount of *necessary* explanation.

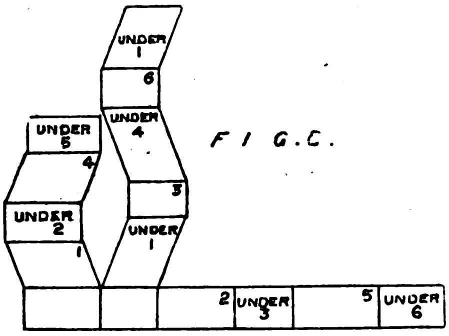

FIG. C.

**Analytical Table.**

| *Cube Simple*; planes entire. | Name of solid cube. |
|---|---|
| Two of its opposite planes brought nearer to, or farther from, each other | Right square prism. |
| Two of its opposite sides approximated | Right rhombic prism. |
| Lateral planes shortened | Right rhombic prism flattened. |
| Lateral edges replaced by rectangles | Right rectangular prism. |
| Elongated in direction of two solid opposite angles | Oblique rhombic prism I. |
| Lateral edges truncated | Oblique rectangular prism I. |
| Shortened in direction of two opposite solid angles | Oblique rectangular prism II.<br>Oblique rhombic prism II. |
| Solid angles deflected from perpendicular in two directions | Doubly oblique prism. |
| Elongated or shortened in direction of two opposite solid angles | Rhombohedron. |
| Plane angles of rhomb. = 101° 55′<br>,, ,, ,, = 60 and 120 } elongated | Acute rhombohedron. |
| ,, ,, ,, = 101 55 | Obtuse rhombohedron. |
| Each rhomb. replaced by scalene triangles | Scalenahedron. |
| ,, ,, two isosceles triangles | Double hexagonal pyramid. |
| + Rhombs. 60° and 120° form subside into | Laminated hexagon. |
| ,, ,, creased in short diagonals | Rectangular octahedron. |
| Planes of remaining octahedrons projected like those of Reg. Oct. | Right square octahedron. |
| Isosceles triangles 33° | Right square octahedron. |
| ,, ,, 70° | Obtuse square octahedron. |
| Scalene ,, 35, 63, 82 | Right rhombic octahedron. |
| Two isosceles triangles | Right rectangular octahedron. |
| Two scalene ,, 33, 60, 87; 38, 64, 78 | Oblique rhombic octahedron. |
| Two isosceles ,, and one scalene | Oblique rectangular octahedron. |
| Four dissimilar scalene | Doubly oblique octahedron. |
| + Rhombs. creased in long diagonals. | |
| Angles 60° and 120° | Tetrahedron. |
| ,, 117° 2′ 8″ | Trigonal dodecahedron. |

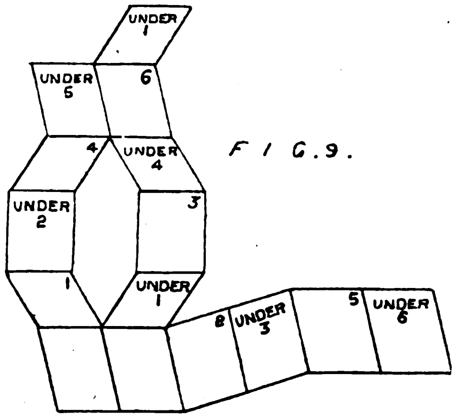

FIG. 9.

The square faces of a cube when projected on a plane surface in a definite order plait into a model of a cube; but other crystal forms, although bounded by planes altogether dissimilar, plait into their respective models in the same consecutive order as those of the cube. On pressing an elastic cube out of its perpendicular in various directions, its faces become transformed into various new shapes and models.

Before closing this letter I will, however, add Fig. 9, the second form of Oblique Rhombic Prisms, so that in another letter I can pass on to rhombohedrons. This prism is bounded by six planes—two rhombs and four rhomboids. For angles of inclinations of planes and plane angles see note on Fig. 7.

Park House, Tonbridge. E. A. Tindall.

## THE MOSAIC COSMOGONY.

[24045.]—In my humble opinion, the discussions which occur periodically in these columns with respect to the first chapter of Genesis are almost, if not altogether, useless; otherwise, I would suggest to our valued correspondent, Mr. Grey (23985), that the defender of the Mosaic cosmogony might take his stand on the nebular hypothesis, according to which the sun would necessarily come into existence last, when the difficulties regarding light and heat for the earth's flora and fauna which he points out would disappear. The antiquity of man is, of course, distinct from the question of his origin.

In structure the gorilla approaches nearest to man. Anatomically, I suppose, there is little difference; yet how great is even the physical contrast between man and the ape! Looking at the flat head of the gorilla, with ridges for the attachment of the biting muscles of the large and powerful jaws (man is the only creature that has a chin), and noting the reversed position of the arms and legs (the fore limbs of the gorilla corresponding as respects length to our legs, and *vice versâ*), I must confess that no amount of *verbal* demonstration will make the animal origin of man to me other than an unproved hypothesis. I am not questioning the law of evolution, only, like almost all other laws, it may have limits and exceptions.

As a matter of fact, so far as is yet known, a large number of animal and vegetable forms have appeared upon the earth suddenly—not generalised, but highly specialised forms. This may or may not be susceptible of explanation by imperfection of the geological record. In the mean time it is an assumption either way.

March 26. J. A.

## THE SIX DAYS OF CREATION.

[24046.]—It was not till after the middle or dark ages, when men were beginning to shake off the chains of religious oppression, which had held them in thrall so long, that they began to make observations in any degree free from the miracle-mongering of the Church. Even in those countries which later on accepted the reformed religion we find philosophers and men of science, either from educational bias, or influenced by circumstances, squaring their views to fit Biblical teachings. It is little more than a generation since that leading men of science were obliged, for truth's sake, to separate once, and for ever, the science of Biblical tradition from science founded on observed facts. Letter 24005, Mr. H. A. Wassell, belongs to the middle period, viz., that of squeezing the round man into the square hole. I, too, like Mr. H. A. Wassell, read the Bible in connection with science; but it was not long before I came to the conclusion that it was an absolute and sinful waste of time. I have studied the Bible for its own sake, and, unlike Mr. Wassell, find that a large portion consists of history and tradition. It is remarkable that many years ago Hugh Miller wrote a paper entitled "The Mosaic Vision of Creation," which tallies in every point with Mr. Wassell's remarks; or is it that his tallies with Hugh Miller's? In either case the observations contained therein are not in consonance with the geological record.

E. S. Hanson, F.G.S.E.

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[24047.]—The scientific value of the narrative of Creation in Genesis may be determined by an investigation into the nature and character of the Hebrew deity. The ancient Hebrews, at different historical epochs, distinguished their God by three distinct appellations—namely, Elohim, which represented the heavens and the heavenly host; Jehovah, the summer; and Adonai (Adonis), the winter sun. In the 110th Psalm we read that "Jehovah said unto Adonai, sit thou at my right hand, until I make thine enemies thy footstool." Now Adonai, Baal, and Moloch signify "Lord," and were names which the Semitic nations gave to the sun as the supreme god, the king of heaven. "Being the source of life to the physical world, his departure from the upper hemisphere in winter was mourned as a temporary death; his return to it, being a new birth, was the occasion of rejoicing." The death of Adonai, at the winter solstice, was commemorated by impure rites by Eastern nations at midsummer, when the sun begins to descend among the wintry signs. Similar ceremonial was practised by the Hebrews in the Temple at Jerusalem (Ezekiel viii.; Kenrick's "Phœnicia," 308-311). The ancient Hebrews evidently worshipped Jehovah both as fire and as the sun. "The fire shall be burning upon the altar; it shall never go out" (Lev. vi. 13). It was as fire that Jehovah appeared—in the thunder and lightnings—on Sinai, the thunder being the voice and the lightning the arm of Jehovah (compare Isaiah xxx. 27-33). Upon the Ark, whose name is Jehovah (2 Samuel vi. 2), fire was kept continually burning, and thus Jehovah went before the Israelites, guiding them, in the wilderness. When removing from their encampments, their God went before them on the shoulders of the priesthood, as a pillar of cloud by day and a pillar of fire by night. When the Ark was removed from the Tabernacle to become the divine leader of Israel on the day's march, the priesthood, on placing it on their shoulders, uttered the invocation, "Rise up Jehovah, and let thine enemies be scattered; and let them that hate thee flee before thee." At the termination of the day's march, the priesthood solemnly solicited their solar God, whose symbol was fire, to "Return, O Jehovah, unto the ten thousand thousands of Israel." Malachi accordingly attributes righteousness to the sun: "Sun of righteousness arise with healing in his wings"; while in the Psalter the solar Jehovah is thus distinguished: "O Jehovah, my God, thou art very great; thou art clothed with honour and majesty. Who coverest thyself with light as with a garment: Who stretchest out the heavens like a curtain: Who layeth the beams of his chambers in the waters: Who maketh the clouds his chariot: Who walketh upon the wings of the wind (Ps. civ. 1—3). Jehovah rode upon a cherub, and did fly: yea, he did fly on the wings of the wind. Jehovah made darkness his secret place; his pavilion round about him were dark waters and thick clouds of the skies. At the brightness that was before him [sunrise] his thick clouds passed, hailstones and coals of fire (Ps. xviii. 10—12). Magnify him that rideth upon the heavens by his name Jehovah, and rejoice before him (Ps. lxviii. 4). Jehovah is King, and hath on glorious apparel; ever since the world began hath thy seat been prepared (Ps. xciii. 1-3). There went up a smoke out of Jehovah's nostrils, and fire out of his mouth devoured: coals were kindled by it (Ps. xvi. 8-9)." It has, therefore, become evident that the God of Israel, as of other nations of antiquity, was the solar deity, and accordingly the Creator of the universe was equally unknown to the Hebrew race as to the inhabitants of the earth at the close of the nineteenth century of the Christian era. The narrative of creation in Genesis is, therefore, of human origin, and consequently of no scientific value in relation to the origin of this planet or the epoch when man first appeared in the pre-historic history of the world. **W. M. Davidson.**

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[24048.]—WITH regard to the fresco of the Zodiac at Denderah, recently referred to by one of your correspondents, the celebrated Egyptologist Champollion has proved that it belongs to the time of the Roman Empire. No conclusion can therefore be drawn from it as to the belief of the Israelites while in Egypt.

May I add, with the utmost possible respect for all who are taking part in this discussion, that it seems to me that the pages of a scientific magazine are hardly fitted for the examination of questions which demand a profound knowledge, not of mathematics or mechanics, but of Oriental languages and theological erudition? **R. D. S.**

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## ETERNITY OF MATTER.

[24049.]—IN his proposition (letter 23997, p. 64) "A. W." assumes that "the material universe has been cooling as long as it has existed." This is not so. The sum of the energy of the material universe, transformable or otherwise, is constant and finite. Hence, in reply to E. G. Tindall (letter 24016), this finite energy, even if transformed into heat, could never have raised the material universe to an infinitely high temperature, for, even after all that energy had been so transformed, we can imagine a still higher temperature.

"R. W. B." seeks an explanation, as applied to heat only, in the transformation of other forms of energy into heat; but the sum of all energies being constant, such transformations cannot go on indefinitely. Yet, while the sum of all energies is, and, according to the law of the "conservation of the physical forces," must remain constant, the equilibrium of these energies must have been, at one time or other, greatly disturbed.

Practically this comes to the same as "A. W.'s" assumption, and makes his argument and conclusion an unanswerable dictum to those who, in order to escape the dilemma of miraculous creation, assume the eternity of matter.

We cannot conceive the existence of matter without energy, so to the "eternity of matter" has to be added the "eternity of energy."

But still more. Energy in a state of equilibrium is like steam applied simultaneously to both sides of the piston, and is practically equivalent to no energy at all. To convert such latent energy into potential energy, the believer in the "eternity of matter and the eternity of energy" must now call in some other unacknowledged or miraculous power to distribute the energy, and so disturb the equilibrium. In other words, to explain Nature as he finds it, he invokes the aid of three unknown powers, while others are satisfied to ascribe all at once to one omniscient, omnipotent, and supreme Being.

The material universe, as we see it, consists of hot bodies and cold bodies. The hot bodies are continually giving out their heat: this heat is not being lost, it is being absorbed by the colder bodies. This has not always been so—remembering that the sum total is constant and finite,—nor will it always continue to be so. Energy is being constantly degraded; work, motion, &c., are being constantly transformed into heat, which in turn is being dissipated to form one universal and uniform temperature throughout the whole material universe, and when the dead level has been attained—as it may already have been anteriorly in the distant past,—life and work will have become impossible. Therefore, as "A. W." proposes, "the present course of events called Nature has not always existed." **H. B. F.**

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## THE ANTIQUITY OF MAN.

[24050.]—THE letters which have appeared for some weeks past upon this subject have all taken it for granted that man has existed through untold ages, and the earth itself also. Now surely this is a Q.E.D. As a working hypothesis I may believe many things as true, but not as an absolutely correct belief. I look upon the belief in a great antiquity and in evolution as I look upon the common definition of a mathematical point—that is, a means of marshalling one's ideas, but surely not to be sworn by. It would be a good thing if the "great antiquity" people would be a little less dogmatic, and allow that a man may have some brains who even held that the earth and its contents are all recent. **Geo. Bishop.**

Curate of St. Ann's, Nottingham.

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## THE STATE OF MAN.

[24051.]—As "Dens," letter 24010, evidently believes there has been a universal deluge, I would refer him to "The Sacred Theory of the Earth," by Dr. T. Burnet, 1699, in which he will find much amusing and some instructive matter. I dissent entirely from the view put forth by "Dens"—that "the idea of a deluge, such as told in Genesis, has been ridiculed as an impossibility from the supposed want of water." That is *one* of the arguments advanced by *some* writers in refutation of the Deluge. I should be much obliged to "Dens" if he will send me six of those same chipped flints as are to be found in the valley of the Somme out of one of the cartloads from any of the chalk pits of Hertfordshire; I will gladly pay carriage. I understand "Dens" to mean the 6,400 years accepted by Sir John Lubbock, from a calculation made by M. Marlet, as referring to the age of the Swiss lake dwellings. But it is quite possible that hundreds of years elapsed during which these dwellings were occupied. Then, again, we have to take into consideration the great lapse of time that must have taken place to produce the degree of constructive ingenuity displayed by the builders of these lake dwellings. So that, as far as the original state of man is concerned, we are as wise as before. In letter 24013, as "Dens" condemns the Age of Ice, I advise him to read, if he has not already done so, Lyell's "Antiquity of Man," Croll's "Climate and Time," J. Geikie's "Great Ice Age," A. C. Ramsay's "Physical Geology and Geography of Great Britain," and also to keep beside him, for constant reading and reliable reference, A. Geikie's "Textbook of Geology"; all these authors treat very fully of the Glacial epoch. I also advise "Priam" (24014) to read the above books. I opine he uses the word "drift" to include boulder clay, glacial drift, and loess, which may be termed river drift. The general questions opened up by this corespondence are far too great, and of too much importance, to be disposed of in a summary manner, and those who have not read up the subject in a systematic manner, but who are interested in it, had better do so at once, and then they will be in a position to draw juster conclusions. Mere reading will be of little avail, unless they, like those who have studied these questions, combine their reading with personal observations of the operations of nature from the geologist's standpoint whose motto is "the present is the key to the past." The observations of James Hutton in Scotland, and William Smith in England—the fathers of geology—were held in quite as much ridicule in their day as the Glacial theory and some others are by their opponents at the present day; still the arguments they advanced, which were founded on observed facts, soon overthrew the hypothetical theories of the earth that had vexed men's minds so long. **E. S. Hanson, F.G.S.E.**

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[24052.]—WHILE I agree with Mr. Wassell in the general scope of his remarks, I consider that it is not necessary to include the geological days or periods between the events referred to in Gen. i. 1, 2. McCausland, in his "Sermons on Stones," has shown the correspondence between these periods and the epochs of geology. The first day included the time before the nebulous matter was sufficiently cooled and consolidated to allow the existence of life on its surface. The semi-solid portion was "invisible," covered with vapour, and "unfurnished," "without form and void" (see Septuagint translation). At its close the darkness cleared away to some extent, and the influence of the sun sufficed for day to be distinguished from night. During the second era clouds were formed, rain fell, and trilobites and other crustacea inhabited the heated sea which then covered the earth. During the third period the Devonians and plants first grew. During the fourth day the clearer atmosphere enabled the sun to exert greater influence (in the poetical language of Moses, to "rule the day"), and the carboniferous flora flourished. In the fifth, from the Lias and Oolite to the close of the Chalk formation, air-breathing animals and reptiles ("great sea monsters") abounded. The sixth (Tertiary) was ushered in by the creation of the gigantic mammals and terminated by the appearance of man.

As the Mosaic account has been treated by some of your correspondents with scant courtesy, allow me to recommend to my fellow readers an inexpensive work, "Old Faiths in New Light" (Ward and Co.), which shows how admirably it was adapted to the early education of the human race. I do not agree with "Dens" that "palæolithic man is only a myth." Has he read "Dawkins's "Cave Dwellings"? May not the flint flakes have been the weapons of a people contemporary with the mammoth, &c., which passed away before the appearance of the Adamic race, to whose history alone the sacred narrative refers? See McCausland's "Adam and the Adamite," "The Genesis of the Earth and Man," by Reginald Poole, and to show that this is no novel notion, see a curious volume of sermons, "Men before Adam," 1656.

I will only intrude further on your valuable space by reminding your readers residing in London or the suburbs that a ticket of admission to the library at the British Museum may be obtained (gratis) on the recommendation of two householders, and that the obliging officials there are always ready to give every assistance to new readers as to the choice of books on every subject, and the means of finding them. **Otter.**

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[24053.]—THE attempt to reconcile the Mosaic account of the Creation with modern scientific evidence is as futile as it would be to attempt to trace the theory of gravitation in the lore of ancient astrology. Discussions of this character are, unfortunately, always liable to jar on the sensitive nerves of some well-meaning people; but it is to be regretted that such individuals should, in order to support their religious convictions, make statements of a scientific character without first being certain of their truth. Thus, "J. H.," in letter 23927, says, "The fault lies with the scientists in not putting events in their proper form and order," and then, by way of putting things in better form, says, "That climatic changes were made by the *internal heat of the earth*, and *not by the sun*."

It would be interesting to learn how the variations of climate *could* be caused by internal heat, but until more light is thrown on the matter, I shall still believe that the sun has "just a leetle" to do with the climate. Then, after speaking of the first dawn and successively higher forms of life, "J. H." says "a glacial period put an end to it all by the world becoming frozen, desolate, and *dead*." Now, I do not think there is any scientific evidence to support this assertion. We know that over certain parts of the earth glacial periods of long duration have prevailed, but not over all the earth simultaneously. And even in Europe and North America, where the geological evidences of intense cold are most abundant, we have the authority of Lyell for believing that "quadrupeds of living, as well as extinct, species were common to pre-Glacial and post-Glacial times." Such a total destruction of life as "J. H." speaks of is not only not in accordance with geological teaching, but is quite reversed to it. It is now generally believed that animal life, since its first existence on earth, has been both continuous and progressive; and to believe, and spread the belief, that all life on earth recommenced after each glacial epoch is inaccurate and misleading.

Another way of attempting to reconcile the Mosaic account of the Creation with geology is to suppose that the six days were six periods, each of which might be thousands of years. There is not, so far as I know, any reason for the word day being regarded in any other than its usual signification; but if there were, it would not materially help to smooth the difficulties of comparison. If six long periods were meant, such as would allow time for the evolution of species as found in geological records, we should then have to believe that the earth existed and passed through the various stages comprised in three of these periods before the sun was in existence; and also that the trees of the field, and the grass and the herbs grew and bloomed in darkness and cold, for they were made in the period preceding that in which the lights were placed in the heavens.

It seems to me like "breaking a butterfly on a wheel" to try to make such reconciliation. The two theories, evolution and special creation, stand quite separate, one supported by a host of natural facts, the other supported only by the Mosaic statement. "O. J. L." and other thinkers may easily choose for themselves which theory to believe. **Silex Seadrif.**

## THE STATE OF MAN.

[24054.]—If your correspondents, "Priam" and "Memnon," will kindly read such an elementary book as Tomline's "Christian Theology," Vol. I. Part 1, they will probably see the shallowness of any arguments that object to Moses being the editor of the Pentateuch. **M. A.**

[24055.]—Some of your correspondents seem to have overlooked one circumstance in connection with the Scriptural dates which surely ought to be taken into account when we wish to determine such a question as whether Methuselah outlived the Deluge or not. It is this: The dates are only given, as it were, in round numbers; that is, only years are mentioned, in most instances, in giving the date of an event; but not months and days—as, age of Methuselah at birth of Lamech, 187 years; of Lamech at birth of Noah, 182; of Noah at Deluge, 600. Total 969 = age of Methuselah. Further on, however, in v. 11. ch. 7, it is said that: "In the six-hundredth year of the life of Noah, in the second month, in the seventeenth day of the month, all the fountains of the great deep were broken up," &c. Now, this certainly seems to imply that Noah, instead of being exactly 600 years old at time of Deluge, was only 599 years, 1 month, 16 days; and, according to this, Methuselah must certainly have outlived the Deluge, as "F.R.A.S." says. Perhaps, however, it will be impossible to come to any certain conclusion on this point without knowing how many months, if any, are to be added to or subtracted from the various ages; but, as the words stand, taking into account the correction in v. 11, it seems difficult to draw any other conclusion than that by "F.R.A.S."

Perhaps the views of our old friend, John Hampden, whatever may be thought of their scientific accuracy, are, at all events, more in accordance with Scripture than are those of many of our readers.

The remark of Mr. Ranyard in your last number (p. 55) that when strong language is used, "They will devote their time to criticising his language rather than to answering his arguments," is certainly deserving of all attention. He well describes the usual tactics of those who have a bad case to defend. Still, however, where great abuses exist they are generally denounced in strong language, nor is it by any means self-evident why the fact that the society in which there may be abuses is a scientific one, should be any reason, as some of your correspondents seem to think it ought, why its proceedings should be exempt from the kind of criticism which would be employed in the case of, say, a Worshipful Company of Bellows-menders; or, again, of those who habitually obstruct business in "another place." **W. G. P.**

[24056.]—In reply to "A. C." (24009), I remark that the reason given in Deuteronomy, *why* the Sabbath was to be kept, is *not* stated to be in addition to the reason given in Exodus, as he infers. To say that it is an addition, is simply to beg the question also. That the words given in Exodus were meant especially for Jews, and not for "man" in general, as the statements are preceded by the words, "I am the Lord thy God, which have brought thee out of the land of Egypt," seem quite clear; moreover, we do not know of any other people keeping the Sabbath for the reason alleged.

That the Sabbath was kept in Babylonia (from whence Abraham came) seems likely or certain; but there it seems to have had connection with the worship in some way, of the seven heavenly moving bodies, and not with the six days of Creation. No such custom was kept in Egypt, and anything which might occur at the Temple of Denderah is of so small value as regards ancient history, as it is a Ptolemaic and very late structure. Deuteronomy is considered by many to be a late book for many reasons, and was probably the book *found* in the temple in B C. 624, in the time of the pious Josiah, but which seem to have been previously unknown; for although in Deut. xxxi. 24, 26, it is said: "Take the book of the Law and put it in the side of the Ark of the Covenant," yet we know it was not there in Solomon's time, for in 1 Kings viii. 9, it says, "There was nothing in the Ark save the two tables of stone." As this Book of the Law was not known till 624 B.C., it is probable that it was written about that time, and its language, &c., seems more suitable to that period than to that of the escape from Egypt. "Numbers" seems more ancient, but probably was written *after* Saul's victory over Agag, as it says, xxiv. 7, "And his King shall be higher than Agag." "Leviticus" must have been written after, and not before, the Israelitish occupation of Palestine, as it says at xviii. 24, 27, 28, "Defile not yourselves in any of these things . . . . that the land vomit not you out, *as it vomited forth* the nations which were *before you*."

The difficulty also occurs in Deut. ii. 12, when it says, "The Horims also dwelt in Seir before time; but the children of Esau succeeded them, when they had destroyed them from before them, and dwelt in their stead, as Israel *did unto* the land of his possession, which the Lord gave unto them." Moses surely would have said as "Israel will do," not "did," as they had *not done it* in his time.

The word "Kirjatharba" is interesting in more ways than "A. C." mentions. We read in Genesis xxiii. 2, "And Sarah died in Kirjatharba; the same is Hebron." And at xxxv. 27, "And Jacob came unto the city of Arba, which is Hebron." These statements must have been written *after* the establishment of the Hebrew cities and Hebrew names, and not before it.

The slight difference of language mentioned by "A. C." (who is sure to have given his best cases) between parts of the Pentateuch and the later books, only proves what I do not deny—namely, that some difference of date exists between the books; but does *not* explain away the difficulty I raised, which is the unreasonableness of supposing that from 70 people of all ages, and their descendants who resided many hundred years in Egypt, an immense slave population of 3,000,000 should issue forth into the deserts, speaking and understanding a pure and well-developed Canaanitish language, just the same as their descendants used in Canaan about 1,000 years afterwards.

There was no reason why they should have preserved the Canaanitish tongue, as they hated the Canaanites, and their Ancestor came from Ur of the Chaldees. When we find them in real historic time in Canaan, we find them using a language related to that of other tribes evidently allied to them; but we know that the Semitic Phœnicians, who were Canaanites, and were related to the Jews slightly, used a language that is not the same as Hebrew, as we know it, but may have been like what Isaac used.

The name "Hebrew" is, I believe, peculiar to the Jews, so that the words attributed to Joseph in Genesis xl. 15, "I was stolen from the land of the Hebrews," simply proves the late origin of the book, as there were but 70 Hebrews then in Canaan, and no one can have called it their land, as no one would know what land was meant by that name under any circumstances but themselves.

I am afraid the names mentioned by "A. C." only go towards proving that the Hebrew tongue was allied to, perhaps derived from, Canaanitish sources—not that pure Hebrew was spoken by Moses's generation. It is perfectly true that our division of the Bible into chapters and verses is modern; but its division into books is not, therefore I fail to see why the last chapter should be transferred to the book of Joshua, which is not part of the Pentateuch at all.

In reply to his objection respecting the references to the Kings of Israel, I must say that kings could not be looked upon with pride or satisfaction by Jacob or Moses, if they were in harmony with Samuel. Indeed, in the face of 1 Samuel viii. 7, where it is said, "The Lord said unto Samuel, Hearken unto the voice of the people in all they say unto thee, for they have not rejected thee, but they *have rejected me* that I should not reign over them," and as the people demanded a king, Samuel gave them one very unwillingly, and after eloquently describing what an unpleasant person a king might be expected to be.

This incident makes the quotation from Genesis by "A. C." appear to be written after the kingly time, and increases the meaning I put on the passages I quoted from Gen. xxxvi. 31. If Moses had written the book, the passage would probably run thus: "These are the kings that ruled over Edom before the Children of Israel entered Canaan," and not "before there reigned any king over the Children of Israel."

I would like to know what Mr. Wassell (24005) understands by "chaos"? or the passage, "The earth was without form and void"? Do they include the development of the stratified rocks with their fossils? Do they permit the growth of trees and plants? Do they allow of the existence of millions of highly organised animals with eyes, &c.? as, if so, had we not better expunge such misleading terms? They were certainly not so understood by any one till recently—till science had proved that the world existed and was filled with plants and animals for countless ages.

I would also like his opinion on the words in Exodus which assert that the heavens and the earth, and also all that in them is were made in six days, as they appear as if written to exclude Mr. Wassell's plan, and to exclude it in words of remarkable clearness and decision.

As there was no one in Eden while the world was being made, it is hard to know why the necessarily erroneous views a man would take if stationed there should be written down for all posterity by Omnipotence as truth.

Allow me to correct a clerical error in my last, as in it I used the name "Manetho" instead of "Menes." Manetho is the earliest Egyptian historian, and speaks of Menes, the earliest king. **Memnon.**

[We must apply "the closure." The letters to hand this week are so numerous that it is impossible to find space for a tenth of them, and each week the subject widens. We regret that in one or two instances correspondents have not shown due consideration for the opinions of others who may not yet have attained to the clearer perception of truth of which they deem themselves assured, and that on the other side an undue nervousness as to the effect of such controversies on religion has been manifested. We think with the writer of one of the ablest of the unprinted letters which lies before us as we write, that "there are no more powerful and insidious enemies of the Bible than those who persist in reading actual history and modern science into its poetry and allegories," and we fear, with the writer, "such a relapse into a blank stupid atheism as may well appal the stoutest heart," as the result of such an endeavour.—Ed.]

## DIAMOND FOR CUTTING TOOLS.

[24057.]—For all the purposes of drilling, turning, and cutting hard steel, I prefer splinters of the crystal or gem diamond. These can generally be selected with suitable sharp edges or points. The black diamond, or "carbonado," came into the market about 35 years ago, or it was at that period that I procured my first example. It was then to be had at 12s. per carat. It has risen since to double that price. I prefer this to the gem for turning glass, as, from an apparent porosity, it retains a rough corner for a longer time, for, after some use as a glass-turning tool, both the gem splinters and the edges of the carbonado get blunt and polished, and the latter being more brittle, a fragment can sometimes be broken off to furnish a fresh edge, or rather corner. I have seen the carbonado in irregular pieces, one nearly the size of a hazel nut, which looked as if it had been broken off something yet bigger; and I am acquainted with a turning tool consisting of a piece of carbonado that cost nearly £11. It is mounted in a long handle, so as to be held to the shoulder.

What is the origin or source of this mysterious but exceedingly useful material? In one lot that I bought many years ago from a dealer in Hatton-garden, there was a piece nearly a perfect sphere, two-tenths of an inch in diameter. The exterior has the appearance of minute crystalisation, or is covered with glittering laminæ, not to be broken off. The weight of the nodule is 1·6 carat, and it forms such an interesting subject for the microscope that I never had the heart to pound it up for lapidary purposes, though it is rather a costly object, its value being 38s. 6d. Are any of the largest nodules invested with a crystaline coat of this description? If so, they would resemble some samples of pyrites? Can any of our readers give a description of the matrix or native bed in which this useful material is found, but which I suspect is held as a monopoly for maintaining a high price. **F. H. Wenham.**

## ORDNANCE MAPS—PROJECTION, &c.

[24058.]—I am glad to have it in my power to give a reply to the query of "F.R.A.S." on this subject, and as I am indebted to the courtesy of the Director-General of the Ordnance Survey for the information, it is, of course, authentic.

I can strongly support the wish of "F.R.A.S." for the issue of a convenient hand-book relating to these maps, as, though there exists a large volume containing information on certain points, such a the mode of adjusting the differences due to errors in taking the levels (by the method of least squares), together with lists of the bench marks, and such like, yet no simple manual has ever been issued. The issue of the maps themselves is also susceptible of improvement. When an ordinary firm finds a large demand for a work, they issue a fresh edition; but the Ordnance Department goes on the opposite principle, and keeps on raising the price till the demand is checked, so that the price is often more than doubled in a very short time.

The following is given in almost the exact form in which I received it, and has not before appeared in print, so far as I know:—

The projection used for the "one-inch" map of England is that employed by Casimir de Thury for a map of France in the last century, and is simply a meridional plane chart.

The distances measured on the prime meridian, and perpendicular thereto, have their true spheroidal proportion on the map. The maximum variation of scale at any point varies with the secant of the distance from the prime meridian; but this variation is not sensible within the limits of a sheet of the map, and is much less than is due to the expansion and contraction of the paper. The marginal lines of the sheets are parallel, and perpendicular to the prime meridian. The projection of the "one-inch" map of Scotland is slightly different, the distances on the prime meridian (4° of west longitude) are in their true proportion, and also the lengths of arcs of longitude (not the perpendiculars to the prime meridian, as in England). In effect, this is a modification of the conical projection, so that theoretically the areas of the surfaces are correctly represented. The distortion of distances is different, but not very dissimilar, to that of the projection used for England.

A. S. L.

### MINERAL-OIL LAMPS.

[24059.]—In your columns of the 27th inst. a letter signed J. Hughes expresses grave dissent from Sir Frederick Abel's opinion that metal "reservoirs" for the oil are preferable to those of glass or earthenware, because, says J. Hughes, metal being a good conductor of heat, rapidly heats the oil; whereas glass, china, and the like being non-conductors of heat, the oil remains cool.

Now, in differing with J. Hughes, my reasons shall be stated. Please to bear in mind the meaning of the two terms as follows:—1. A conductor of heat conveys it away. 2. A non-conductor of heat retains it.

Of two lamps of the same size and shape, let us assume all things identical, such as oil, wick, burner, chimney, flame, &c.; but one lamp shall have its reservoir of copper, a good conductor, and the other of earthenware, a non-conductor.

Of course, the heat generated by each of the burners will be the same. Will J. Hughes kindly state what becomes of it? Is it conveyed away or retained?

His letter finishes thus: "But I am convinced that far more danger would accrue from the general heating of the oil in metal containers than from the few occasional fractures."

Now, the fact is, that lamps of tin, the "reservoirs" of which are about 2½in. by 2in. by 1¼in. deep, costing 6d., are in use by the million in this country, also in Europe generally, and probably over all parts of the world.

**J. D. Shakespear**, A.M.Inst.C.E.
Institution of Civil Engineers, 25, Great
George-street, S.W., March 30.

### THE SKRIVANOW BATTERY.

[24060.]—Is there likely to be any truth in that paragraph which appears on page 54? It was also given by an electrical paper, and I wrote to an eminent firm, who manufacture such forms, to ask if these results had really been achieved. Their answer did not give much encouragement.

But if there is anything in it, would not the Grove battery be superseded for the electrical lantern? And, by the way, how would the "Sun" incandescent arc-lamp answer for this purpose, instead of the Duboscq? Has it been tried?

**Antares.**

**Transit of Jupiter's Third Satellite.**—ERRATUM.—In Mr. Ellis's letter on p. 78, eighth line, "II." should be "Jupiter," the mistake having arisen through the use of the sign for that planet.

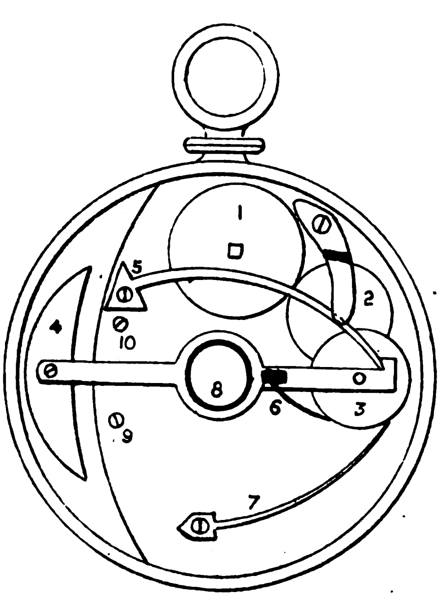
A TELEPHONE ticket, at half a franc, has been issued, the holder of which is entitled at any of the Paris post-offices to hold five minutes' conversation with persons in any other post-office, or at any of the Telephone Company's stations. The system came into operation on Sunday last. The Telephone Company offers, at the same rate, conversations at any of its eleven stations with persons at any other station or at the residence of any of its subscribers.

## REPLIES TO QUERIES.

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[55827.]—**Gravity 'Scapewheels.**—I am sorry I cannot give Mr. Floyd any definite information about the use of aluminium bronze for the 'scapewheels of large gravity escapement clocks, beyond my own opinion that it is well adapted for them. But Messrs. Gillett and Co. (no longer Gillett and Bland) use phosphor bronze for them, which seems to do very well, and I believe is cheaper than the other. It has the advantage over steel for large wheels that it can be cast, while steel ones have to be cut out of a plate. For regulation size, up to about 5in. diam. in a four-legged wheel, I have never seen anything but steel used, because lightness is desirable.—EDM. BECKETT.

[55930.]—**Watch Winding.**—As requested by "M.M.I.Sc.S.," I send the following sketch.



1 is wheel fastened on to end of barrel-arbor on square under dial; 2 is an intermediate pitching into No. 1, and into pinion under 3; 3 is a ratchet-wheel with the finest possible teeth; 4 is the pendulum working up and down by the action of walking; 5 is spring to keep it evenly balanced between two screws 9 and 10; 6 is spring attached to pendulum working into ratchet-wheel; 7 is spring fastened to plate, working also into wheel; 8 is a space to free the hour wheel. The above is patented under the name of Loehr's.—ANNIE.

[55870.]—**Optics with the Lantern.**—The reversal of the sodium line is always a rather ticklish experiment. When I was working it out, I used a jet lent me by a friend for some time, of great power; some time after that, when I attempted it in just the same way with an average jet, I found considerable difficulty. The essentials appear to be, a very brilliant light for the ordinary spectrum, sufficient to *overpower* the sodium light; and then a good gush of sodium vapour, from quite a good piece of metal, *not too hot*. The latter condition is best attended to by varying the position (perpendicularly) of the gush of sodium vapour; and hence the boxed-in arrangement described by "S." is a drawback to success. The closer the slit and sodium can be got to the lime the better; as the further off they are, the greater *proportionate* brilliance has the sodium flame on the screen; whereas we want it the least possible. I have lately been endeavouring to devise details which may make the result certain; but they are not finally tested yet, and more pressing experiments must hinder for at least a week or two. As the subject is not of very general interest, if "S." will send his address, through the Editor, as soon as I have time to perfect them I will communicate with him, or if in London in person. Meantime he may derive a hint from the description last week of Mr. Cleminshaw's experiments, though the results as exhibited would by no means satisfy me; the condensation of limelight on the slit is, however, sound, and the principle of my own arrangements. Lastly, in reference to the letter (23978) of "E. R. P.," whose lantern arrangement seems very ingenious and useful, it will be observed that his position for a prism, described as "close in front" of the *lantern* objective, is practically just close to the crossing-point. However, there is no reason why anyone should not place a prism or any other apparatus precisely wherever he finds it best; though if "S." is in London, I should like to get to the bottom of his experience.—L. WRIGHT.

[55933.]—**Old Locomotives.**—In the *Mechanics' Magazine* for Jan. 28, 1832, there is an account of some experiments "recently made" on the Canterbury and Whitstable railway, in the form of a letter, which bears the date of Jan. 7, 1832. The line, it appears, ran out of Canterbury up a gradient through a tunnel until it reached a summit, whence it proceeded fairly level to a falling gradient followed by a level run of a mile, and then a descending curve into Whitstable, the distance being six miles. Stationary engines were placed at each end of the summit level; but the level run of a mile was worked by "one locomotive engine, on Stephenson's principle, of 10 horse-power." This engine appears to have gone at the rate of 4·61 miles per hour going to Whitstable, and at 8 miles an hour on the return journey. The name of the engine is not mentioned, although the writer took the times and distances himself. He signs himself "F. W.," and writes from Ely-place. It is evident, therefore, that a locomotive engine was running on the Canterbury-Whitstable line at the very beginning of 1832, and tolerably obvious that it must have been there in 1831. As to what explanation can be given of the statement referred to, it is only that which is patent to all who have had occasion to examine historical evidences, that the writer was stating only what he believed to be true. Old volumes of the *Mechanics' Magazine* can occasionally be picked up at second-hand bookstalls; they are worth all the money usually asked for them.—NUN. DOR.

[55961.]—**Horse-power of Engines.**—The method of calculating the horse-power of steam-engines has been frequently given, and "Side Lever" can hardly expect that anyone will sit down and work out a sum for him which will be of no use to anyone else.—ESSAR.

[55967.]—**Shading.**—Would this querist explain what it is he wants to know? If he means colouring or tinting drawings, surely the answer will be, In the usual way.—ESSAR.

[55970.]—**Soluble Essence of Ginger.**—"Nemo" asks how to make the insoluble resin and volatile oil found in essence of ginger miscible in water. It cannot be done, or, to be more accurate, no one has yet done it. The soluble essences are prepared by precipitating and filtering out the substances which will not mix with water.—NUN. DOR.

[56025.]—**Trueing Grindstone.**—In my reply, p. 40, I did not refer to "Nun. Dor.," and did not know anything of the accusation he says has been made against him. Has he not found a cap, tried it on, and found it to fit, and appropriated it? If "Nun. Dor." will refer to Mr. Williams's question and subsequent explanation, he will see that Mr. Williams, when he first wrote, knew nothing about what he now says is the fact—viz., that the invention in question was not protected by patent. I agree with "Nun. Dor." that, notwithstanding the words of the prohibitory clause in a patent, a man may make a patented machine for the purpose of seeing whether it can be improved; but Mr. Williams was not (in his letter) asking for information for the purpose of making experiments.—Z. Y. X.

[56055.]—**Diazo-Salicylic Acid Sulphate.**—To "C. W. S."—This is obtained from salicylic acid. The process is somewhat complicated, it is true, and requires a practical acquaintance with the preparation of many of the compounds in organic chemistry. Salicylic acid is produced by several methods. 1st. Oil of winter green (*Gaultheria procumbens*) distilled with potash. 2nd. From the flowers of *Spiræa ullmaria*. The flowers are exhausted with ether, or the water distilled from them, with frequent cohabation, is shaken up with ether; the ethereal solution is distilled, and the residue is treated with water which dissolves salicylic acid and tannin. The aqueous solution is neutralised with carbonate of soda, evaporated and distilled with hydrochloric acid. The watery distillate, slowly evaporated, yields colourless crystals of salicylic acid. 3rd. Salicylic acid is now prepared on the large scale by synthesis from phenol. Sodium phenylate is first prepared by dissolving phenol (better known as the white crystalline carbolic acid) in caustic soda, and then passing carbon dioxide into the dry salt, which is slowly heated up to 220° to 250° (Centigrade). The sodium salicylate thus formed is distilled with hydrochloric acid, as given in the previous method. Now, diazo-salicylic acid sulphate is the double acid of diazo-salicylic acid and sulphuric acid, and is prepared by dissolving diazo-salicylic acid in sulphuric acid (not too strong); the solution, on cooling, deposits the substance you require—viz., diazo-salicylic acid sulphate. Diazo-salicylic acid is prepared by passing nitrous acid into an alcoholic solution of the hydrochloride of amidosalicylic acid, when slender needles are formed, which may be recrystallised from hot alcohol, but are decomposed by long boiling, with evolution of nitrogen. Hydrochloride of amidosalicylic acid is produced by the action of tin and hydrochloric acid on nitrosalicylic acid. The liquid obtained solidifies to a crystalline pulp, consisting of a compound of stannous chloride, with the hydrochloride of amidosalicylic acid, which, when dissolved in water, decomposed with sulphuretted hydrogen, and evaporated in a stream of that gas, yields colourless crystals of the hydrochloride of amidosalicylic acid. This acid is insol. in cold water and alcohol. Its hot, aqueous solution exposed to the air quickly decomposes. Nitro-salicylic acid is produced by acting on salicylic acid by means of boiling nitric acid, and washing the resulting crystals in cold water. Hence to obtain diazo-salicylic acid sulphate, you require to form the compounds as hereinbefore described in the following order: 1st, Salicylic acid; 2nd, nitro-salicylic acid; 3rd, hydrochloride of amidosalicylic acid; 4th, diazo-salicylic acid, and 5th, the compound you require. Your query states you have "dialysed for it": this would lead me to suppose the "diazo" has misled you. Dialysis is distinctly a method of separating crystalloids from colloids, and is in no way connected with what you require. Try Woolley and Sons, 69, Market-street, Manchester, as I can often obtain from them what I cannot in London.—JOHN E. CHASTER.

[56064.] — **Troublesome Battery.** — Many thanks to "C. D. R." and Mr. J. Kean for their kind answers to my query of the above. I have done to my battery what both those gentlemen suggested, and up till now I find them going on satisfactorily. Why I ask if old charge would do in new pots—I have some which have given up working, and thought new pots were wanted. 2, I want to make a coil for strong shocks. I have been reading back numbers, and cannot find where to connect the handles, and by drawing out the brass tube as a regulator, does the core come out also? If Mr. J. Kean or some other kind reader would give me the best way to proceed, I should be greatly obliged. Would a piece of ¾ iron pipe cased outside with brass do for the regulator? Now for the battery. I have a glass cell, two plates of carbon 5¼ long, 1⅜in. wide, and a zinc the same size, with six ounces of bichromate of potash to a pint and a half of water. Would that do to work the coil? Please say how much primary and secondary will be wanted.—J. PARSONS.

[56081.] — **Baffled.** — To "A. S. T. E."—I beg to thank "A. S. T. E." for his reply to my query, and to inform him that I cannot use a pivoted needle on account of the E.M.F. being only just sufficient to move the astatic one. I have tried the platinum and carbon contact he recommends with the astatic system, but with less favourable results than with the platinum alone, as I find the two require a considerable amount of pressure before they will act. I wish to say, however, that I regard the sticking of the contact pin as an advantage rather than an evil, as I propose to apply a contact breaker to the needle, which will only be allowed about a quarter of an inch play. Leaving out the carbon, if I moisten the pin with a little sulphuric acid, its action is nearly perfect. Could he kindly suggest any other material for the pin, since sticking is no obstacle? I should mention that I used common gas carbon in the experiment above referred to.—BAFFLED.

[56086.] — **Optical Formulæ — Nobert's Ruling Machine.**—I am glad my friend "Ascalon" has called attention to the formula in Ross paper on page 445, last volume. Ross annexes the two small letters *o* and *c* to the capital R to denote the *outside* and *contact* surfaces of the flint, and as the letter *c* is afterwards introduced into the calculation, some confusion is liable to arise. The italic *f* is a misprint or mistake for F″, and in the denominator the value *c* is apparently involved in its own formula. Perhaps I had better alter the nomenclature by making R′ denote the outer radius, *r′* the inner radius, using a capital C instead of a small *c*, and a small *c* instead of *c′*. Then the formula should stand as follows:—

$$R' = (1 + q')\,F'a' \ : \ r' = \frac{1 + q'}{q'}\,F'a'$$

Next for the auxiliary values:—

$$b = \frac{a'}{1 + a'}\ ;\ C = \frac{F''}{r'}\ ;\ c = \frac{(1 + a')\,F''q'}{a'F'' - R'}$$

And, finally, for the spheric aberration:—

$$p = \left\{ \begin{array}{l} \dfrac{(C + q')^2}{(a'C - q')^2} \cdot \dfrac{C + (a' + 2)\,q'}{C(a'c + a + 1)^2} + \\ \dfrac{(c + 1)^2}{(bc + 1)^2} \cdot \dfrac{(c + 2 - b)\,q'}{c} \end{array} \right\} \frac{a\,s}{q' + 1}$$

The reader who wishes to correct the formula on p. 445 must recollect that wherever C appears in the present formula, *c* should appear in the original one; and wherever *c* occurs in the above, *c′* should be found in the other referred to. The sign of *b* should be "minus" not "plus," as there printed. My series of articles on the object-glass is now finished, that is, until something new, or old, turns up. If "Ascalon" or any other reader chances to come across anything more respecting Gauss' o Hastings' formula, I hope we shall hear of it. The account of Nobert's ruling machine, which appears in the report of the R. M. S. meeting, will have interested a large circle of readers. I earnestly hope that when the full illustrated account appears in the *Journal* of the Society, it will be reproduced in these columns. The description of so unique a contrivance will specially interest "our" American friends.—ORDERIC VITAL.

56097.]—**Conics.**—The tangent to a conic has for equation $y = \frac{x}{n} + a\,n$, where *n* is the co-tangent of its inclination to the axis, and the intersection of the tangents corresponding with $n_2$ and $n_3$ is $x_1 = a\,n_2 n_3$, $y_1 = a\,(n_2 + n_3)$, with similar expressions for the intersections with the $n_1$ tangent; but the area of the triangle with vertices at $(x_1\,y_1)$, $(x_2\,y_2)$, $(x_3\,y_3)$ is—

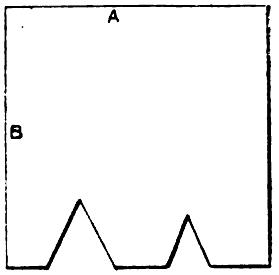
$$\tfrac{1}{2}\,[x_1\,(y_2 - y_3) + x_2\,(y_3 - y_1) + x_3\,(y_1 - y_2)],$$

or, in this case—

$$\tfrac{1}{2}\,a^2\,[n_2 n_3\,(n_2 - n_3) + n_3 n_1\,(n_3 - n_1) + n_1 n_2\,(n_1 - n_2)].$$

which becomes $a^2 n^3$ on writing *n* for the differences $n_1 - n_2$, and $n_2 - n_3$, which are equal since the co-tangents are in A.P.—R. E. B.

[56098.]—**Grinding V Tools**—The best angle for V tools for screw-cutting is the angle of 55 degrees. You can make a gauge from sketch below, which will serve for grinding and setting the tool to. If you are cutting outside threads, place A side of gauge against the work, and set tool to one of the V's, according to size of tool. If inside threads, place B side against face of work and set tool as before.—VALETTA.



[56106.]—**Gun-Barrel Browning.**—I have already replied to this query. I should not have done so had I known that "Armourer" intended to come forward, who has used the process more extensively than I have done. My own practice has been limited to developing the striations and contortions in faggotted and scrap-iron forgings, and also replenishing the pattern of the barrels of my own shooting-irons. Having met with a similar difficulty as that mentioned by "A. Z.," I can perhaps give him a useful hint. The distinctness of the twist or pattern developed in a gun-barrel much depends upon the metal used. If a mixture of iron and steel, there is not much difficulty, but if the barrel is forged entirely of steel, or of strips of metal alike in quality, the pattern will not be so marked. In this case the barrel must be "pickled"—that is, immersed in a trough of water acidulated with sulphuric acid for an hour or so; a galvanic action takes place, the softer parts being corroded by the acid from the positive influence of the hard portions. Of course, the muzzles of the barrels should be well corked up, and the breech blocks (if any) coated with wax. When the twist appears plain enough, remove the barrels, rinse them, and at once give the first coat of bronzing liquor. Do not rub this on, but give one light stroke with the sponge. After laying by from one to three hours (according to the dampness of the weather or place) pour a kettle of boiling water over every part of the barrel, and while hot scratch-brush it all over. Using the scratch-brush on a barrel the least degree damp is fatal to the process. Repeat this operation till the colour is dark enough. It is sometimes difficult to get the admired purple striation on some barrels with any number of repetitions. In this case, having gone as far as possible after the last brushing, give the barrel a wash with a dilute solution of perchloride of platinum.—F. H. WENHAM.

[56122.]—**Small Brace.**—To "INVICTA."—I want brace for hand, suitable for model-making, if you will oblige me.—S. B.

[56122.]—**Small Brace.**—If this querist will look on page 547, Vol. XXXV., he will see illustrations of several small braces which will probably suit his purpose. There is also a very good article attached on Riveting China, &c., by "Alfojoe." I often wish "Alfojoe" would come to our aid in several little matters that remain unanswered from week to week.—ARVONIA.

[56126.]—**Chemistry Exam., London University.**—"Londoniensis" must study the following: O, H, C, N, Cl, Br, T, Fl, S, P, Si, $CO_2$, CO, oxides and acids of N, $NH_3$, $C_2H_4$, $CH_4$, $H_2SO_3$, $H_2SO_4$, $H_2S$, HCl, $H_3PO_4$, $PH_3$, Si; air, flame, combustion, fuel, water, combination, nature of acids, salts, bases, symbols. I do not consider Gill's a fit book; Roscoe (Macmillan, 4s. 6d.) is the best. I think it is too bad that "Londoniensis" should be snubbed as he has been, and I hope that the communications of his advisers will be placed in the index with the A.'s (Advice to a Grandmother); otherwise readers may be misled. I often think it a pity that contributors to "Ours" do not take Montaigne for precept, and our old friend "Sigma," for example. I am sure all readers of "Ours" will cordially agree with latter part of 55982, page 85. If "Londoniensis" thinks I can give him any further information, let him write again to "E. M.," or to—H, 74, Charrington-street, N.W.

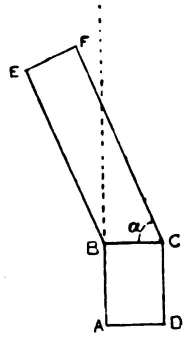
[56132.]—**Cutting Pipes.**—I fear that Mr. Geo. A. Walton must have been rather hurried in his reply to this query, as his reply is "a' vrang thegither," as an old Scotch acquaintance would put it. In such a case as that given in "M. B. M.'s" sketch (where C F terminates on line A B produced)—

$$BE = \frac{(CF)^2 - (BC)^2}{CF}$$

Taking dimensions given in sketch—

$$BE = \frac{625 - 36}{25} = 23{\cdot}56\text{ft.}$$

In a case where C F does not terminate in line A B produced, length of B E can be easily found when C F, B C, and angle B C F (= *a*) are known. B E = (C F − B C . cos. *a*). Value of "cos. *a*" can be found from a table of sines or of cosines. Is it not rather unusual to have part "A B C D square"? The cross-section of part E B C F will be, not a circle, but an ellipse (i.e., if pipe A B C D be of circular cross-section). Should not line B C bisect angle A B E? If so, then value of B E in this case also is (C F − B C . cos. B C F). I presume that "M. B. M." understands how to arrive at development of joint B C?—JNO. M. ADAMS.



[56135.] — **Value of Gas Liquor.** — Both "Stud. Inst. C.E." and R. Hannen have important errors in their replies to this query. Liquor of 5° Twaddel does not contain 2·55 per cent., but 2·25 of ammonia, and Scotch liquor of 5° Twaddel frequently contains only 1·52 per cent., and thus 3,810 gallons are required to make one ton of sulphate of ammonia. The hydrometer does not show the value. It would be some comfort to those at present experiencing such heavy losses in this trade to find the price had gone up to £15 to £20 per ton. I know a very superior lot could not be sold last week at £11 nett in buyers' bags!—$NH_3$.

[56142.]—**Wheatstone Bridge.**—Use a tangent galvanometer, and have a number of various resistances loose, or in a box; insert your unknown resistance (R) in the circuit of your galvanometer and battery, regulating your battery power so that the deflection does not exceed 60°—between 30° and 45° is best; deflections beyond 60° are very unreliable. Note the deflection carefully. Take out your unknown R, and insert your R coils until you have the same deflection; then the last R will be equal to your unknown R. Use only Daniell cells. —J. K.

[56143.]—**Hermit Crabs.**—As "Yesallaw" has given his hermit crabs proper food, I am of opinion that the cause of their untimely death is in the improper construction or management of his aquarium. The ordinary globe aquarium sold in shops is about the worst that could possibly be devised; being contracted at the mouth, it does not allow the water to become properly aërated, a sine quâ non in all aquariums, and for marine aquariums it is particularly objectionable, as there is not sufficient area on the bottom for crabs, &c., to live in health. The simplest suitable form of aquarium is an ordinary fern-glass inverted and placed on a turned pedestal; for a marine aquarium, the hollow at the bottom should be filled with sand, and a rockery might be made in the middle; coral is imitated by coating coal-cinders with melted resin mixed with Venetian red, and finishing off with a penknife. As to management, the water should be occasionally drawn off by a siphon, and fresh water substituted, and should be daily aërated either by lifting cupfuls and pouring back from a height, or by drawing off and violently squirting back by a syringe. It is very advantageous to have some seaweed in an aquarium; but care must be taken that what is put in does not decay. As a general rule the most beautiful specimens will not grow even in the most favourable circumstances—and a few periwinkles might be put in, as they eat the green fungus which adheres to the sides. For crabs a rockery should be built rising above the water, as apart from the fact that crabs are great climbers, they are amphibious, and like occasionally to come out of the water, and when feeding them do not take the food out of the shell, but break the shell and throw it in. Remove plants with wooden tongs, and when removing fishes do not draw the greater part of the water and make grabs at the fish, but stir the water round with your arm, causing a strong current, which the fish are unable to swim in, when they can be captured with ease. The aquarium should not be placed where it is exposed to the sun's rays all day, or the water will soon get too hot for anything to live in it, and if there is much dust or dirt about, a glass cover should be put on, raised, however, to allow air to enter, but even this will require to be removed at times to allow proper ventilation.—James M'Cash Govan.

[56146.]—**Spiral Springs.**—Having got the steel to the right shape, heat to a cherry red in a bright charcoal fire and plunge in cold water; then get a lot of brass or copper filings, or small turnings, and put them into a metal vessel on a slow fire; by putting the springs in this you can watch the temper, and you will be sure of having them tempered evenly all over. I think a light blue would be best, but I am not quite sure.—$H_2S$.

[56152.]—**Tempering Steel.**—To "Uncas."—If you read our friend "Essar's" letter (23962) on page 57, last week's number, you will find that he goes on hot about tempering medicine. He may be able to do it without, but all of us are not. The question then naturally arises, How can we do it? We must try something else. Take 1oz. of common washing soda, and 1oz. saltpetre; dissolve in half gallon of cold water; heat to a cherry red and put the tools in it as far as you want hardened, and let them cool; but keep from soap.—G. T. D. C. E.

[56153.]—**Test for Oils.**—Really the conscience of some querists is very elastic. Here "W. E. P." asks for information which would take a number of the "E. M." to satisfactorily answer, and then I question whether he would be able to state definitely whether a given sample of oil was pure or not. I would recommend "W. E. P." to secure Spon's "Encyclopædia of Industrial Arts," and carefully study the sections on "Oils," "Soaps," "Candles," and practise testing samples of oils; practice is the only thing which can make anyone a good oil tester. —George H. Hurst, Salford.

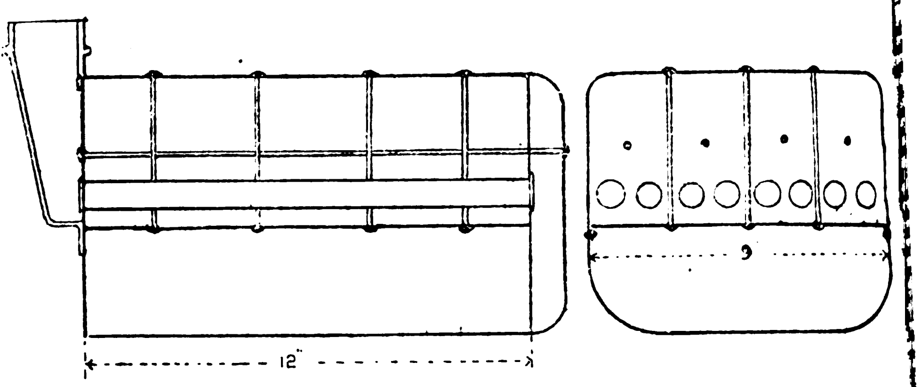
[56156.]—**Chemical Action of Bichromate Battery.**—In the bichromate battery the sulphuric acid combines with the zinc to form sulphate of zinc and hydrogen; this hydrogen, some of the sulphuric acid, and some bichromate, combine to form water and chrome alum, which is a double sulphate of potassium and chromium, thus—

$$H_2SO_4 + Zn = ZnSO_4 + H_2$$

$$3H_2+4H_2SO_4+K_2Cr_2O_7=K_2SO_4 \;.\; Cr_2 3SO_4+7H_2O$$

It is owing to the presence of the double salt of potassium and chromium that the solution becomes black. I am not aware that the refuse liquor is of any practical use.—$H_2S$.

[56159.]—**Model Engine—Boiler and Boat.**—Boiler for your engine should be a horizontal one; but with engines of such size you will want a very powerful boiler. The best illustration I can give you of such a boiler is that of one I designed for a friend in New York some time since, where the engine power was a trifle more than yours, it being a pair of cylinders 1½in. by 2½in. The boiler should be made from sheet copper 3/32in. thick, and of the sizes shown, the surfaces being principally flat ones, so that the boiler could be kept below the deck. It would require staying. This was done as shown by means of four horizontal and 12 vertical stays, made from 3/16in. brass wire, with the ends only well annealed so as to rivet over well. The water space was traversed by eight ¼in. brass tubes, also well annealed on the ends only, which were well turned over on the tube plates. The return at the end and the smokebox were as described on page 326 of last Vol., and the steam dome was ultimately fitted to the flat top of boiler, the dimentions being 3in. diam. and 3in. high. This was a casting in brass. The spirit lamp was also of peculiar form, it being of the siphon class, and with flat parallel wicks running longitudinally. Length of each wick was 3in., number of wicks, 6; size of funnel, 2in. diam. But I would advise an oval funnel 2¼in. on the longest axis and 1½in. on the minor axis. This was subsequently fitted with an improvement in the general appearance. Owing to the tubes being kept well down, the water level admitted of considerable variations of level, allowing a fall of no less than 1½in. without decreasing the heating surface of the boiler. The steaming power is very good, giving a large volume of steam of a moderate pressure. In actual use this boiler carries about 10lb. to 12lb. pressure, which is ample for a model engine. Now, as to the boat, that I would make, say, 6ft. long, 12in. beam, and 8in. deep under the deck. In your case, with such a tall pair of engines, I would make the depth over 9in. or 9½in., and then cover the remaining height of engine by either an engine-hatch or a saloon. The engines are, in fact, too high; but having got them, I should not certainly condemn them. Screw may be 5in. to 6in. diam., and about 6in. pitch. I should prefer three blades.—Invicta.



[56160.]—**Planing Machine.**—The only machines which I know of where such a condition is fulfilled are those driven with links or cranks.—J. H.

[56161.]—**Telescope.**—If by "making" the instrument you mean grinding the lenses as well as fitting them up, an amateur would experience great difficulty indeed; but if the lenses are already procured, it is simply a matter of suitable tubes, careful adjustment, and a respectable stand. For an object-glass 3½in. aperture, 4ft. focus, to magnify 125, a single lens of a trifle less than ⅜in. focus should be applied, or an optician will send you a compound eyepiece, giving better results, at a moderate cost. You omit to state whether your o.g. is achromatic or not. If not, it is hardly worth a compound eyepiece.—Arthur Mee.

[56170.]—**Microscopical.**—I am glad to see in the pages of your highly useful and interesting journal, a discussion on the relative advantages of the binocular and monocular forms of microscope. I think it can be rendered of great practical utility, not only to students and workers with the microscope, but also to the manufacturers of that instrument. The facts to be discussed, and the problems to be solved, are, I take it, these: Is not the binocular form less wearing for the eyesight, especially in the case of prolonged observations; or can the monocular form be so employed as to obviate all danger of the sort? Secondly, does not the binocular afford a more complete and definite idea of the object than it is possible to obtain with the monocular? Thirdly, could not the tubes of both forms be much shortened, and the mountings and accessories reduced in size, thereby effecting a great reduction in price? I know that the Germans, who have made the greatest discoveries with the microscope, employ almost invariably the monocular form; but that is no reason why we should not employ the binocular if it proves to be more convenient and less hurtful to the eyes. We should make our work, however, productive of really scientific and practical results, which may increase our knowledge of the operations of nature, such as the splendid researches of the Rev. Mr. Dallinger, instead of the utterly useless examination of diatom markings.—R. D. R.

[56175.]—**Books on Herbal Medicine.**—"W. M." will find the following suitable for him:—Gerarde's "Historie of Plants," Parkinson's "Herbal," Hill's "Herbal," Culpeper's "Herbal," Robinson's "Herbal," Dr. Coffin's "Family Guide," Skelton's "Family Guide," Stevens's "Family Guide," Fox's "Family Guide." American: Dr. Beach's "Reformed Practice of Medicine," Dr. King's "Dispensatory." If he desire to recognise the herbs while growing, the illustrated herbals will be of great service to him, as also would be a journey or two with a herb gatherer. If I can assist "W. M.," I shall be pleased to do so.—C. Lakin, L.R.C.P.

[56177.]—**Earthenware.**—Mr. Haydock can make a white glazing by slipping his ware, previous to putting on the glazing, with clay that will give a white glaze when the ware is in a stiff state fit to take the slip. Will give Mr. Haydock all the information I can if he will write to my address.—S. Arlidge, Weedon, Northampton.

[56178.]—**Gum Juniper.**—The best solvents are alcohol and ether; "Koila" should try these. Gum juniper is not completely soluble in any other liquids.—George H. Hurst, Salford.

[56180.]—**Martini-Henry Rifle.**—1st. With a hammer and punch knock out the split pin (it looks like a screw at first sight) which holds the breech-block in place. The punch should be a shade smaller than the s.p.—any bit of iron, even a blunt nail, will do for a punch. My way is: Knock the s.p. about three parts out, then pull out with pincers. Now depress lever, and the breechblock will somewhat spring up, when you can lift it out. 2nd. On the left side of the body (that large piece of iron which on the one side is screwed on to the barrel, and on the other is made fast to the butt, is called the body), and pressing against the end of the indicator, observe a small screw, with a little piece, arch fashion, cut out of its head, turn that screw till the arch forces the end of indicator, then push out indicator Then draw out the lever, the tumbler comes with it. As gentlemen of a certain land might say, the other pins are screws. You have only to unscrew them, and the parts come away very easily. 3rd. Go back to the B.B. You will see in the back end of the B.B. a large screw and a small one by the side of it similar to that which keeps the indicator in place. Turn the small screw as you did in the case of the indicator. Then unscrew and take out the large screw (which is called a stop nut), and the main spring and striker will fall out. Putting the action together: When you take out the B.B., and before you remove any of the other parts, look into the body, move the lever and trigger, and observe how those parts act and sit. With two exceptions you have only to observe the order in which you took the action to pieces to replace the parts again. The two exceptions are important: 1st. Notice that the slot or slit in the striker is tapered, so that it is longer on the one side than the other. In putting it back into the breech-block, you need pay no attention, just drop it in anyhow; but when you get in your stop-nut and its keeper, screw in place; then, with your screwdriver, turn the striker round till its longer slot agrees, or is even, with the slot in the B.B. Now assuming that you have your guard, trigger, lever, tumbler, indicator, and extractor in place, lay in the B.B.; put your finger on the trigger as in firing, press it back, and with the other fingers grasp the lever, place the ball or back part of the left hand on the extreme back part of the B.B. Now, while you press back the trigger, you must work the lever backwards and forwards, and at the same time press on the back part of the B.B. with some force with the left hand; the B.B. will fall into place. All the motions should be done together. I may remark that getting the B.B. into its place is the only trouble in a M.-H.R. action at first and to an amateur; but all that trouble goes after having performed the work three or four times. The Lubricant.—I think you are mistaken in thinking that the lubricant used is thicker than oil. Most likely, when you got your rifle, whether from a gunmaker or Government stores, there was some thick composition on, to prevent rust for the time. Well, I cannot tell you what gunmakers use or recommend; but the only oil used for the Service rifles (Army) from about 1859 to 1880—beyond 1880 I can't speak—is Rangoon oil. I don't think it is a well-known oil. It is rather dear, being 8s. a gallon; but it goes a long way, and one of its virtues is, it never clogs. It leaves no dirt behind. From 14 or 15 years' experience, I can strongly recommend it. For an oil it is extremely thin. I have had a little experience in purchasing Rangoon oil; and in asking for it at one druggist's shop I was simply laughed at, and put down as one on whom a First of April trick was being played. Doubtless it is now better known. Let me add that no rifle in use at the present requires less oil than the M.H. Indeed, it is a great mistake to over-oil any piece of machinery.—Armourer.

[56182].—**Sweet-making.**—If this querist sends a penny stamp to J. Willson, Church-street, West Hartlepool, inquiring for book on this, he will get what he requires, very cheap.—Arvonia.

[56183.]—**Force and Motion.**—The tension on the rope is only that of one horse. The steam on the cylinder is the same per square inch as on the piston; but, of course, if the area of one is greater than that of the other, the total pressure on one will be greater than on the other.—$H_2S$.

[56185.]—**Astro. O.G.'s.**—"T. P." will find a great deal of information relative to fluid lenses in back volumes of the Mechanic, a perusal of which will likely convince him of the disappointment occasioned by their non-permanence. The old astronomers did the best they could with non-achromatic o.g.'s by making them of great length in comparison with their aperture, thus obtaining considerable magnifying power whilst keeping down the aberration. Reproductions of old views of these unwieldy refractors appear in Flammarion's "Terres du Ciel," Newcomb's "Astronomy," and elsewhere.—Arthur Mee.

[56185.]—**Astro. O.G.'s.**—As the result of my own experience many years ago, I should strongly dissuade "T. P." from attempting the construction of fluid lenses. The trouble would be very great, and the chance of success very questionable. The old astronomers avoided the imperfections of the common uncorrected o.g., by making its focal length so great in proportion to its aperture that the errors were reduced within bearable limits. But the inevitable result was the employment of most cumbrous and inconvenient instruments; an o.g. of only 3in. aperture, requiring a tube of about 30ft. It is most honourable to their perseverance that with such appliances they should have discovered as much as they did.—T. W. Webb.

[56186.]—**Gum for Micro. Slides.**—The mucilage used for postage stamps is made by dissolving 2oz. dextrine in 1oz. acetic acid, diluted with 5oz. water. When the dextrine has dissolved, add 1oz. alcohol to the solution.—Mikros.

[56196.]—**Gas-holder.**—Several plans are in vogue for the purpose. One I have used when putting plates all round a 36ft. holder was broad tape soaked in boiled linseed oil and rolled into a ball for use as required. This is placed between the joints as they are put in position, and the rivets well hammered up.—Arvonia.

[56200.]—**What is a Diamond Carat?**—Jackson, in his "Modern Metrology," gives the following:—

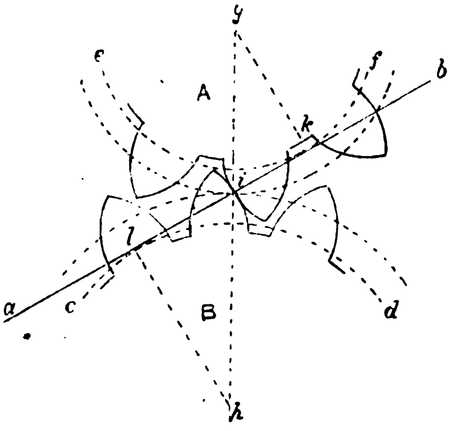
| | Grains. | Mils. |
|---|---|---|
| English diamond carat .. | 3·168 | 7·250 |
| " Pearl carat...... | 3·200 | 7·323 |
| German diamond carat .. | 3·171 | 7·257 |
| French ditto .......... | 3·177 | 7·270 |
| Dutch ditto ............ | 3·165 | 7·243 |
| Austrian ditto .......... | 3·181 | 7·280 |
| Egyptian ditto .......... | 2·959 | 6·772 |
| Persian ditto ............ | 3·232 | 7·397 |

The "carat" is connected with the term used for expressing the quality of gold and silver alloys in this way—that the old "mark" was divided into twenty-four real carats or weight units.—N. E. Child.

[56205.]—**Tennis-court.**—The size of a court I have, and which I let during the visiting season, is made of grass kept well rolled and level, and grass very short. The measurement of court is as follows: Outside mark, 78ft. by 36ft.; inside length is 42ft. width, less the 36ft. by 4½ft. each side. A chalk mark also running through centre from end to end. The net being put across reduces each central square to 21ft. You will find a lot of trouble in making one of ashes, as the turf all wants removing, and soil taken out to a foot depth at least, and filled in with any rough stones, &c., on which weeds may not grow. Then, when properly levelled, put on cinders, rough first, then finer, and finish by rolling with heavy roller, levelling with spirit level, &c.—Arvonia.

[56206.]—**Teeth of Wheels.**—The form of teeth in your sketch is weak and of bad design. I recommend you to get a book called the "Work Manager's Handbook," by Hutton, wherein you will find a simple method of drawing wheel teeth. I have had some wheels made by Hutton's method, and find they work sweetly, and the teeth are very neat and extremely strong. The book is published by Crosby Lockwood and Co., Ludgate-hill. I notice in this book, among a long list of alloys, one or two to stand acids that would suit "Enquirer," No. 56041, and the book is crammed with valuable practical information for Engineers.—Abbey Mills.

[56206.]—**Teeth of Wheels.**—I know of no teeth made with only one sweep, except the involute form, and they are struck as follows:—In the wheels A and B in the annexed figure, the path of contact of the teeth is represented by the diagonal line *a*, *b*, and the amount of its obliquity determines the amount of obliquity in the tooth-flanks. This line cuts two circles, *c d*, and *e f*, which represent the working depth of the teeth of the two wheels. In striking out it is necessary to assume either a definite depth for one of these lines below the reputed pitch line of its wheel, or to fix an angle for the line *a b*, relatively to the line of the centres of the wheels *g h*, and either will furnish a suitable base of operations. If we assume the line of working depth *c d*, we must draw the diagonal *a b*, cutting the reputed pitch circles at *i*, and prolong it, as shown in the figure. Then a line *g k*, dropped from the centre *g*, at right angles to *a b*, gives at its point of intersection the radius of the base line *e f*. If, however, we start with the line *a b*, our working depth of tooth will be given by the intersections of the normals *g k*, and *h l*. Then the teeth are pitched, not on the reputed pitch lines, but on the base lines, and their curves are struck, either by a needle-point driven into the edge of a straight edge, whose edge is rolled around the base line, or by an approximate radius whose length is equal to about one-fourth the distance from *i* to *l*, or from *i* to *k*, for their respective wheels. Two or three experiments may have to be made before a good tooth is obtained, since the degree of obliquity of the line *a b* depends upon the relative sizes of the wheels. Too much obliquity will cause the teeth to fall short of their proper working depth, and throw the strain on the shafts at too great an angle, while too little will needlessly diminish the length of teeth.—J. H.



[56211.]—**Water Pressure.**—The question does not admit of an accurate answer, as the coefficients for any particular cases must be obtained by experiment. As a rule, however, proceed thus: Ascertain the velocity of flow, and calculate through what height a body must fall to gain that velocity, then multiply by a coefficient for the particular case. The following case is given by Haswell: A fire-engine discharges 14 cubic feet per minute through a ·75in. pipe. Find vertical height of projection—14 × 1728 ÷ ·4417 (area of pipe) ÷ 12 (ins. in feet) ÷ 60 (seconds) = 76·07ft. velocity. But velocity of stream from a vessel is $\frac{2}{3}$ that due to its head ∴ 76·07 × $\frac{3}{2}$ = 114·1ft. By experiment in this case, coefficient is 67 ∴ height of projection is 65·04ft. The most suitable exit pipes are long, slightly convergent cones.—Geo. A. Walton.

[56212.]—**Dr. Johnson's Opinion of Mechanics.**—Dr. Johnson meant that mechanics were persons in a lowly position. The word itself means something pertaining to machines, and therefore low as compared with mind, the intellect. Walker gives—"Mechanic: a manufacturer, a low workman;" and the adjective as "mean, servile; constructed by the laws of mechanics." Shakespeare, "Antonio and Cleopatra," V. 2, says:—

> "Mechanick slaves,
> With greasy aprons, rules, and hammers."

And "Coriolanus," V. 3:—

> "Do not bid me
> Dismiss my soldiers, or capitulate
> Again with Rome's mechanicks."

It was undoubtedly a term of disparagement. Both "low" and "vulgar" have acquired a different signification since Walker's time, for he expressly says that "vulgarism" was not in any dictionary he had examined; but he inserted it in his own as sufficiently authorised both in writing and conversation.—N. E. Child.

[56213.]—**Common Red Ware.**—For common red ware it requires nothing but good common brick clay well prepared either by washing or grinding, by means of a roller mill, then well dubbed or passed through a pug-mill. We used to pass our slip clay, for slipping, through a fine lawn sieve, the clay to be mixed with water in a pan to about the consistency of cream, then passed through the sieve into an outer pan by gently tapping the top of the sieve with a bit of stick, to make it pass through quicker. Don't want a slip kiln for common ware; would not pay. The large jowels are thrown on the wheel down to a penny pan, and when dry the lead or glaze is put on by means of a brush, or slipped on, according to the nature of clay, then set in the kiln and fired. No biscuiting for common ware: that belongs to our better kind of ware, such as yellow dishes, teacups, basins, pitchers, &c., which are fired in jaggers—jaggers not required in common red ware. Will give any-one further information so far as I know.—S. Arlidge.

[56221.]—**Blue Shadow.**—The greenish-blue colour in the first case, and the decided blue in the second, noticed by J. Gayler, are the complementary hues of the two colours respectively, and are always evoked by the sensorium, and seen by the eye under given conditions, these being an adjacent grey, of which a shadow consists. An analogous experiment will show similar results in a satisfactory way. Puncture the bottom of a half-ounce pill box with a small needle, place a sheet of white paper on a table by gaslight—now look through the small needle-hole at the paper with the other eye closed, a small round white disc will be seen. On opening the other eye the disc will appear of a beautiful cobalt blue colour. Blue being the complement of yellow, the kind of light emited by gas flame.—John Gorham.

[56222.]—**Testing Gauges.**—Weight so arranged as in sketch would give a pressure of somewhat more than 20lb. on the circular inch, as area of piston rod must be deducted from that of piston in order to find effective area causing pressure. Same remark applies to finding pressure per square inch. (If cylinder B were a square inch in area, it would be $1\frac{1}{8}$in. full (1·128) in diameter, not $1\frac{3}{16}$). If you give diam. of piston rod, there will be no difficulty in determining what weights you ought to employ to produce any desired pressure per square (or circular) inch. If opening A were at the other side of piston, and weight acted in the opposite direction (say by means of a cross-head), diam. of rod need not be regarded. A large proportion of the loss from friction could be obviated by arranging the cylinder vertically, and hanging weights directly to end of rod (or to cross-head); but weight of piston and rod would have to be regarded as part of the compressing weight.—Jno. M. Adams.

[56222.]—**Testing Pressure Gauges.**—"Jack's" first supposition is correct—namely, that the pressure on the piston and on the gauge is the same per unit of area. The area of a circle $1\frac{3}{16}$ diam. is more than 1 sq. inch. A circle of 1 sq. inch area would have a diam. of 1·12838. Does it not occur to "Jack" that if his cylinder were vertical, and the nose A had a right angle elbow on it, that he would avoid the friction of the pulley, and would work his experiments easier. I would also suggest that the area of the piston is immaterial if he calibrates his instrument thus: Attach about a yard of glass tube to A, and notice the level of water in it when the weight E is just sufficient to overcome the friction of the instrument. Then find what additional weight will raise the level of water 2·24ft. This weight will correspond to a pressure of 1lb. to the sq. inch. Then any given multiple of this weight will correspond to a similar pressure per sq. inch. So much for instrument proposed; but there are simpler and better ways of obtaining good results.—Geo. A. Walton.

[56233.]—**Intensity Coil.**—The best way to find the size of condenser for an intensity coil is by experiment. Try three square feet of tinfoil with a 1½ pint bichromate cell, connecting condenser temporarily, and adding more sheets of tinfoil, one at a time, as long as beneficial results are observed. It is not easy to say what length of spark you may expect, as, from the dimensions you have given, it will depend very much on the space between primary and secondary caused by insulation, and on the thorough insulation of the secondary layers. A rule which is commonly followed, and which does not always hold good, is that with sufficient battery power a spark ought to be produced at the rate of an inch per mile of secondary; but no such result has been got, even from coils of unusually large size.—Bobadil.

[56239.]—**Filtering Acids.**—Asbestos filtering cloth—or, if more convenient, the fibre—is what "F. G. S." requires.—$NH_3$.

[56239.]—**Filtering Acids.**—If your acid does not attack cotton goods, and the filtrate is not loaded with the precipitate, a filter press, such as may be obtained from Messrs. Needham and Kite, of Vauxhall, London, or of almost any engineer in the Staffordshire Potteries, might possibly suit your purpose.—Pottery Tech.

[56243.]—**Fuses for Projectiles.**—In answer to "Ex-Garrison Gunner," I must say that the service fuses have been having a lively time of it since he left the regiment. The chief changes are as follows:—The 5, 9, and 20-seconds Boxer time fuses are superseded by a 15-second and 30-second fuse, on the same principle, but with several powder channels (eight in the 30-second fuse), and marked for boring spirally in tenths and half-tenths. The "E." time fuse is extinct. In its place we have the "Fuse Time and Concussion, Armstrong, medium," which is very similar in appearance to the E time fuse, but can be used as a concussion fuse if necessary. The "C." time fuse is modified and now called the "B.L. plain." There is a "Sensitive Percussion Fuse" for use with the 7-pounder guns and howitzers. Its name denotes its character. The R.L. percussion fuse still remains. There is a "Delay Action Fuse," used for base of battering shell 64-pounder (for the 64-pounder R.M.L. gun has risen to the dignity of having a Palliser shell!). This fuse has a percussion action which, on impact, ignites a column of fuse composition, which burns long enough to give the shell time to bury itself in masonry, &c., before bursting. At present, the fuse is only used with 64-pounder shells, and it seems to answer well. These are the chief changes I can remember; but if "Ex-Garrison Gunner" wants more information I shall be happy to look it up for him when I have time. He will know what a job it is hunt up an item in "Changes of War Material" for the last five years, as the Government is too economical to publish new manuals of artillery. I have been employed extra-regimentally for the past two years, so perhaps may have missed out some new fuses, but I think that the above are the principal changes.—Garrison Gunner.

[56244.]—**Skrivanoff Battery.**—Make a paste of the precipitate got by boiling one part mercury oxide and four parts ammonium chloride. Boil for about three hours in a glass vessel; wash and dry the precipitate thoroughly, and mix it with a solution of chloride of zinc, and a few drops of sulphuric acid. Having made the paste, add a little common salt, in the proportion of three parts of salt to ten of paste, cover zinc and carbon plates with any kind of thick cloth, or with a good pad of blotting-paper, dipping them for a few seconds (after covering) into a solution of chloride of zinc and common salt. Apply the paste to one plate not much thicker than the edge of a new sixpence, and lay the other on it. You will thus have a plate of carbon and a plate of zinc, each in a porous envelope, with the paste between which is the exciting element.—Bobadil.

[56247.]—**Photographing Engravings and Plans.**—Put the plan or engraving in the sunlight in such a position that it does not reflect the light, and so make an indistinct photograph; also you must, of course, take care that no shadows fall across it. No variation will be necessary in the developer; but take care to put in enough ammonium bromide to get all the detail distinct. With these precautions you ought to succeed all right; far from being more difficult to photograph engravings than views, it is generally easier. Take care not to overexpose the plate, or you will have such a thin picture that the engraving is almost invisible.—R. A. R. Bennett.

[56248.]—**Turning Cast Iron.**—First of all, give your hard cast-iron one or two good coats of turpentine, then turn with an ordinary front roughing-out tool with a very little rake on it, making the tool as hard as the steel will stand; the turpentine works wonders on the hard scale, and it is a wrinkle worth knowing.—Little John.

[56248.]—**Turning Cast Iron.**—Use a crutch tool tempered to a very light straw colour. Take a deep cut and a slow feed, and thus get beneath the crust at a single cut. When the tool dulls take it to the grindstone again. If the tool dulls at once, throw away the casting and go to another foundry. Finally, if this is impracticable, place the casting in a fire and keep it bright red for two or three hours and place in a large box of sifted ashes to cool.—Geo. A. Walton.

[56250.]—**Engine Making at Home.**—No; not in all details. All working centres, lengths of rods, &c., should be halved exactly, but thicknesses and diameters would vary. If you are going to make an engine on this type, the best way will be to proprose queries of parts in detail, and I will answer them. In reference to the cylinder on p. 24 of Vol. XLI., where the thickness is given as $\frac{5}{16}$in., if the bore were reduced to 1⅜in. the metal thickness should not be reduced proportionally, but should be ¼in. if in iron, or $\frac{3}{16}$in. in brass; and this, of course, as I there explained, solely from considerations of convenience in construction. The flanges should be not less than 3in. diameter, which is also more than half 5⅜in., what you have to consider there being sufficiency of bolt room, and their thickness should not be less than ¼in. when finished. The ports will not vary as the diameter, but as the area of the cylinder, and, using the same rule, will be 2·0 × ·055 = ·1100 area, or, say, ¼in. by $\frac{5}{32}$in., or less than half those in the 3¼in. cylinder. I should put them ¼in. by $\frac{3}{16}$in. On the steam-chest face, and on the feet for bolting down you must see that you get sufficient bolt room; $\frac{3}{16}$in. bolts will be a suitable size, and their heads will measure ⅝in. across the angles, so you want room for these to turn, and about ¼in. metal beyond the outer edges of their holes. In reference to the mahogany bed: By all means adopt it if you do not feel competent to tackle the metal one; a block of mahogany of, say, 2½in. or 3in. thickness, having a moulding worked around its edges and polished would look well in contrast with bright metal work. Have sufficient width, so that the screws or bolts by which you fasten the parts thereon shall not split it out at the edges, and see that the crank shaft is long enough to carry the flywheel clear of its edge. The bosses for the guide bars would be best made of brass or wrought iron, furnished with a central screwed pin to run into the wood. In so small an engine omit the force-pump at the side of the cylinder, and make one of shorter stroke worked by an eccentric.—J. H.

[56251.]—**Australian Vertebrates.**—Mr. Gould's "The Mammals of Australia," 3 vols., folio, coloured plates. It is a magnificent work; but, unfortunately for weak purses, the price is also magnificent—forty guineas, or thereabouts. See various articles in the new edition of "Encyclopædia Britannica."—R. C. D.

[56253.]—**Alizarine Oil.**—"A. C. M." has not given quite sufficient data to satisfactorily answer this question. The mode of using alizarine in printing varies so much at different works, and the character of the oil used also varies, that one cannot say definitely what is best unless acquainted with the details of each particular case. Supposing "A. C. M." works thus: 1, Prints on colour; 2, ages and dungs; 3, dyes with alizarine and oil; 4, oil and steams; 5, wash and soaps. Then I should not recommend him to add anything to the oil in No. 4. He might add acetate of lime at 21° F., in the proportion of $\frac{1}{10}$th of the alizarine used; or he may use a little tin crystals with the soap in No. 5—say, about 2oz. to 3lb. of soap.—George H. Hurst, Salford.

[56261.]—**Selenite.**—"F. E." will probably know it better by its ordinary name of "Plaster of Paris." It is calcium sulphate, and all the "permanent hardness" of water is due to the presence of this salt.—R. A. R. Bennett.

[56261.]—**Selenite.**—This is a pure, natural variety of calcium sulphate ($CaSO_4$). It is a suitable substance to add to soft water for brewing purposes, as it is soluble in 500 times its own weight of water. The hardness imparted to the water is just the thing for brewing. The amount of hardness imparted to water by dissolving 2lb. of selenite in 25 barrels is 15·5 degrees. Calculated thus, 25 barrels contain: 25 × 36 = 900 gallons; 2lb. = 14,000 grains; $\frac{14{,}000}{900} = 15{\cdot}5$ grains per gallon = degrees of hardness for $CaSO_4$ in water.—George H. Hurst, Salford.

[56266.]—**Rolled Iron Joist.**—The dimensions given will safely carry nine tons.—Arefes.

[56266.]—**Rolled Iron Joists.**—Will have flanges 4½in. by about ½in. thick, and web about ⅜in. thick. The sectional area of each flange, including due proportion of web, may be taken as 5 square inches, with a distance between centres of flanges of 9½in., and with a span of 15ft. and a strain of 5 tons per square inch on the iron, the distributed load is 10 tons.—J. S. C.

## UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

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| 55964. | Circular Saw, 549. |

## QUERIES.

[56267.]—**Surfaces.**—Will some fellow workman, engaged in the machine-tool trade, tell me how to make surfaces look like, what for want of a more explanatory term, I must call a sort of fish-scale pattern of scraping? I have tried to imitate it by grinding the scraper various shapes, but without success. It looks to be as if the surface was all scraped over in one direction and then, what I must again call the fish scales scraped on with a peculiarly ground-up scraper across the direction of the first scrape by a turn of the wrist, maintaining a trellised pattern throughout. It does not look difficult; nevertheless I can't do it. I should like to be told where I fail, by someone who is used to such a job. I don't want a reply from a novice—too many of whom, it appears to me, answer various queries without sufficient practical knowledge. The scraping in question is only for finish, and is little benefit to a tool, but looks very showy. I have had large surfaces to go over where truth has been more the object than pattern, but find something fresh to be learned day by day, even after near a quarter of a century spent as a—Tool Maker.

[56268.]—**Shocking Coil.**—I have at length completed my coil, but find, when I connect three Leclanché cells, that I get shocks too strong to bear in one hand, whilst in the other scarcely anything can be felt? Would J. Kean, or some other electric reader, kindly tell me how I can remedy same? I had to make two joints in my secondary coil near the end, to which I cannot get shocks. Would this cause it?—C. J. R.

[56269.]—**Collimation.**—Will a correspondent kindly compute the following for collimation error in a transit? I have worked it myself, but am not sure about the result:—

δ Orionis Feb. 28.85 23.7° S.
Wire I. 5h.25.22
" II. 5h.25.36.8.
" III. 5h.25 50
" IV. 5h.26.03.S.
" V. 5h.26.18
March 8.85 51 Cephei 87.13.30 N.
Wire I. 6h.35.50
" II. 6h 40 37
Instrument reversed.
Wire II. 6h.51.16
" I. 6h.56.03

—Rosicrucian.

[56270.]—**Lunar Perturbations.**—Would "F.R.A.S.," or some other astronomer who possesses Proctor's "Moon," second edition, kindly explain to me one or two points connected with the paragraph on page 68, which states the ratio between the sun's maximum perturbing action on the moon, and his direct action on that body? Proctor says in the paragraph referred to (inter alia) "Now the line from the earth to the sun is about 91,500,000 miles long; while the line $M_1$ A is equal to the diameter of the earth's orbit, or to 238,800 miles." I suppose the words "earth's orbit," in the above quotations, are a mistake for "moon's orbit," but what I particularly wish to know is this:—The line $M_1$ A, according to Fig. 12 (referred to on p. 63 of the second edition) is equal to the diameter of the moon's orbit, so why is 238,800 miles, instead of the diameter of the moon's orbit, used in the paragraph referred to, in order to obtain the ratio between the sun's direct action, and his perturbing action on the moon? A few words as to this point will exceedingly oblige.—Resultant Force.

[56271.]—**Portable Engine.**—Will "Invicta" or others, kindly tell me the best way to make a boiler for a model portable engine, also the size and thickness of plates required for a cylinder 1¼in. bore, 3½in. stroke, and also if I can make it with a single flue instead of tubes?—A New Subscriber.

[56272.]—**Lifting Water.**—Will any of "ours" kindly say what power would be required to raise a volume of water to the height of 90ft. through 10in. pipes, also what size bucket would be required to raise 300 ton 24 per hours through same, at the rate of 12 strokes per min.?—Student.

[56273.]—**Secondary Battery.**—I am making a secondary battery as follows, viz., four lead plates, 10in. by 8in., suspended from pieces of wood across top of wood box. Can you tell me if it matters what number of plates and how to connect them together? I want the accumulator to drive a small motor to take into the country once a week. I have a three-cell Leclanché battery, large size. Can you tell me if this would b suitable, if I give it intervals of rest? I have looked through all my back numbers, but cannot find anything about these batteries.—J. J. Hammond.

[56274.]—**London Intermediate Science Examination.**—I should be much obliged if any correspondent could give me the names of a few books suitabl for the requirements of the above examination, in the elements of co-ordinate geometry, also elementar spherical geometry? Is there any textbook that woul cover the ground of the biology syllabus for 1885?—A London Undergraduate.

[56275.]—**Eyepiece.**—I have an astronomic o.g of 45in. focus, and 3in. in diameter. I wish to construc for it an eyepiece, giving a power of 200, and will than some friend to say what focus, size, and distance apar the two plano-convex lenses must be, so as to make suitable Huyghenian eyepiece, giving 200 diameters?—E. B. F.

[56276.]—**Egyptian Troop Boats.**—Will any o your readers give me information where I can get sketch and measurement of the boats used on the Nil for the troops?—if in *Engineer*, or other paper, wha number?—Porcelain.

[56277.]—**Skewers.**—How are the wooden skewer made with a tapering point—if by any special machin please describe?—Porcelain.

[56278.]—**Wood Filler.**—Wanted an effective woo filler to go on yellow pine before varnishing, one whic will not raise the grain as much as ordinary size.—Porcelain.

[56279.]—**Tennis Grounds.**—I shall be glad to kno whether hard-rolled tar paving has been found suitabl in hot summer weather?—R. F.

[56280.]—**Lever Watch.**—I have an English lever watch, and sometimes it will go well for months, and neither lose nor gain, and then it will take a fit and lose, say, for a fortnight, and after that it will keep good time. Can any brother reader tell me the cause, and if I can get it made to keep time?—J. A. C.

[56281.]—**To "F.R.A.S."**—Will "F.R.A.S.," with his usual courtesy, give the longitude of the earth's last perihelion passage, which would be about Dec. 31st., 16 hours N.A. time?—J. A.

[56282.]—**N. E. Locos.**—Have any of the performances of the new bogie engines, 664, 1492, &c., built last year, from Mr. McDonnell's design, been published? If we are to believe the drivers, these engines are a truly dismal failure; so if there is anything to be said on the other side, perhaps some correspondent will let us have it?—W. B. Thompson.

[56283.]—**Small Dynamo.**—I am about to construct a small dynamo machine. The pole pieces are 3in wide, and 3in. square, looking sideways, bored out to receive a 2¼in. armature, and the cores are 1in. round iron, 6in. long. I mean to have a Catella ring armature, recently described in these pages. Please tell me what size and what quantity of insulated wire ought to be wound on fields to get best results, also how many five-candle-power Swan lamps will it light? How can I fix the plates on armature?—Amateur.

[56284.]—**Dynamo.**—I wish to study construction of dynamos before making one—what books should I read? G. A. Walton.

[56285.]—**Drilling Square Hole.**—I have purchased instructions and sample. The sample shows a clean square hole, but the instructions are unintelligible. The only one which is clear to me, states that if I don't understand how to make the tool, I can buy it. Can any reader describe the tool so that I can work from the instructions?—Geo. A. Walton.

[56286.]—**Gas-Engines.**—To "R. A."—You mentioned in letter No. 54520, 12th Sept., 1884, that it was your intention, after the completion of your letters on the Gas-Engine, to describe a gas-engine for small powers. Would you kindly give promised description, as I should like to make one?—Pontiauak.

[56287.]—**Four-footed Bird.**—Some time since this was noticed in these pages. Can any reader give further information concerning it?—Paul.

[56288.]—**Crank Shaft.**—What diameter should a crank shaft (double ended) be for a cylinder 1in bore, 3in. stroke? 2. Will the crank or flywheel have to be balanced, and if so, how?—Osman.

[56289.]—**Exhaust Pipe.**—Could anyone give a remedy for the disagreeable noise of the exhaust steam in chimney of a portable engine, without removing the tube from the chimney, as it is a nuisance to neighbourhood?—Isaac T. Davis.

[56290.]—**Water Gauge.**—I am working a 9-horse portable engine. Would some of our readers inform me why the water in the gauge glass rises out of sight every night, after drawing fire, and cannot be seen down again till after two hours run with engine in the morning? All passages are clear; it has only been in use four days. Makers, Barrow and Stewart.—Isaac T. Davis.

[56291.]—**Wheatstone's Bridge.**—Will someone please tell me the battery power required (that is the number of Leclanchés I should want) to measure resistances from 5 to 1,000 ohms, using 5 ohms in each left-hand arm of the bridge up to 500 ohms; and then 10 ohms in each left-hand arm to measure from 500 to 1,000 ohms? I shall have to measure these resistances shortly, and want to use the least number of cells in each case to get the best results.—M.M.I.Sc.S.

[56292.]—**Watch Work.**—Will any reader kindly inform me where I am in error? I have small English turns with the two centres ready for use, but fail to see how to turn down new pivot, as the end of staff intended for pivot is already in a hole of one of the centres, and, of course, cannot be reached with graver or file.—Turns.

[56293.]—**Geometrical Conics.**—A tangent to an ellipse, whose foci are S H, meets two given conjugate diameters in T, *t*. T S, *t* H meet in P: show that the locus of P is a circle.—W. H. B.

[56294.]—**Chemical.**—Will some chemist kindly formulate for me the action that takes place when chlorine is passed into milk of lime for producing calcium chlorate, used in the manufacture of potassium chlorate? Is any calcium chloride or calcium hypochlorite formed?—Caloric Acid.

[56295.]—**Soldering Lamp.**—Can any of "ours" suggest anything in the way of a small handy apparatus for soldering overhead telephone wires (chiefly $^{3}_{20}$ phosphor-bronze). A very small iron is sufficient for the purpose; but an ordinary fire-pot and copper bit is much too inconvenient to use on housetops, &c. Something that can be readily lighted and extinguished, and capable of being used in very rough weather is what is required. Some combination of spirit lamp, with copper soldering bit all in one, seems the most feasible arrangement. Any information or practical suggestion will be welcomed by H. Jones.

[56296.]—**Sand Blast.**—I have a gas-engine, and should like to construct a sand-blast arrangement in connection with the same. Should I be allowed? and, if so, would some of your correspondents kindly inform me how to proceed?—An Old Subscriber.

[56297.]—**Musical Bells.**—I have several octaves of these, and lately I have found them to produce harsh sounds even when softly rung. The leather tongues seem soft enough, and the springs are good. Can any reader give me a hint how I might rectify the harshness?—Roscott.

[59298.]—**Records of the Past.**—In the course of my reading I have lately come across references to a book called "Records of the Past." The book, I believe, contains the results of some discoveries which have been made in the East, and bearing on Jewish history. As I am unable to get a copy, I should be glad if any reader of the English Mechanic would explain the nature of the discoveries, and when and by whom they were made?—Alpha.

[56299.]—**Gramme Dynamo.**—Having succeeded in making a Gramme dynamo capable of lighting eight 5 c.p. lamps, and owing that success in part to knowledge gleaned from the pages of the English Mechanic, I am desirous of making a larger and more useful machine of the same type, and would be greatly obliged if some fellow amateur could give me the leading dimensions of a dynamo capable of maintaining twenty 20 c.p. lamps. The armature being the principal part, I should like to know its external diameter and the diameter and length of the iron wire ring, the best number of sections and the gauge of the wire to be employed. If the Pacinotti ring can be recommended, where can the rings be obtained? Would it be advisable to wind the machine in shunt, as it will only be used for incandescent work; or, if wanted, for arc work? Spare series wound coils can be exchanged for the shunt ones; in any case the relative resistances, with regard to the armature, would be useful knowledge. From the general dimensions of the machine, I shall be able to deduce the size of the F.M.s and pole-pieces; but the fuller the information given, the greater will be the facility with which the machine can be made by others besides—D'Eloo.

[56300.]—**Violoncello.**—Could any of your readers furnish me with the following particulars in making this instrument?—1. What are the general thicknesses of the back and belly? 2. What is the thickness of the ribs? 3. How can an amateur bend them to shape? 4. What is the most suitable mould? 5. The length and general dimensions of the bass bar? 6. The cutting of the *f* holes. 7. The neck and its fitting. I have an idea that if the lids are made about double the thickness of a violin set, I will not be far wrong. Am I correct? There does not appear to be any authority on the subject, although I have most of the latest publications on the subject.—Eleph.

[56301.]—**Flower-Pots.**—I am told by a friend from America, that flower-pots are made there by machinery, by means of moulds, and that paraffin was used to oil the moulds and the balls of clay. I have made some moulds and attached them to my lathe, which made very nice pots, but not one in twenty would leave the moulds through sticking. Can any one help me?—S. Arlidge.

[56302.]—**Japan.**—Can any of "ours" kindly inform me of a good method to strip Japan from old machines? —and oblige—Melto.

[56303.]—**Blowpipe Lamp.**—Would some reader kindly describe a paraffin lamp for use with the blowpipe? The expense of getting in gas would be too great for anything I should have to do. I would prefer one that would not make too bad a smell.—$H_2$ S.

[56304.]—**Query Meaning.**—An advertisement says that material A is 100 per cent. cheaper than material B. Suppose material B is £100 per ton; then what is the price of A. per ton? You can say that A. is 150 per cent. dearer than B, which I understand, as B. being £100 per ton, that A. would be £250 per ton. You can also say that A. is 99·999 per cent. cheaper than B., but can the first quoted phrase be right? If so, it seems to follow that A. can be 150 per cent cheaper than B., and it could then follow that the vendor had to pay the purchaser.—Z. Y. X.

[56305.]—**Albo Carbon.**—Will anyone give me chemical formula of this? At what heat does it melt and give off gas? Is the gas given off inflammable in the absence of oxygen or common air?—Z. Y. X.

[56306.]—**Boring Mill.**—To "Invicta."—Many thanks to "Invicta." What I want at present is simply a sketch of your smaller machine to be driven by hand and bolted on to the front or flange of cylinder. Is boring bar a screw, or is the head keyed on to it? Also, how is feed applied to head with cutters on boring bar, as the head has to travel the whole length of cylinder? Do they generally put in three cutters on head and all three to cut at once?—No. 1 to take first (or roughing cut), and No. 3 the finishing cut.—Hombre.

[56307.]—**Cheap Condenser.**—To "Novice."—The condenser is chromatic, not achromatic. The distance between the bottom of my stage and the top of the mirror (when flat or parallel to the stage) is 1¼in. bare; so there is less room in mine than in yours. I should screw the carrier into the hole in the stage, and mount a hemispherical lens, ¼in. diameter, in the sliding tube. Notice that you must use a plane mirror; mine was only concave, so I stuck a piece of plane mirror on the back.—Edward M. Nelson.

[56308.]—**Secondary Battery.**—I am desirous of making a battery of this type, for experimental purposes with my small Gramme dynamo. The dynamo will light up 8 by 5 c.p. lamps, and I should like the battery to be of sufficient size to do the same for a few hours, as I cannot always obtain the power necessary for driving my dynamo at night, and would therefore be glad to have an occasional substitute for it. Could any fellow reader give me an idea as to how to set to work to accomplish this, either by detailing the construction of one cell and giving the number of cells necessary, or by referring me to a source whence I may obtain this information?—D'Eloo.

[56309.]—**Parallaxes of Stars, Binary Stars, Place of Spica A D. O, &c.**—Would "F.R.A.S.," or some other astronomer kindly give a complete list of all the parallaxes of stars which have been determined, and their actual distances in solar distances or light years, and the periods of all the binary stars which have been calculated, with their eccentricities and semi-axis-majors. I have lately seen in a book that Spica Virginis has been supposed to have been the star of the Magi? What was its exact place in Anno Domini 0, and is there any foundation for this belief? What are the stars in the heavens which have the greatest proper motions, and what are the greatest amounts of proper motion known—say the first ten? Has the companion predicted to Procyon, owing to its irregular motion, been discovered yet? Answer would oblige others besides.—M. Askwright.

[56310.]—**Coil.**—Would some of our obliging friends state whether a condenser can be attached to a shocking coil, and, if so, does it increase the strength of shock? 2nd, What is the melting heat of nickel?—Melto.

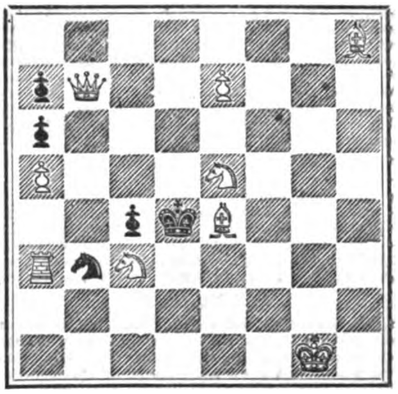
## CHESS.

All Communications for this department must be addressed to J. Pierce, Llandwrog, Carnavon.

### PROBLEM DCCCCXXXIII.—Tessie.

(Tourney Problem).

*Black.*



*White.* [9+5

**White to play and mate in two moves.**

### Solution to 931.

| *White.* | *Black.* |
|---|---|
| 1. R-K 2 | 1. P-K 3 (best) |
| 2. R-Q sq | 2. P takes R |
| 3. Kt-Q B 3 | 3. Anything |
| 4. Kt or P mates | |
| If 1<br>P takes P | 2. Kt takes P. &c. |

The author has overlooked the second solution beginning 1. R takes P.

The Solution Tourney begins with the above Problem 933. Solutions must be *received* before the publication of its solution.

Criticisms on the problems are invited.

### NOTICES TO CORRESPONDENTS

Correct solutions to 930 by C. Meiklejohn (second solution), R. C. J., Anon (both solutions), M. (ditto); to 931, by B. Fison (ditto), Rev. W. Anderson (Old Romney) and J. E. Piper—last two, second solutions.

H. Harborow.—Your solution to 931 is unintelligible.

Bethnal Green.—You have been unfortunate in both your attempts. In 930, Black on second move can take Kt with P; in 931, the K escapes on fourth move at R 4.

H. Jackson.—We have answered your inquiry by post.

"E.M." Tourney Game between J. Russell (White), and F. A. Vincent (Black)

(Evans declined).

1. P-K 4, P-K 4 / 2. Kt-K B 3, Kt-Q B 3 / 3. B-B 4, B-B 4 / 4. P-Q Kt 4, B-Kt 3 / 5. P-Q R 4, P-Q R 3 / 6. P-B 3, Kt B 3 / 7. P-Q 3, P-Q 3 / 8 Castles, B-K Kt 5 / 9. P-R 3, B-K 3 / 10. Q-Kt Q 2, P-K R 3 (*a*) / 11. B takes B(*b*), P takes B / 12. Kt-B 4 (*c*), B-R 2 / 13. R-R 2, Kt-K 2 / 14. Kt-R 4 (*d*), P-K Kt 4 / 15. Kt-B 3, Kt-Kt 3 (*e*) / 16. K-R 2, P-Kt 5 / 17. Kt-Kt sq (*f*) P-K R 4 / 18. B-Kt 5, P takes P / 19. Kt takes P at K R 3, P-Q 4 / 20. P takes P (*g*), Kt-Kt 5 (ch) / 21 K-R sq (*h*), Q takes P / 22. Q-K 2 (*i*), K-Q 2 / 23. P-B 3 (*k*), Q R-K B sq (*l*) / 24. R-K sq (*m*), R-B 4 / 25. Q-K 4, Kt-B 7 (ch) / 26. Kt takes Kt, R takes B / 27. K-Kt R 3, R-B 4 / 28. Q-R K 2, R-K sq / 29. P-Kt 5 (*o*), P takes P / 30. P takes P, B-B 4 / 31. Kt-R 5, Kt-B 5 / 32. Kt takes Kt, R takes Kt / 33. Q takes Q (ch) (*p*), P takes Q / 34. P-Q 4, P takes P / 35. Kt takes P (*q*), B-Kt 3 / 36. R takes R, R-R 5 (ch) / 37. K-Kt sq, P takes P (dis ch) / 38. R (K sq)—K 3 (*r*), R-K 5 (*s*) / 39. Resigns.

### Notes.

(*a*) Q-Q 2 seems better.

(*b*) Not commendable. Already Black has the better position.

(*c*) The Kt is no good here. Kt R 4, preferable.

(*d*) This is useless, and two moves thrown away. Why not Kt-R 2?

(*e*) Black, through the last few moves on both sides, is able to initiate a strong attack.

(*f*) Home, sweet home!

(*g*) Kt-Q 2 looks better than thus helping to develop Black's game.

(*h*) This shows that K should have gone to R sq on 16th move.

(*i*) P-B 3 driving the Kt away at once is better.

(*k*) Useless, as P dare not take Kt, on account of P takes P. There seems no objection to Q-K 4.

(*l*) Black keeps up the attack with vigour.

(*m*) Still Q-K 4? Note if P takes P, P takes P / R takes R, R takes P mate.

(*n*) To provide for Q takes Q, Black's attack is now effectually parried, and the prospects look drawish. White's next three moves are the result of a desire on his part to force the fighting, which had been better left to the adversary.

(*o*) To prevent P-Kt 4; but it enables the B to work its way round, and increase the attack.

(*p*) If Q-R 7 (ch), R-K 2 / Q takes R P, (B 5) B 2 and wins.

(*q*) Kt-Kt 3 would (as pointed out by Mr. Vincent) have at least secured a draw.

(*r*) If K-B sq, R-R 8 (ch) / K-K 2, R takes R (ch) / K takes R, K takes R / and Black's pawns must win.

(*s*) A beautiful move and decisive; altogether a surprise to White, who expected B takes R (ch) / R takes B, and the Kt returns in time to catch the pawns.

**Catapults**, 7d., 1s., 1s. 2d.; elastic 2d., 3d. foot; square 1d. to 4d. yard.—Moody Bell, Cheltenham.

**Elastic Stockings** for Varicose Veins.—W. Smith and Sons, 37, Breck-road, Liverpool. None made in London.

**Cat Gut**.—Gut Hooks and Eyes for lathes and machinery.—James Bellaers, Regent-street, Leicester.

**Bellaers' Gas Stoves**, 1s. 3d., 2s. 3d., 3s. 3s., for boiling. Breakfast Stoves, 8s., 11s., 14s. 6d. Send for lists.

**Edward W. Drury**, Hull, Glass Bottle and Cork Manufacturer, Importer of Chemicals, Caramel, Glucoses, Tinned Wire.

Edco six-cell **Battery**, twelve new porous pots, new zincs; will drive sewing machine, motor, or three 5 c.-p. lamps 120 hours without recharging for 8s. inclusive; last price, £4 10s. Cost £7 10s.—Address, C. R. Hear, 62, Coleman-street, E.C.

**Locomotive Photographs**.—N. L. Ry., G. N. Ry., &c., 8in. by 5in., 1s. Specimen carte and list, 5 stamps.—F. Moore, 1, Naas-road, Wood Green.

**Harmonium Reeds**, 2 sets, with pan, all best make, 36s.—J. H. G., 100, West-road, West Ham Park, E.

**Banjo**, with waterproof cover. 20s. Great bargain. Carriage paid.—J. Kinleyside, 61, George-street, Perth.

**Lathe**, 3½in. centre, with tools, chucks, leg vice: bargain.—Mechanic, 34, Crownfield-road, Leytonstone-road, Essex.

"**Thought-Reading**." Full explanation for 2s. 6d. —J. E. Parr, Ainsworth, Bolton, Lancashire.

**Diagrams**, large crayon, plain or coloured, for lectures on microscopy, &c.—J. E. Parr, Ainsworth, Bolton.

Twisting, Reeding, and Fluting **Lathe**. While inventing the spiral lathe my aim has been to make it in as few parts, to lessen the friction, and make it as cheap as possible, so that it may be within the reach of every woodturner. I have done small pillars of stone, coal, and clay. Will some one make an offer for it?—Scott.

**Koumiss**.—The secret of making this valuable wine price sixpence.—Robert Lawrence, 125, Thistle-street, Glasgow.

Model **Engine Castings**. Best and cheapest. See list (stamp) and compare.—Wood, Dalley-street, Broughton, Manchester.

Celebrated Kerry **Ferns**, 12 varieties, including rare filmy, 1s. 6d. free.—FitzPerr, Rathanny, Tralee, Kerry.

**Rose Engine Lathe**, with overhead, reciprocating, quantity of attachments; in excellent order; not rubbish, but a genuine bargain, £30 or offers. Also a Medallion Machine. May be seen by appointment.—Particulars from R. White, 50, Finsbury-square, London, E.C.

**Type-Writer** (Hall's), in perfect condition, £6, or offers.—R. White, 50, Finsbury-square, London, E.C.

**Tricycle Wheels**, Bicycle Wheels, and Fittings. Wonderfully cheap. Also for safety Bicycles.—W. Gwinnett and Co., Wolverhampton.

Upright Vertical **Engine**, cylinder 3in. long by 2⅜in. dia., flywheel 9½ dia.; would work a lathe; excellent order; cash, 25s.—R. H. Pease, 45, Chester-street, Saltney, Chester.

**Gas Bath Heater**, Phillips' patent, with towel warmer.—Baker, 9, Mincing-lane, London.

**Incandescent Carbon Lamps**, low resistance, 3s. each; Fairy Lamps, 3s. 6d.; Platinum Lamps, 1s. 3d., post free.—Todd, 14, Wentworth-road, Manor Park, Essex.

**Incandescent Lamp Holders**, new pattern, best in the trade, 12s. dozen; sample, post free, 1s. 3d.—Todd, as above.

**Formulas Worked Out** for winding Dynamos from 10 c.-p. to 500 c.-p., 8 stamps each.—H. Jones.

**Dynamo Castings**, 100 c.-p., cog armature, Gramme fields, 9s. a set. Motors with patent armature, 3s. a set. —H. Jones.

**Dynamos**, patent improvements, No. 2,122. 70 c.-p. machines, £5. 32 volts, ampères.—H. Jones.

**Dynamos**, best small machines in the trade, and cheapest double-covered Wires to 20 gauge, 1s. 8d. lb.—H. Jones.

**Dynamos** for Home Lighting.—5 lights, or arc of 600 c.-p. Price £6 10s., approval. Warranted.

**Dynamo Castings**, with laminated armatures, 8 c.-p., 5s.; 16, 5s. 6d.; 20, 6s. 6d.; 30, 7s. each.—H. Jones.

**Dynamo**, laminated armatures, no heating, ventilating; 70 c.-p., 16s. a set; finished, £5. Warranted.—H. Jones.

**Dynamo Machines Repaired**. Motors, with wire, 5s. 6d.—H. Jones, 48, High-street, Lambeth, S.E.

Model **Steam Engines** made or repaired. Separate parts fitted up, boilers made to order.—Lucas and Davies, 21, Charles-street, Hatton-garden, London.

Steel **Name Stamps**, 3d. per letter. Figures (set), 2s. 4d. Letters, 6s. 4d., per post.—E. F. Baldwin, Robinswood-hill, Gloucester.

Nickel-plated tubular pocket **Microscopes**, magnifying 5,000 times, post free, 1s.—Arnold, Spring-grove, Kingston, Surrey.

**Lathes**, Lathes. Cheapest and best. List, 2 stamps Nothing equal at price.—Robinson, Somerset-road, Sheffield.

The **Telegraph Tricycles**, T-framed, front steering, ball bearings, scientifically constructed. List free.—Norton, Crockherbtown, Cardiff.

Circular **Stocks and Dies** for cutting full threads at once running down. A great improvement on the old style. See testimonials. Price lists, one stamp.—Jerry and Son.

**Testimonial**:—"Gentlemen,—I am very satisfied with the screw-tackle. It is certainly a novelty. It is particularly well suited for amateur mechanics and small manufacturers." For full copy of this and other testimonials, send for lists.—Jerry and Son, North-street, Stafford.

**Hematite** for Jewellers.—Richard Baker and Co., 9, Mincing-lane, London.

**Brazilian Peebles** and Crystals.—Richard Baker and Co., 9, Mincing-lane, London.

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*FRIDAY, APRIL* 10, 1885.

## MODERN RAILWAY FACILITIES.

ALTHOUGH, according to the adage, "familiarity breeds contempt," it is certain that railways and locomotives have an extraordinary hold on the mind, not only of those who have a mechanical turn, but also of many who know little of the inner mysteries and study only the time-tables. It is not by any means news to those acquainted with the history of the subject to be told that they travel no faster nowadays than they did thirty years ago—nay, not even so fast as they could have travelled by one train on the Great Western; but only those who study the subject are aware that no such services as we now have on our main lines were available even twenty years ago. There is at present no desire to exceed a running average speed of, say, 50 miles per hour, for high speeds mean a great increase in working cost; but there is, at least where competing lines touch the same places, much endeavour to increase the comfort of passengers, to study punctuality, and to run longer trains. The high speeds of thirty years ago were made with trains of two or at most three coaches, but they did not pay, and so far as the travelling was concerned the passengers had much to complain of. Nowadays railway travelling in Pullman cars and saloon carriages is almost a luxury—at least, it can be accomplished with ease and comfort, and the passenger who leaves London at 10 a.m. can be in Glasgow or Edinburgh by seven in the evening without feeling any inordinate amount of fatigue. If he likes he can dine without leaving the train, or, if he prefers it, he can travel at night and go comfortably to bed, to find himself at his destination when he awakes in the morning. These modern facilities are not so much appreciated in this country as they are on the Continent and in America, for the longest journey here is a mere trip compared to the runs which are now made with regularity and punctuality in Europe and America. In a paper recently read by Mr. Barnet Le Van before the Franklin Institute, the claim is made that the most luxurious travelling is to be found on the Pennsylvania Railroad, which for long-distance runs stands first in the whole world. The New York and Chicago "limited" accomplishes a distance of 912·2 miles in twenty-six and a half hours, including the ferry at New York and eight stops, which consume sixty-six minutes—thus giving an average running time of 36·18 miles per hour; but that does not satisfy Mr. Le Van, for he holds that if the law would only step in and make such regulations as prevail in this country, America could far surpass England, for here the law gives the companies complete control over their roads, while in America not only are sharper curves allowed, but the companies are compelled to run their trains subject to all sorts of rights of trespass on the track. As to the question of safety, Mr. Le Van contends that the safest line is the one which is best managed, and to run the most and fastest trains it is obliged to be the best managed. According to Mr. Le Van, railway speed in America, both for short and long distance runs, is second to none obtained elsewhere. For evidence in support of this statement, he points to the run between Baltimore and Washington on the Baltimore and Ohio road, where a distance of 40 miles is run in 45 minutes, or a speed of 53⅓ miles; to the run between Germantown Junction and Jersey City on the Pennsylvania line, which is 84·3 miles, and is accomplished in 1 hour and 44 minutes, or, roughly, a speed of 50 miles an hour; and to the run from Altoona to Harrisburg on the same line which is done in 3 hours 20 minutes, a speed of 39½ miles for 132 miles. It will be seen that there is nothing in these examples to compare with the Great Western run to Swindon, 77 miles at the rate of nearly 54 miles per hour, or with the Great Northern, Grantham to King's Cross, 105½ miles at the rate of 51 miles per hour. In long-distance runs the Pennsylvania Railroad stands "first in the world" because no other line has control of such distances; but it cannot be doubted that if either the Great Western or the Great Northern experienced any necessity for accomplishing a rate of 51 miles over a distance of 1,000 they would do it, for there is nothing about American locomotives or rolling stock which renders them superior to what can be found on our first-class railways. Pullman cars do not find much patronage in this country, except from a certain class who frequent race meetings and the like; as a matter of fact, they share only in the patronage obtained by modern saloon coaches and ordinary first-class carriages, which, to the ordinary Britisher, are the essence of luxury, if not of comfort, on even long-distance journeys—such long distances as we have here, that is. The running on the Pennsylvania road, however, is probably quite as much as can be expected, for within certain limits railway speed is a matter which is determined by the fares passengers are prepared to pay. As it is, on the portion between New York and Philadelphia there are bits which are run at the rate of 70 miles an hour, and the whole distance of just upon 90 miles might be done quicker than it is if it were not for the fact that, with the exception of a few straight runs, the line is really a series of curves and re-curves, some of which are of rather small radius. With all these drawbacks—90 curves in 90 miles, the total curvature of which would complete 10 circles—the Pennsylvania line runs one train each way daily at the rate of nearly 50 miles an hour between Philadelphia and New York, and it would probably run more if there were passengers to foot the bill. That is the gist of the whole matter. Heavy trains and stiff gradients limit the speed; but railway companies both here and in America are prepared to run at higher velocities if the public demand them, and are prepared to pay the price. But as it is, to make 50 miles over a long distance parts must be run at 70 miles or more, and there is not much likelihood of any regular trains being run here or in the United States at much quicker rates than can be found nowadays. As a matter of fact, railway companies have means of knowing exactly what they can do at given prices; and though the Great Western line remains the same as it always has been, we hear nothing of those fast expresses which, when Gooch's 8ft. engines were first put on the line, ran from Paddington to Didcot, a distance of 53 miles, in from 48 to 50 minutes. Running speed is still as high as ever it was, except, perhaps, in connection with the train just mentioned, which in 1847 rarely had more than three coaches; for time is now lost at stations owing to the increased number of passengers (and their luggage), and the average is reduced by the "waits." It has been calculated that each mile of speed above 40 miles an hour represents now twice as much performance as it did thirty years ago; but what we have to consider in "modern railway facilities" is the fact that where thirty years back there was one specially fast train, there are now a dozen all running almost as fast as that one engine and perhaps three coaches which constituted the "express" of a generation ago. The high speed attained on the 40 miles of the Baltimore and Ohio road between Baltimore and Washington seems to have led the pen of Mr. Barnet Le Van slightly astray, for he speaks of that road as having marked "many an epoch in railroad history," and as the "first passenger railroad in the world." But the facts are that the Baltimore and Ohio line was commenced on July 4, 1828, and 15 miles were opened as the first passenger line in America in 1830, the cars being drawn by horses. The first railway in the United States was one of two miles, which in 1826 ran from Milton to Quincy, a distance of two miles, and was worked by horses. The Liverpool and Manchester and the Baltimore and Ohio lines were in reality contemporary, but it was not until the utility of the locomotive had been demonstrated on the former that it found its way on to the latter, the first locomotive for which was built by Davis of York, Pennsylvania, with upright boiler and cylinders. The Baltimore and Ohio line can no more claim to be the first passenger railway than can the Liverpool and Manchester, but it is certain that Philadelphia can claim to have in Oliver Evans one of the pioneers of railways—a man who foresaw what they would arrive at within the next generation. Oliver Evans was the first in America to start a steam carriage, and it was he who stated that it would travel at such speed that it would be possible for the traveller to set out from Washington in the morning, breakfast in Baltimore, dine at Philadelphia, and sup in New York on the same day. Stephenson said that the time would come when it would be cheaper for the working man to travel by steam than to walk, and all the world knows now that Stephenson's dictum did scant justice to the railway, for the cost of boot leather, not to speak of the expense of lodgings and the loss of time, would make a considerable item when compared with the fare charged nowadays. A workman can at the present time transport himself wherever he is wanted at a comparatively small outlay, while those who can afford luxuries can travel with ease and comfort over distances which were veritable journeys to their ancestors. Reflecting on things as they are compared to what they were half a century ago, and remembering the pithy words of Edward Pease, "Let the country but make the railroads and the railroads will make the country," it must be acknowledged that we owe much of our prosperity, and nearly all of our contentment and comfort, to the "modern railway facilities."

## REVIEWS.

*Elementary Textbook of Zoology*. By Dr. C. CLAUS. Translated and edited by ADAM SEDGWICK, M.A., with the assistance of F. G. HEATHCOATE, B.A. London: W. Swan Sonnenschein and Co.

WE noticed the first part of this work on p. 353 of the last volume, and mentioned then that, edited by Mr. Sedgwick, Claus's "Elementary Zoology" easily takes first place amongst books of the kind. The special part, "Mollusca to Man," is paged as a separate volume, but the engravings are numbered consecutively with those in the first part, an arrangement which has an advantage when the student remembers a subject by the number of the illustration. The view taken by Dr. Claus of the position of man in the animal kingdom may be gathered from the following sentences:—"All these peculiarities, which are of the greatest importance for the intellectual development of man, cannot be regarded as fundamental distinctions, but must rather be ascribed to gradual deviations, since there are still greater differences between the highest and lowest apes. Efforts have been vainly made to show that certain parts, which are always present in apes and other mammals, are absent in man; and the attempts to prove the converse of this—viz., that there are parts of fundamental value in the human organism which are found in no other mammal—have as completely failed." A student of this work who carefully follows it from beginning to end—taking nothing upon trust that he can possibly verify for himself—will probably arrive at the same conclusion as the author and editor, that the high intellectual development and the possession of articulate speech, which render man capable of reaching perfection, form a great gap between him and the highest beast, but still leave him separated from the higher animals only in the degree of development to which his mind has attained. As an elementary textbook of zoology the work covers the whole field, and, while necessarily dealing with many points in a brief manner, still affords the student all the information he needs before tackling the more elaborate monographs on branches of the subject. The notes referring to the authorities will be found of much assistance.

*Harbours and Docks.* By Leveson Francis Vernon-Harcourt, M.A. Oxford: Clarendon Press.

This work, which appears in two volumes (text and plates), is issued in the Clarendon Press Series, and should be of considerable value to the rising generation of civil engineers, for besides embodying in its pages the results of personal observation, experience, and practice, Mr. Harcourt has freely sought the co-operation of his professional brethren, and consequently we have details and plans of harbours and docks in all parts of the world. The plans on the different plates are all drawn to the same scale, so that they are comparable at a glance. The preliminary chapters deal with the varieties of harbours, influence and prevalence of wind, the generation of waves and their force; the tides, currents, and changes produced in coasts; forms of harbours, and so on. The author then proceeds by classifying harbours, e.g., those with jetties, with rubble mound breakwaters, with concrete block mound breakwaters, &c. No harbour at which any engineering work of importance has been carried out seems to have altogether escaped, and of many he gives a full description and plan. Docks and quays are treated in a similar manner, and to a certain extent lighthouses also; in fact, the work describes the physical features, history, construction, equipment, and maintenance of harbours and docks, with statistics as to their commercial development. It will be of great utility to many besides civil engineers.

*Chess Eccentricities.* By Major George Hope Verney. London: Longmans.

Major Verney's little work on "Four-Handed Chess," published in 1881, attracted so much attention that he has given us a more extended account of other varieties of the game of chess, nearly all of which he has tried and found interesting, while affording unlimited scope for the most scientific play. The work is appropriately named "Chess Eccentricities," for besides a description of the four-handed game, which is becoming widely known, Major Verney explains the mysteries of three-handed chess on a board of 136 squares as devised by Marinelli, and his own plan of three-handed round chess on 96 squares. Chess for six players on 192 squares, and the game for eight players on 448 squares also have some pages devoted to them. For those who wish to try their hands at a game differing materially from the ordinary two-handed chess, Major Verney recommends one of the "eccentricities" on a round board; and those who wish to test their skill, science, and forethought are advised to try the three-handed game of Marinelli or that of Tesche. The volume is full of matter which will interest students of chess who take a wider view of the game than is possible with the ordinary board.

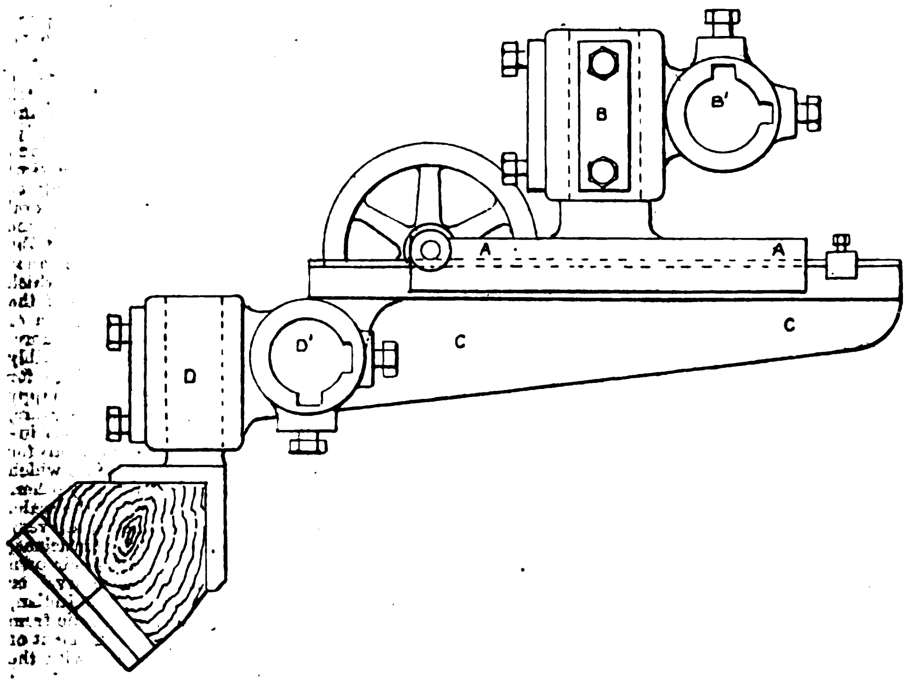
*Lessons in Elementary Practical Physics.* By Balfour Stewart, M.A., and W. W. Haldane Gee. London: Macmillan and Co.

This work is in reality an elaboration of the manuscript notes which Professor Stewart and the assistant lecturer and demonstrator in physics at Owens College have used in the laboratory of that institution. Nowadays manuscript notes have to be very voluminous to answer all purposes, and it is inconvenient to be continually referring to books which are of necessity located in the library; hence the authors determined to collect the notes and gather them into a volume for use in the laboratory; but they soon discovered that the matter grew in their hands, and accordingly determined to divide it into three volumes, the first of which, that on the general physical processes, is now published. It will be followed by others dealing with "Electricity and Magnetism," and "Heat, Light, and Sound." The plan adopted is to divide the matter into a series of lessons, each one descriptive of something to be done by a definite method with definite apparatus; hence there is very little of theory in the volume. Works of this kind are of much value, not only in the laboratory, but to those who have no chance of appreciating the advantages of a well-appointed "workshop."

We have also received *An Elementary Treatise on Dynamics*, by Benjamin Williamson, M.A., and Francis A. Tarleton (London: Longmans), which will be useful to those who desire an introduction to the higher works, for the authors start from the most elementary conceptions, and demand from the student only an acquaintance with the notation of the calculus.——*Physical Arithmetic*, by A. Macfarlane, M.A., D.Sc. (London: Macmillan), is a treatise on arithmetic chiefly as applied in physical science, and supplies a want which has long been recognised by examiners and teachers. The author adopts what he terms the equivalence method, in which each quantity is analysed into unit, numerical value, and, when necessary, descriptive phrase. The rate, or law, or convention, according to which one quantity depends on one or more other quantities, is expressed by an equivalence, which is either of dependence or substitution, and the equivalences are combined according to a form which is a development of the chain rule. The work will be found useful by all students of physics.——*Technological Dictionary of the Physical, Mechanical, and Chemical Sciences* (English-German), by F. J. Wershoven, D.Sc. (London: Symons and Co.), is the first part of a dictionary for science students, giving technical words in English, French, German, Italian, and Spanish.——The *Electricians' Directory* (London: G. Tucker) contains, besides a list of those commercially and professionally engaged in connection with electricity, a variety of useful information, and a "carefully compiled biographical section, giving interesting particulars concerning all the leading scientific men of the world"—a sentence which is misleading, for the biographical notes refer only to those who are connected in some way with electricity, either scientifically or commercially.——*Photo-Micrography*, by A. Cowley-Malley (London: H. K. Lewis), is the second edition of a work which is looked upon as the authority in the subject of which it treats. It is freely illustrated, and is adorned with some photo-micrographs.——*Standard Practical Plumbing*, by P. J. Davies (London: E. and F. N. Spon), is the first volume of a standard textbook on plumbing, the character of which can be gathered from the articles published in these columns. The matter has been rearranged, or rewritten, by the author, and the work is, in fact, the only treatise on practical plumbing which can be recommended to the diligent study of the apprentice.——*Scientific Theology*, by Thomas Walter Barber (London: Elliot Stock), is a series of essays towards the development of religious truth on the basis of modern science. The author tells us that he offers his remarks "more in the way of suggestion than authoritative or dogmatic statement, being fully aware that they are in no sense final"; but as he appears to think that scientific men "have all along either denied or refused to recognise" the existence of a power which they would be compelled to acknowledge if they attempted to arrive at the cause of the natural forces, scientific men can afford to leave the author of this work to the enjoyment of his opinions.——*Pottery Painting*, by Fred Miller (London: Wyman and Sons), is a course of instruction in the various methods of painting on pottery and porcelain, which may be recommended to those who desire to practise the art either as a pastime or as a means of livelihood.——*Wood-carving*, edited by Fred Miller (London: Wyman and Sons), is a useful work, chiefly valuable for its illustrations and descriptions of old work, though the editor has selected a number of practical hints from several authors.——*Notley's Commercial and School Book-keeping*, by A. F. Notley (London: Bemrose and Sons), will be found useful by teachers in schools, and also by those who are endeavouring to learn at home. Mr. Notley calls his subject the "Science of book-keeping," and he has certainly produced a manual which may be commended to all who desire to understand the mysteries of the art.——*A Handbook of the Teeth of Gears*, by G. B. Grant (Boston, Mass.: 66, Beverley-street), is a small pamphlet on the teeth of wheels, which will help to facilitate the comprehension of the subject by the average workman. The author describes some new odontographs, which he believes to be superior to those heretofore in use.——*A Collection of Examples on Heat and Electricity*, by H. H. Turner, B.A. (London: Macmillan), will be useful to many. The examples have been selected from examination papers set in various college examinations and the mathematical tripos.——*Elementary Principles of Carpentry*, by Thomas Tredgold, C.E., revised and enlarged by E. Wyndham Tarn (London: Crosby Lockwood and Co.), is the sixth edition of the standard authority in the English language. The publishers have done justice to the work by producing it in quarto size, with large type and excellent illustrations and plates. This sixth edition has been thoroughly revised by Mr. Tarn, who has rearranged a great portion of the contents and brought the whole up to date.

## MOULDING TOOTHED WHEELS.

An improved machine for moulding toothed wheels has been recently patented by Mr. J. Whittaker, of Oldham, who claims the combination of a slide having a universal joint with a mould carrier having similar play. The invention is applicable to wheel moulding machines of various constructions, the object of the invention being to adapt such machines to the special purpose of moulding helical or double helical toothed wheels, wherein the teeth are parallel to each other, but are at an angle to the axis of the wheel, or what are known as skew bevel wheels. In moulding wheels by machinery, it is usually the practice to withdraw the pattern from the sand either vertically or horizontally, according to the construction of the machine, or the wheel to be made; but it is difficult or altogether impracticable to withdraw the pattern of teeth of the above-described class from the sand by the ordinary machine, and in order to facilitate the moulding of this class of wheels, the patentee attaches to the ordinary machine a slide so constructed and arranged that it can be adjusted at any angle, so as to work either horizontally, vertically, or diagonally as may be required for withdrawing the patterns of this class of teeth from the sand. The mould carrier is also attached to the slide by a universal joint, so that it can be set at any required angle with regard to the slide, and by these means helical or skewed toothed wheels can be moulded by means of the ordinary moulding machine. In the drawing, which is a side elevation, it will be seen that the slide A A is fitted with a universal joint B B$^1$, the former part B of which works on a vertical axis, and the latter B$^1$ on a horizontal one, so that it can be set to move diagonally to any angle required. The arm or mould carrier C C is also provided with a similar universal joint D D$^1$ for the same purpose, and it will be evident that by the combination of these two universal joints, not only can the slide be set to move to and fro diagonally at any angle required, but that also the mould carrier may be adjusted to any desired angle with regard to the slide, and hence the moulding of helical spur wheels and skewed bevel wheels will be greatly facilitated, as the mould or pattern can be caused to enter and leave the sand in any direction and at any angle.



# NOTES ON CASSEGRAINS.—III.

By DR. ROYSTON-PIGOTT, F.R.S.

### Construction.

IN my last article (March 27, p. 72) the word "focus" is omitted, and the sentence should read: "The small convex being 20·9in. outside or beyond the convex *focus*, a cone of light converging thither will almost exactly fill the convex with light coming from an 18in. mirror, with the condition that the convex is $3\frac{1}{16}$in. in diameter."

We have not done yet with magnifying power. It so happens that we can get two values for it which gives an interesting method of finding the value of ($x$), the actual distance between the big focus, F, and the little focus, $f$; for we have two equations—

$$M = \frac{F}{E} \cdot \frac{F+f}{f}, \text{ and}$$

$$M = \frac{F}{E} \cdot \frac{f}{x}, \text{ whence}$$

$$\frac{f}{x} = \frac{F+f}{f}, \text{ or}$$

$$x = \frac{f^2}{F+f} = \frac{f}{\frac{F}{f}+1}.$$

Now, $f$ and F being given, $x$ is known. Example.—In my Cassegrains—

$$M = 129 : f = 28\tfrac{1}{2}.$$

Then—

$$x = \frac{28\frac{1}{2}}{\frac{129}{28\frac{1}{2}}+1} = \frac{28\frac{1}{2}}{5{\cdot}53} = 6{\cdot}28 = \text{F}f.$$

It is clear, then, the focus of the convex must be placed about 6¼in. beyond the focus F, or the convex surface be placed 22¼in., nearly, behind the big mirror's focus F.

In designing the Cassegrain several points are indispensable.

1. The diameter of the convex should exactly equal the diameter of aperture in great mirror, and be about one-sixth of it.

In my Cassegrain I ordered convexes of 40, 28½, and 16in. These had all to be adjusted to different positions, in order to throw the final image 15in. behind the aperture in the parabolic mirror. The focus F of this latter was 129in. It may be interesting to note the effects and positions of these appliances as regards change of focus.

In focussing with the 40in. convex by calculation, the eyepiece has to be shifted about 14 times faster than the convex—i.e., if convex is focussed 1-14th in., the eyepiece must be shifted above 1in. further away. Some heavy calculations are requisite for determining the results embodied in the accompanying table. I now proceed to the interesting question—the effect of slight movements in focussing with the convex mirror upon the position of the eyepiece.

### The Change of Focus in Cassegrains.

The Cassegrain can, in my opinion, become highly popular, especially in instruments of large size. At the present moment I propose to refer to an untouched point, the change in the final focus arising from small movements of the convex mirror. I take a case. Let

A F be sidereal focus of concave, 129in.
sidereal focus of convex, 40in.
A $f^1$ distance of final focus from concave, 107in.
A B distance of convex surface to concave, 99⅞in.

I now propose to move the convex gradually nearer to the concave and calculate the effects; as B moves towards A, $f^1$ moves a small space to to the left, i.e., A $f^1$ increases.

$$\overline{f^1 \quad A \qquad\qquad\qquad B \quad F \quad f}$$

At 107in. for B$f^1$ the ratio of the variation of the position of $f^1$ the final focus for a given small variation in the position of the convex $\frac{du}{dv}$ is 1 to 13½. When B$f^1$ reaches the value 120, the ratio becomes 1 to 16. In other words, the position of the concave is, so to speak, 16 times more sensitive than the eye focus. At present this state of things requires the small convex to be moved in change of focus by means of a distant screwed rod, or cord, as in the Melbourne monster Cassegrain; but it may fairly be expected that the foci may in time be brought to such a position as may permit focussing by the eyepiece. I have indications of this desirable result already. In the achromatic telescope it is well known that any instrument whose focus is not sensitive to the 1-50th of an inch change in the position of the eyepiece is of no

TABULAR RESULTS FROM CHANGING POSITION OF A CONVEX OF 28½ FOCUS, COMBINED WITH A CONCAVE OF 129IN. FOCUS.

| Dist. of convex from $f^1$, the eye focus. | Dist. of convex from concave focus. | Radius of convex. | Increase of B$f^1$ |
|---|---|---|---|
| B$f^1$. | B F | — | |
| 116·545in. | 22·9 | 28·5 | $\Delta_1 = 2{\cdot}637$ |
| 119·182in. | 23·0 | 28·5 | $\Delta_1 = 2{\cdot}734$ |
| 121·916in. | 23·1 | 28·5 | $\Delta_1 = 2{\cdot}839$ |
| 124·775in. | 23·2 | 28·5 | $\Delta_1 = 2{\cdot}947$ |
| 127·702in. | 23·3 | 28.5 | $\Delta_1 = 3{\cdot}063$ |
| 130·765in. | 23·4 | 28·5 | |

TABULAR VIEW OF THE FOCAL CHANGES FOR VARIATIONS IN THE POSITION OF THE CONVEX MIRROR.

| B F. | Inches B$f$. | Concave to final focus A$f$. | Convex to Concave Focus F. | Focus of Convex. | Dist. between mirrors A B | Ratio of variations of A$f$ and A B. | REMARKS. |
|---|---|---|---|---|---|---|---|
| 29·12 | 107 | 7½ | 29·12 | 40 | 99⅞ | Times<br>13½ | The eye focus $f^1$ is displaced 13½ times as much as the convex for this value of A B, the distance between mirrors. |
| 29·19 | 108 | 9·2 | 29·19 | 40 | 99·8 | 13·7 | The magnifying power increases in the ratio of B$f$ to B F, and if an eyepiece give power 107 for the first position, the power will be increased to 120 at the last. |
| 29·26 | 109 | 9½ | 29·26 | 40 | 99·75 | 14 | |
| 29½ | 110 | 10½ | 29½ | 40 | 99·66 | 14·1 | |
| 29·40 | 111 | 11·4 | 29·4 | 40 | 99·6 | 14·2 | The ratio of variation is as the square of B$f$ to the square of B F, Example $(111)^2 : (29{\cdot}40)^2 :: 121 : 182$. |
| 29·47 | 112 | 12·5 | 29·47 | 40 | 99·5 | 14·3 | Note.—A$f$ changes very nearly as fast as B$f$ diminishes, a remarkable property. If B$f$ gains an inch, so will A$f$. |
| 29·532 | 113 | 13·5 | 29·53 | 40 | 99·5 | 14·6 | |
| 29·610 | 114 | 14·6 | 29·61 | 40 | 99·4 | 14·8 | |
| 29·67 | 115 | 15·67 | 29·67 | 40 | 99·3 | 15·0 | Here a change in the final focus from the 2nd position amounts to 8in. for a movement of half an inch of the convex towards the concave. |
| 29·746 | 116 | 16·75 | 29·74 | 40 | 99·3 | 15·2 | |
| 29·80 | 117 | 17·8 | 29·80 | 40 | 99·1 | 15·3 | Remark.—The actual changes, not between convex and final focus, but between convex and focus of concave B F, are nearly 7-100ths for each increase of B$f$ an inch at a time. |
| 29·87 | 118 | 18·87 | 29·87 | 40 | 99·0 | 15·5 | |
| 29·94 | 119 | 19·94 | 29·937 | 40 | 99·0 | 15·8 | |
| 30 | 120 | 21 | 30 | 40 | 99·0 | 16 | Power increased from 107 to 120 by moving convex ⅛in. nearer concave mirror. |

extraordinary quality. Here a change of 3-100th of an inch for $Bf^1 = 112$ throws $f^1$ 1in. further from the convex. I have observed that the number of the diffraction rings presented by a star of the second magnitude can be decidedly changed with a very small focussing distance of the eyepiece. In an instrument of exquisite quality this valuable test of exalted beauty of definition may be applied—but at present, alas, for astronomical weather!*

These differences put into round numbers are 2·6, 2·7, 2·8, 2·9, 3·0, with a second difference of 0·1 nearly, showing that $Bf^1$ increases in arithmetical progression very nearly by the tenth of an inch for the same increase of distance between the convex and the focus of the big mirror (the concave). Whoever wishes to test the performance of his Cassegrain should never be satisfied till he has tried a considerable number of convexes against one standard parabolic concave, which can be essentially tested as a Newtonian. I possess six different convexes. The optician matches the various lenses of a microscopic objective with almost endless industry, now trying this pair, then that, till he obtains a minimum aberration for white, or for coloured light. In the Cassegrain we have only to deal with the aberration of homogeneous rays, and, therefore (neglecting eyepieces, which themselves are deeply afflicted with optical error), the question is one almost entirely of "marrying" the curves of the mirrors. A great variety of combinations practically are possible. To match a convex to a given concave is a difficult affair. If we plunge into the vivid phenomena given by solar discs in perfectly favourable air by splendid telescopes, and tabulate the niceties of change in the diffraction rings discoverable, both within and outside the best focal point (a course of philosophy during two favourable springs I do not again desire to undertake), doubtless we may arrive at strong conclusions for or against our favourite mirrors. For this purpose a small lens of the ⅓rd of an inch focal length gives splendid results placed to the north with the sun brilliantly shining upon it at a convenient distance—60yds. or more (Calver, I believe, prefers 150). Beyond 40yds. or 60yds. I have found the terrestrial radiation and warm-air currents excessively annoying except in the early part of spring, or even May. Daylight testing is then a pleasure —between 9 and 10 a.m.—after that hour the solar heat causes too much radiation and atmospheric undulation. I believe Schwabe chose the hour of 9 a.m. for solar spot observations, and, at that time, the air seems to be comparatively still and free from heat currents. Then is the time to test the focal changes wrought by slight focal displacements.

(*To be continued.*)

## THE MUSICAL SCALES OF VARIOUS NATIONS.

A LONG and elaborate paper on the Musical Scales of Various Nations, was read the other day, before the Society of Arts, by Mr. Alexander J. Ellis, F.R.S., but we can afford space only for the following extracts. The paper will be found in No. 1638 of the *Journal* of the Society, and is mainly composed of matter that is entirely new, which has been gathered together only by laborious research, and has been presented in a novel shape by Mr. Ellis, assisted by Mr. A. J. Hipkins.

In my "History of Musical Pitch," I defined "the pitch of a musical note to be the number of double or complete vibrations, backwards and forwards, made in each second by a particle of air while the note is heard;" and I gave a full account of the methods by which this is ascertained, and showed how, by means of a sufficiently long series of tuning-forks, first, their own pitch, and then the pitch of all other notes of sufficient duration which fall within their compass can be ascertained to one vibration in ten seconds. I chiefly used the forks of the late celebrated Scheibler for that paper. For the present investigation I have employed a much longer series of forks, with their pitch ascertained from those of Scheibler within that limit. Further, in Art. 3, I defined musical pitch to be "the pitch of any named musical note which determines the pitch of all the other notes in a particular system of tuning." By that system we are therefore able to tune all the notes on an instrument. These notes, when sounded in succession from the lowest to the highest—that is, from that which has the smallest to that which has the largest pitch number —forms the scale of the instrument, from which are selected the notes used for any piece of music forming the scale of that composition. The word scale properly means ladder, because the notes thus sounded give us the sensation of ascending by definite distances. An interval between any two notes is the sensation of the distance passed over in proceeding from the first note to the second. It is measured properly by the ratio of the smaller pitch number to the larger, or by the fraction formed by dividing the larger by the smaller. When these ratios are known for each successive pair of notes, the scale itself is known, for means then exist for tuning the whole scale when one of its notes is given. Clearly, if we assume, for the purposes of calculation, that the lowest note makes one vibration in a second (which could not be heard as a note), the ratios mentioned would give the corresponding numbers of vibrations for each note, and these all multiplied by the real audible number of vibrations in the lowest note, would give the absolute pitches of the actual notes heard. These ratios, therefore, are the important matters to ascertain, and they are said to give the relative pitch of each note in the scale. The absolute numbers, which is what engaged my attention last time, are now of little consequence. We do not want to know how to tune in any particular pitch, but how to tune at any pitch whatever. Hence it is the law which determines the relative pitch that we wish to find, or, in other words, the system of ratios or of their equivalents. Now these ratios convey no conception whatever to the musician, who, without considerable instruction, can attach no musical meaning to such ratios as 2 : 3, 3 : 4, 4 : 5, 5 : 6, 6 : 7, 7 : 8, 8 : 9, 9 : 10, and so on. Hence some other way of expressing them is necessary, especially for describing scales. It will not be, perhaps, too great an assumption to pre-suppose that every one present is acquainted with the pianoforte, and knows that it is divided into sets of tones called octaves, and that there are twelve digitals, or finger keys, to each octave, seven long and white, five short and black. But perhaps every one may not know (as he ought to know) that the object of the tuner is to make the interval (or sensation of distance or ascent) between any two notes answering to any two adjacent finger keys throughout the instrument precisely the same. The nearer he succeeds the better the tuner. The result is called equal temperament or tuning, and is the system at present used throughout Europe. For the purposes of measurement, I must assume that the tuner has succeeded, although I am bound to say that no tuner ever has as yet succeeded perfectly, on account of the great difficulty to be overcome. Then we say that the interval of an octave is divided into twelve equal intervals called semitones. Now I must go a step further. Suppose a piano made of such a gigantic size that we could interpose 99 smaller finger keys between any two at present existing, and that we could tune these at exactly equal intervals, called cents, so that 100 cents would form an equal semitone. It is as well to know at once that this is impossible. No ear has yet succeeded in hearing the interval of one cent between two notes played in succession. Even the interval of two cents requires very favourable circumstances to perceive, although five may be easily heard by good ears, and 10 to 20 ought to be at once recognised by all singers and tuners. When the two notes are played at the same time, these 2 cents make a distinct difference in consonances, and 5 cents are felt to be out of tune. The tuner has constantly to deal with intervals of from 2 to 22 cents. and he corrects his ear by playing the notes together. If, then, I say that a certain interval has 316 cents, I mean that it contains 3 semitones (counted by the keys on a piano) and 16 cents or a very little more. But how are we to determine the number of cents? By finding the interval ratio already mentioned, which is best ascertained from the absolute pitch numbers of each note, and may be approximately ascertained by taking the ratio of the sounding lengths of two pieces of the same musical string, when they are in unison with the two notes as determined on an accurate monochord. Having found these two numbers, the discovery of the number of cents is a mere matter of arithmetic. When the numbers of cents have been ascertained by the process, a scale, which I particularly leave unnamed, is written thus:—

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vib. | 270 | | 308 | | 357 | | 411 | | 470 | | 540 |
| Cents | I. | 228 | II. | 256 | III. | 244 | IV. | 232 | V. | 240 | I'. |
| Sums | 0 | | 228 | | 484 | | 728 | | 960 | | 1,200 |

Here I., II., &c., are the notes of the particular scale, of which are here five, I'. being the octave of I. The numbers between these note-symbols show the number of cents in the interval from one to the other. The numbers under them show the number of cents in the interval from I. to the note in question. The number above is the absolute pitch number of the note as already defined, that is, the number of vibrations which it makes in a second, as found from observations. But this may be omitted when merely the relative pitch is wanted. Of course, practice preceded theory in music as in everything else. The sound of a fourth was perfectly well known to singers and lyrists, long before it was discovered that the whole length of a string and three-quarters of its length, when plucked, would give this very interval. But this once found, theory followed rapidly, and intervals were defined by lengths of string with great minuteness. It was the ratio of these lengths of string that was used to determine the intervals; and it is only of recent years that these lengths were found to be inversely proportional to the pitch numbers of the notes, and then these pitch numbers, which were applicable to all musical sounds, and not to those of strings only, became exclusively employed. The property just named, that the pitch numbers of notes are inversely proportional to the length of strings producing them is, unfortunately, quite true only for a heavy perfectly flexible and elastic mathematical line, limited by mathematical points, and any attempt to divide a real string of wire or catgut by bridges or frets fails for several reasons. In the case of frets, the pressure of the finger behind the fret increases the tension of the string and increases the pitch. This circumstance is of great importance in the Indian vina, which has very high frets, so that the pressure of the finger behind the fret can easily raise the pitch of the note by a semitone, that is 100 cents or more. Even in the modern guitar the intervals are sensibly sharpened. Hence the lengths of the strings for the principal intervals can only be termed a happy guess; and it remained for quite recent observers, such as Helmholtz, to establish, by ingenious instruments, that the actual ratios of vibrations for the consonant intervals was precisely those which are now well known, and could not be any other. Thus it was possible to have a theory of the scale. The theory implied exact measurements, all very well for instrument-makers, but not for musicians, who have only one standard to go by—their own ear, that is, their own appreciation of interval or relative pitch. Some musicians, like the Indian, repudiate all measurement and all arithmetic from the first, and leave everything to the judgment of the ear. In this country we are familiar with the pianoforte, harp, and violin, all of which are tuned exclusively by ear. For the harmonium, indeed, "beats" are available, but they are rarely used. On the contrary, organ-tuners are accustomed to a rough appreciation of the occurrence of beats, but few of them know the exact numbers, or understand how to employ them properly. Hence, as we may expect, tunings by ear, or the actual notes produced in the scale by a tuner, seldom or never give precisely those intervals which theory lays down. It seemed to me advisable, before trying uncivilised or semi-civilised nations, to see how well good English tuners could tune. Mr. Hipkins, who has the best possible means of knowing, says that it takes a quick man three years to learn to tune a piano properly. We may take it for granted, then, that most pianos are improperly tuned. Now, in order to find the scales which I have to communicate to-night, there were two courses only open—theory and practice. For Greece, Arabia and Persia, India and Japan, treatises exist, giving the scales more or less accurately; probably also for China, but they were not accessible to me. Where I could find these couched in intelligible language (very far from being generally the rule), I was glad to follow them, as they showed what those best able to judge considered to be aimed at in tuning. But the treatises that furnish accurate numbers are confined to Greece and Arabia, with Persia. Indian treatises rather ostentatiously eschew arithmetic, so that in reality their theory depends on oral tradition. In India, then, in China, in Java, and the various savage countries, there was nothing accessible but the instruments, and perhaps (as at the Aquarium in 1882, the International Exhibition of 1884, and the Japanese Village in 1885), native musical performers on a visit to England. Now, any musical instrument on which a native can play to the observer furnishes a set of notes actually produced, and these can have their pitch numbers determined with more or less certainty. In this way I was fortunate enough to get thirteen scales, five Indian, seven Chinese, and one Japanese, all recorded in numbers of vibrations, by the kind help of Mr. Hipkins. Instruments without a native performer seldom record themselves. Wind instruments, of course, require a native practised musician to blow, because the pitch can be greatly varied by the style of blowing. Stringed instruments without frets, or with movable frets, are also worthless without a native player. A stringed instrument with fixed frets (like the ordinary guitar), is, to a certain extent, available. If there are several strings, the law of tuning them is generally unknown. But if there are many frets on one string, enough to cover an octave (as on the guitar), then by measuring the vibrating lengths of the strings from the bridge to the edge of the fret next to the bridge, we can approximate to the relative pitch of the scale of notes which would be produced by sounding the string when properly stretched. The absolute pitch it is, of course, impossible to discover. That can only be obtained by help of a native performer, and would probably differ from one performer to another, for I have discovered nothing like a standard pitch anywhere. We have not yet arrived at fixing a standard pitch even for Europe. There are some instruments which play themselves. Anyone with proper tuning forks could count the pitch of the notes in a piano, dulcimer, harmonium, or organ, when they have once been tuned, provided they have not since had an opportunity to get out of tune, as such instruments so easily have—the harmonium least. The Chinese Shêng (and Japanese Shô) are reed instruments, not easy to sound certainly, but presumably rendering very nearly the sounds to which they have been tuned. The main instruments of uncivilised music, however, are flutes, bells, gongs, and harmonicons, consisting of bars of wood or metal. It is the last which have enabled us to obtain the pitch of the notes used even without the assistance of native players. Unfortunately, such harmonicons are apt to fall out of tune, and their intonation is injured by travelling, and (especially the wooden ones) by damp. Hence there is no practical way of arriving at the real pitch of a musical scale, when it cannot be heard as played by a native musician; and even in the latter case, we only obtain that particular musician's tuning of the scale, not the theory on which it was founded. To reverse the process, to go back from the best we can do with the instrument to an hypothesis concerning the relations intended, is very risky indeed. We certainly ought to do the best we can in this way, but we should never forget to give the observed data whence our hypothesis is derived. After all, we have only determined the notes used, not the scales employed for any piece of music. It would be impossible, from our knowing the twelve semitones to the octave used in Europe, to determine the double form of the major scale (without and with the grave second), and the triple form of the minor scale (without and with the major sixth and seventh), not to mention the so-called ecclesiastical modes. So in other countries. Here we are thrown entirely on theorists or information from natives, and where these fail us, we only know the notes employed, not the scales made by selecting some of them. In a few cases these are known, but in others we can only guess. There are, however, two distinct kinds of scales, considered as divisions of the octave used in playing airs. In the first, between a note and its octave, six notes are interposed, and the octave derives its name from the circumstance of being the eighth note, including both extremes. Occasionally two or more notes are left out, and occasionally one to three are inserted as alternative notes. But the main run of the scales consists of seven notes. The scales are called heptatonic, and are prevalent in Europe, Arabia, India, and other places. The next great division inserts only four notes between the first and what, from European habits, we still term the octave, which, however, is now the sixth note, both inclusive. These scales have in later times been often filled up by inserting two other notes; but these are clearly intrusive, and in the most typical case, Java, it has not been done. These scales are, therefore, termed pentatonic. They are found in the South Pacific, Java, China and Japan, and it is believed, from the nature of older Scotch, Irish, and Welsh melodies, were used by the Celts. Of the music of Egypt we know nothing; the instruments preserved, and their pictures, do not suffice to give a scale. We cannot tell what influence Egypt had on Greece. We do not know whence Greece derived her music, though Persia is a possible source. Different as all the Greek scales are in character, mainly shown by the final cadence, they all agreed in one point. They were purely melodic. They could not be sung in harmony, as in the modern chorale or part-song. To do this properly, it was necessary to alter all the intervals slighly. The principles on which this was possible was fully explained in my second edition of Helmholtz, App. XX. Sec. E, and cannot be intruded here. The final result, however, may be added. In this the C-mode was retained, and the others were fused into the A-mode, to which three forms were given. All these forms give beautiful consonances, which may be heard from almost any unaccompanied chorus, especially of tonic solfaists; but the consonances are greatly injured by the equal temperament which reduces the European scales to the following:—

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* "Garrison Gunner," whose letters I have admired for years, does not seem to be aware that night reflectors can be made so as to resist atmospheric tarnish.

1. Major mode. C 200 D 200 E 100 F 200 G 200 A 200 B 100 c.
2. Minor mode, three forms:—
   - C 200 D 100 E fl. 200 F 200 G 100 A fl. 200 B fl. 200 c.
   - C 200 D 100 E fl. 200 F 200 G 200 A fl. 300 B 100 c.
   - C 200 D 100 E fl. 200 F 200 G 200 A 200 B 100 c.

This intonation, as I explained in my paper on the "History of Musical Pitch," is only about 40 years old in England. The scales played before that time at the Philharmonic concerts, and on all organs, though probably never heard from unaccompanied part singers, were in "mean tone intonation," or—

1. Major mode. C 193 D 193 E 119 F 194 G 193 A 193 B 117 C
2. Minor mode in three forms:—
   - C 193 D 117 E fl. 193 F 194 G 117 A fl. 193 B fl. 193 C
   - C 193 D 117 E fl. 193 F 194 G 117 A fl. 269 B fl. 117 C
   - C 193 D 117 E fl. 193 F 194 G 193 A 193 B 117 C

The object of all these changes was to reduce the number of necessary notes in the octave to 12. The last, or mean tone system, perfected by Salinas in 1577, prevailed over Europe for nearly 300 years. As long as only three sharps, F sh., C sh., and G sh., and to flats, B fl. and E fl., were required, it admirably answered its purpose of furnishing organs with endurable harmonies. But modern music requires perfectly free modulation, and the equal temperament was the only one which would furnish this within the limits of twelve notes to the octave. Hence, notwithstanding the harshness of its chords, arising from the undue sharpness of its major third, sixth, and seventh, it has prevailed universally, and many modern musicians are not even aware of its nature and defects, or that there ever was any other possible intonation. Mr. Ellis then described at length the musical scales found in Persia, Arabia, Syria, and the Scottish Highlands; those found in different parts of India, in Siam, Singapore, Burmah, West Africa, South Pacific, Java, China, and Japan. In concluding, he summarised the facts as follows:—First, the relation of the octave, naturally given by the voices of boys and men, is naturally recognised, although not always correctly tuned on the instruments examined. At this we must not be surprised, for it is often incorrectly tuned even on modern pianos. The next interval most generally appreciated is the fourth. All Greek music, and hence all modern European, as well as all old and mediæval music, is founded on this interval. The fifth seems to have been rather appreciated as the defect of the fourth from the octave, though modern tuners find the fifth much easier to appreciate than the fourth. The tone was appreciated only as the difference between two fourths and the octave, or between a fourth and a fifth. But, in very early times, in the tetrachord of Olympos, the just major third of 386 cents made its appearance, and with it the just diatonic semitone of 112 cents, as the difference between it and a fourth. Unless, indeed, as in Japan, the semitone was tuned by a kind of guess, and the major third obtained as the defect from a fourth —and this seems to be a very likely hypothesis. At any rate these intervals (assumed by Helmholtz as 15 : 16, or 112 cents, and 4 : 5, or 386 cents) were soon ousted by the strict system of fourths, on which the later Greek scale was formed. In Arabia and Persia, however, other distinctions came in. The old division of the fourth into C D E fl. E F was disliked, the E fl. of 294 cents from C was felt to be too flat. The Persians raised it to 303 cents, as nearly as possible to our equally tempered minor third, but retained the old E 408 cents. The division was then practically our equal one of 0 100 200 300 400 500 cents. But there was a lutist called Zalzal, who evidently disliked these 300 and 400 cents, and introduced the halfway-house or neutral 355 cents, where the ear is unable to determine whether the interval is major or minor. This practically employed the trumpet scale 8 : 9 : 10 : 11 : 12, for 10 : 11 is 167 cents, and 11 : 12 is 151 cents. An entirely new interval was thus introduced, and seems to have struck deep root, the interval of three-quarters of a tone. The mediæval Arabic system drove it out of classical musical scales, by continuing the number of fourths to 16, using, therefore, 17 notes, which gave very artificial scales, generally bordering on the old Greek, but often greatly diverging from them, occasionally employing even eight notes in a scale. The later Arabic forms, by dividing the octave into 24 equal quartertones, sufficiently reconciled Zalzal and the mediæval musicians. But the normal scale was Zalzal's of 0 200 350 500 700 850 1000 1200 cents, and this scale we imported into England, and still possess in the Highland bagpipe, which has not yet been harmonised. The attempt, however, to conform to the other Arabic scales led to sharpening or flattening any of these notes by a quarter of a tone, which was one of their degrees, thus producing a large number of varieties. Now, did India draw upon Arabia, or conversely? In India we have a remarkably complex system. First a scale very like our major, but with a sharpened sixth of 906 in place of 884 cents. There was consequently a separation of the scalar intervals into three kinds, major, minor, and half tones, and these were supposed to be divided into four, three and two equal parts respectively, which I have called degrees. Practically these, being produced by shifting frets, pressing on strings behind the fret, or deflecting them along the edge of the fret, were never precise, but were always about or slightly exceeding a quarter of a tone. Then came the habit of altering the intervals by a degree, which is extremely like the Arabic quartertone system; although it must have been generated independently, yet it certainly frequently produced in the different modes and modelets, those three-quarter tones which in Arabic music we owe to Zalzal. China and Japan introduced nothing new beyond the original limitation of the scale to five notes, which arose, in fact, from the divisions of tetrachords into two parts only, for example, a semitone and major third, like those of Olympos, whose very division we find in the popular music of Japan, or else into a tone and a minor third, the thirds arising in each case as defects of the first intervals from a fourth. Such tetrachords were then either conjunct or disjunct. But they were always capable of being completed into Greek scales, as has been actually done in Japan, and possibly in China. On the instruments as tuned or played by natives, China offers many examples of the three-quarter tone interval. But neither China nor Japan, any more than Europe, have reached the complete Quartertone system, which we find in Arabia, and practically in India. On the other hand, Japan at least, and China also, according to Amiot, have attained to a system of twelve, more or less exact, equal semitones. The double pentatonic system, as developed in Java, is, however, something new and entirely different from the Chinese and Japanese. The first system seems to be formed by taking the fourth flat enough to give, practically, a division of the octaves into five equal pentatones. Remarkably enough, the fourth note of the scale thus becomes very nearly indeed the natural harmonic seventh of the first note. But upon this system, if I am correct, both fourth and fifth are defective, the fourth being flat, and the fifth sharp. Whatever be the theory of the scale, this fact is certain, and it entirely destroys the assumption of the necessity of founding a scale upon the fourth or fifth. This is further confirmed by the second class of pentatonic scales in Java, for which I have not been able to find any satisfactory principle, although they adopt intervals of very nearly 100, 150, and 300 cents, that is nearly semitones, three-quarter tones, and minor thirds. This system has a fund of seven notes to the octave, and out of this fund it selects different sets of five to form a scale. Whereas, then, in the first system no interval between consecutive notes in so small as a tone, or so large as a minor third; in the second system, differences of 100, 150 (rarely or never 200), 300, 400, 450, and even 550 cents occur. The first set of scales are therefore remarkably uniform, the second as remarkably diverse. Another singular difference is that in the first system the fourth is flat, and the fifth sharp; but in the second the fourth is very sharp, almost a tritone, and the fifth is nearly a comma flat. In the first system, and on at least two scales of the second (Dangsoe and Bem), the harmonic seventh is developed. The final conclusion is that the musical scale is not one, not "natural," nor even founded necessarily on the laws of the constitution of musical sound, so beautifully worked out by Helmholtz, but very diverse, very artificial, and very capricious. At the same time the contributions I have been able to offer towards the study of this vast subject, are, notwithstanding the inordinate length of my paper, relatively very small and manifestly extremely imperfect in observations. They really require completion by the long and careful observation and study of many physicists who have some notion of music, rather than of musicians whose ears are trained to particular systems with but slight knowledge of physics.

## MALT AS FOOD.[*]

By J. Milner Fothergill, M.D.

MALT as food has a great future before it. In the process of malting (which is a rapid germination) a distinct change is brought about in the seed. By the action of the diastase the insoluble starch is converted into soluble dextrine, which goes sweet in the mouth, so near maltose is it. The malt-combings, which are too rich in albuminoids for the brewer's purposes, are useful when malt is looked at as a food. Malt contains dextrine (some diastase), soluble albuminoids and phosphates, and when ground is an admirable food, while it is not expensive. Its taste is pleasant. It can be made into a pudding with an egg and some milk, and as such is palatable. It can be made a constituent of a milk pudding with advantage. When the brewer mashes his malt with hot water the diastase remaining in the malt converts the dextrine into maltose, which the yeast (next added) breaks up into alcohol and carbonic acid gas. The best white malt is not heated to more than 190°, as the diastase is acted upon injuriously by a heat above that point. Maltose is a sugar which does not readily undergo the acetous fermentation, and, therefore, as Dr. Mitchell Bruce points out in his "Materia Medica and Therapeutics," "will not give rise to acidity and dyspepsia." This is a great matter, as the cane sugar the cook adds to stewed fruit and milk puddings readily undergoes the acetous fermentation in many stomachs. The lævulose sugar of fruit, like maltose, readily undergoes the alcoholic but not the acetous fermentation. Maltose being less powerfully sweet than cane sugar, a greater quantity is necessary to sweeten the pudding. If the raw starch, semolina, sago, or tapioca be first put in the dish by itself, and placed in the oven for an hour (taking care not to have it burnt by the oven being too hot), not only are the starch cells cracked, but a certain conversion of the starch into dextrine takes place. If to this be then added an equal quantity of ground malt and some hot milk poured on, and the dish be allowed to stand a few minutes before being put into the oven again, the diastase of the malt acts upon the farina and converts it into dextrine and maltose. Dextrine and maltose being soluble, the pudding is very thin. Such a pudding is admirably adapted for invalids and dyspeptics, as requiring scarcely any digestion in the body. For those with whom ordinary milk puddings produce acidity, such a pudding is specially suitable. Ground malt may be added to fresh milk, and forms an admirable food in cases of acute disease. Baked flour perhaps goes better with meat broths, to which it gives a high food value. (Well-baked flour requires but a touch of saliva to render it soluble, and, added to meat broths and gravy soups, renders them very nutritive.) Malt, being sweet, goes better with milk, or apple-water, or tamarind-water, or lemonade, and gives us a food which being all but independent of the digestive act, can be most usefully employed in the sick-room. Beef-tea (which alone is scarcely a food) and milk-and-seltzerwater pall upon the palate of the sick person, who craves variety just as do healthy persons. The adoption of ground malt as a food will solve for us one or two knotty questions connected with feeding people when the digestive power is feeble. Drinks like lemonade, made with malt instead of cane-sugar, would not only not go sour in the mouth and stomach, but would contain some phosphates and soluble albuminoids, and so form admirable beverages in pyrexial states. The many malt extracts now in the market are well adapted for such end.

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[*] From the *Lancet*

## SOLUBLE GLASS OR SILICATE OF SODA.

In his "Manual of Alkalies," Dr. S. Pick says: —It has been long known that glass is a compound of silicic acid with alkali; the other combinations of silicic acid, however, with lime, e.g., were ignored as unimportant, until Prof. Fuchs, of Munich, showed (1818) that by the fusion of silicic acid a glass-like mass was obtainable, but which is soluble in water, and which he therefore named "water-glass." He indicated for its production the formula:—45 parts quartz powder, 23 anhydrous soda, 3 charcoal, fused together. Later experiments were made to replace the soda by cheaper sodic combinations. Kitchen salt, for instance, can be decomposed by silicic acid at a high temperature and in the presence of steam, when water-glass and hydrochloric acid are formed. Water-glass can also be produced in the wet way, by treating natural amorphous silicic acid, which is more susceptible to the action of alkalies, with some caustic alkali. Such an amorphous silicic acid is flintstone for instance. When pulverized and treated with a concentrated soda lye under ¼ atm. pressure, it is dissolved in the lye. Liebig proposed to employ fossil earth, which is found in large deposits and is nearly pure silicic acid, for the production of water-glass. According to his method, the earth is first calcined, in order to destroy the rest of organic matter; the earth is then completely soluble in soda lye; only a small quantity of sand remains undissolved and forms a small sediment with alumina, oxide of iron and lime. 74·5 parts crude, calcined soda are dissolved in five times its weight of water, and boiled with 56 parts, by weight, slaked lime or 42·5 parts quicklime. After the lye is brought by evaporation to 1·5 sp. wgt. 120 parts fossil earth are added; when 240-245 part swater-glass jelly are obtained, containing 46 to 47 per cent. dry silicate of soda, which consists in 73 per cent. silicate acid and 23 per cent. soda. At the time, when Liebig proposed this method caustic soda was not yet an article of general commerce, as it is at present. Nowadays it is more convenient, instead of preparing the lye of soda, to employ a corresponding quantity of caustic soda, and bring its solution to the above concentration. More recently silicate of soda is manufactured from the fossil earth, which is found in Hanover, as follows: Caustic soda lye of 1·22-1·24 sp. is mixed in a digesting apparatus with stirerr with so much calcined fossil earth, that the mixture contains 1 part sodic hydrate for 2·8 parts earth. Under 3 atm. steam pressure, the solution is complete in a few hours; when the lye becomes soon clear, a dark brick-red sediment being thrown down. Care must be taken, however, that no excess of silicic acid be employed, in which case a clear liquid is hardly obtainable. It is, therefore, only possible to produce a solution of water-glass of 1·18 sp.gr. If caustic soda lye of 1·30 sp. gr. is used, a water-glass solution of 1·22 sp. gr. is obtained, which requires nearly a week to settle. Finely powdered silicate of soda boiled with water is the solution which is known in commerce as "prepared water-glass," of 38 or 66°, that is, containing 33 or 66 per cent. solid silicate of soda. This solution is readily decomposed by acids, even carbonic acid, and gelatinous silicic acid is separated from it. It must be kept, therefore, in well-closed vessels.

Numerous ways have been suggested to utilise silicate of soda for a variety of purposes, but proportionately few have been found practical. On the ground of the fact that silicate of soda converts chalk and other porous substances into a hard mass, and that it forms a stone-like mass with caustic and slaked lime, it was supposed to allow of the employment of building material of inferior quality. An architect, however, will hesitate with right, to use material which must first be given the resistance which it does not possess by the aid of an artificial means. It has been adopted, however, to some extent, as a coating to give the plastering of houses more resistance against atmospheric influences. Experts, however, object to this usage, and have called attention to the circumstance that the ground, which was prepared with silicate of soda, for the first of the celebrated frescoes by Kaulbach in the vestibule of the museum of Berlin, is traversed by innumerable cracks, and that in some portions of the painting a white film is forming upon the paint. This is caused by the transformation of the silicate of soda into alkaline carbonate; which untoward circumstances renders also the impregnation with silicate of soda of building lumber impracticable, because the wood becomes by it more likely to rot. The same is the case with silicate of soda paints for iron, as they rather promote than hinder the oxydation of the iron. Only as a paint for theatrical scenery, rendering it less accessible to ignition, silicate of soda has been adapted without restriction.

As regards the use of silicate of soda in the manufacture of palm oil and cocoanut oil soaps, the opinions also differ. In this manufacture, 24-40-60 per cent. of a 35° B. solution of silicate of soda are added to the hot liquid soap on being dipped from the boiler, and vigorously stirred in until nearly congealed. It is claimed that the alkaline cebaceate, which in hard water causes the formation of an insoluble lime-soap, which settles upon the tissues as a greasy, yellow mass, hard to remove by injurious mechanical operations, is partly decomposed by the silicate which causes elimination of silicate of lime and free silicic acid, both which bodies are easy to remove by rinsing. Besides, the alkali contained in the silicate of soda acts by loosening grease and dirt. For this reason it is particularly recommended for wool-washing, giving a much cleaner product, as is asserted, than soap and soda. As another advantage it is claimed that silicate of soda does not cause felting of the wood, and can be applied, therefore, at a higher temperature. Silicate of soda alone cannot be used in clothes washing, as the silicic acid, which is separated in washing affects the yarn fibres. This evil is to be remedied by the commercial so called "composition of silicate of soda," or white soft soap. This preparation, however, is nothing but a solution of 1 part cocoanut oil soap in 30 parts heated solution of silicate of soda 39° B.; after stirring and cooling down it forms a soft soap of the consistency of a collection of little lumps.

## OPTICAL ANOMALIES IN CRYSTALS OF THE REGULAR SYSTEM.

The two well-known theories generally advanced to account for the action on polarised light, exceptionally exhibited by certain regular minerals, have recently undergone an important modification due to the discovery by Mallard, that sections of boracite, when heated above 265° C. (509° Fahr.), become perfectly isotropic. As is now generally known, Mallard, Tschermak, and their followers accounted for these optical anomalies by what is termed "pseudosymmetry"—*i.e.*, the imitation, by certain crystals, of a geometrical form of a higher grade of symmetry than they themselves actually possess, by complicated and repeated twinning. Klein, Krocke, and certain other German mineralogists, on the contrary, maintained that the optical peculiarities were produced, not by twinning, but by a molecular disturbance due to an internal tension caused by the irregular growth of the crystals. Klein had even succeeded in proving that the apparent twinning lines—the boundary between the areas of different optical orientation—could be made to move by raising the temperature, and the interpretation put by the same writer on the interesting observation of Mallard is very important, as offering a possible means of reconciling the different views which have hitherto existed regarding these anomalous optical phenomena. Klein suggests that the fact that boracite becomes isotropic above 255° C. proves that this substance is dimorphous, crystallising in the regular system above, and in some other, probably the orthorhombic, below this temperature. The crystals must therefore have been formed at a temperature above 265° C., and hence possess geometrically the regular shape; their internal condition is due to the effort on the part of the molecules to rearrange themselves in accordance with the altered conditions, which is strong enough to produce a profound optical disturbance, but is not able to pull to pieces the crystalline form. Boracite crystals at ordinary temperateratures are, in fact, a kind of paramorph, composed of optically orthorhombic portions enclosed in the regular framework in which the substance originally, at a higher temperature, crystallised.

Still more recently Klein has shown that leucite becomes isotropic at high temperatures, and Merian obtained a similar result for tridymite; thus it seems very probable that many other substances, like garnet, analcite, perofskite, senarmontite, &c., which show optical properties in no accord with their external form may be satifactorily explained by the assumption that they are dimorphous.

Another class of substances like potassium sulphate, leadhillite, aragonite, &c., whose optical properties at ordinary temperatures are in perfect accord with their crystalline form, have been shown capable of transference by increase of temperature to a state where their optical properties have a higher grade of symmetry, and consequently are no longer what the form would require, *e.g.*, both orthorhombic aragonite and monoclinic leadhillite become uniaxial when sufficiently heated.—*American Naturalist.*

## NEWTON'S FERROCYANIDE DEVELOPER.[*]

In November of last year, Mr. H. J. Newton, of New York, published the formula of a new developer, which differed notably in its composition from any other in general use by the photographic world. It was claimed for it, that it presented advantages in requiring only a minimum exposure of the plate, and gave full detail with plenty of density—in short, was a powerful yet controllable developer, and was a step in advance of most of the developers now in use. The formula is as follows:—

| | | |
|---|---|---|
| No. 1.— | Water | 9½ ounces |
| | Carbonate of soda | 480 grains |
| | Yellow prussiate of potash | 480 ,, |
| | Sulphite of soda | 160 ,, |
| No. 2.— | Water | 9 ounces |
| | Chloride of ammonium | 510 grains |
| | Solution of one drop of $H_2SO_4$ in one ounce of water | 1 drop |
| | Pyro (1 commercial ounce) | 437 grains |

For a plate 8 by 5, that has received a drop-shutter exposure take—

| | | |
|---|---|---|
| | Water | 5⅓ drachms |
| | No. 1 | 2⅔ ,, |
| Also | Water | 7 ,, |
| | No. 2 | 1 ,, |

Thinking it looked good, I determined to give it a fair trial, and, judging from an experience of it in photomicrography for three or four months, I am well satisfied with it. I have not tested it against Beach's potash developer, nor have I yet been able to try it in landscape work, but for photo-micrography it is admirable. The exposure appears shortened by fully one-third, and negatives abounding in detail, strength, and density are easily obtained. The colour of the negatives is not the nice black-and-white given by potash, but is of a strong olive brown, and very non-actinic. Owing to this fact, care must be taken not to push the development too far, or unduly dense negatives will result.

I do not wish to praise this developer as the "best," seeing how many good developers are already before the public, all of which give good results when used with intelligence; but I think the ferrocyanide developer has advantages in cleanliness and freedom from green fog, as compared with ordinary pyro and ammonia, and is more powerful, requiring much less exposure of the plate. During the cold weather of this winter I have found it work exceedingly well, and uniformly bring out brilliant and plucky images.

One word of warning: there are some makes of plates that will not stand this developer without fogging, unless bromide be used. The same may be said of plates that have received an excessive exposure. When I first tried the developer I got fogged images on several negatives in succession, and felt inclined to blame the plates, but for the fact that on one or two from the same box I got negatives of exceptional brilliancy. These, I afterwards discovered, had received the correct exposure, while the others were over-exposed and could not have been saved without the use of bromide. After this I found it best with every plate to start with two drops of a ten-grain per ounce solution of bromide of potassium, increasing the dose to six or eight drops if necessary. Using the bromide I found I could count on every plate turning out a success with a much shorter exposure than I had been accustomed to give—fully one-third less, and in some cases perhaps one-half—which is a decided advantage when working with artificial light.

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[*] By I. H. Jennings, in the *Photographic News*.

# SCIENTIFIC NEWS.

ACCORDING to Dr. Gould, a star a little below the eighth magnitude, in the constellation Sculptor, has a large proper motion, his Cordoba observations for 12 years making its annual motion as much as 6·2″ in a great circle. It is numbered 1584 in Hour XXIII. of the Cordoba Zone Catalogue, and its place is R.A. 23h. 58m., N.P.D. 127° 59′. The largest proper motion in a star north of the Equator is that of Groombridge 1830—viz., 6.976″, as determined by Argelander in 1843.

The Rev. T. W. Webb, M.A., has published by Messrs. Longmans a little manual entitled, "The Sun: a Familiar Description of his Phenomena," which he thinks may be found serviceable in elementary instruction. It is an excellent little book, which may be commended to teachers and those who wish to learn. We hope it is to be followed by a series of manuals on the other members of the Solar System.

Amongst the after-Easter lectures at the Royal Institution there will be a series of eight "On Digestion and Nutrition," by Prof. Arthur Gamgee, on Tuesdays, April 14th to June 2nd; five lectures by Prof. Tyndall, "On Natural Forces and Energies," on Thursdays, April 16th to May 14th; three lectures by Prof. C. Meymott Tidy, "On Poisons in Relation to their Chemical Constitution and to Vital Functions," on Thursdays, May 21st, 28th, June 4th; four lectures by Mr. William Carruthers, "On Fir Trees and their Allies," on Saturdays, April 18th to May 9th; two lectures by Prof. Odling, "On Organic Septics and Antiseptics," on Saturdays, May 16th and 23rd. The following are amongst the probable arrangements for the Friday evening meetings: April 17th, Prof. S. P. Langley, "Sunlight and the Earth's Atmosphere;" April 24th, Mr. W. Carruthers, "British Fossil Cycads and their Relation to Living Forms"; May 1st, Lord Rayleigh, "Water Jets and Water Drops"; May 8th, Mr. W. F. R. Weldon, "On Adaptation to Surroundings as a Factor in Animal Development"; May 15th, Prof. Burdon Sanderson, "Cholera: its Causes and Prevention"; May 29th, Mr. J. J. Coleman and Prof. J. G. McKendrick, "The Mechanical Production of Cold, and the Effects of Cold on Microphytes."

Local scientific societies can now join the British Association as corresponding societies. The rules agreed upon by the special committee have been printed, and applications to be placed on the list should be sent to the secretary of the British Association for the Advancement of Science, Albemarle-street, W., before the 1st of June next.

The meeting of the Marine Biological Association at the rooms of the Society of Arts, which we mentioned on p. 101, has been postponed from April 13th to May 13th.

The Scottish Marine Station at Granton is progressing apace. In addition to the floating laboratory, the Ark, which is moored in the old quarry, premises have now been acquired on shore, and a building of two stories has already been converted into a laboratory and museum. It should be understood that the establishment is not a teaching station; it is intended solely for research, and to the extent of its accommodation is open to biologists engaged in such work. As lodgings are not readily obtainable in the vicinity of the station, it is intended to fit up one of the larger buildings recently acquired as a library, with several bedrooms and a dining room. The property was formerly a tanyard, and the pits are to be converted into aquaria. This summer a branch is to be opened for two months at Millport, and a trip will be made to the west coast for dredging purposes. Mr. Mill, the chemist and physicist at the station, is at present engaged in testing several new scientific instruments, amongst them a new anemometer devised by Prof. Crum-Brown and Prof. Chrystal, which is intended to be used for recording the force of gusts of wind on Ben Nevis.

A rather curious suggestion for rendering sea-water potable was made in a paper read before the Manchester Literary and Philosophical Society, by Mr. T. Kay, of Stockport. He proposes to change the chlorides by means of citrate of silver, leaving the sodium, potassium, magnesium, &c., in solution as citrates. Sea-water thus treated would be slightly aperient and diuretic if taken in large quantities, but would be suitable for moistening the parched throats of shipwrecked mariners.

An analysis of Dead Sea water has been made for the Rev. W. Allan, under the direction of Dr. Bernays. The specimen which was taken from the northern end of the sea, but not near the Jordan, was found to have a sp. gr. of 1·1528 at 15·5° C., and the total residue was equal to 15,260 grains per gallon. In round numbers the salts present were calcium carbonate, 70gr.; calcium sulphate, 163; calcium chloride, 594; magnesium nitrate, 175; magnesium chloride, 7,388; magnesium bromide, 346; potassium chloride 1,089, sodium chloride 5,106, and oxides of iron and aluminium 10, with organic matter, &c., 317 grains. The water was taken in the month of March; but in the autumn and further south, the solid matter is found in still larger quantity.

Mr. Reckenzaun's electric tramcar was tried last week on one of the South London lines. With some trifling alterations in details, the car will be perfectly successful from the mechanical point of view. The question to be determined is the cost of working in actual practice.

"The Moon and the Weather" is the title of a work by Mr. W. L. Browne, of St. Petersburg, which Messrs. Baillière and Co. will publish shortly.

A new volcano has been discovered in Russia. Twelve versts from the town of Ielna, in the Government of Smolensk, a hill is at present showing signs of volcanic activity. Ten years ago it was noticed that snow never rested on it, but melted away; and three years ago smoke began to issue from it, accompanied by subterranean rumblings. Lately, flames have shot up, and fragments of melted iron, cinders, and sand have been thrown up. A pole plunged in the ground was burnt up in a few minutes. All around the base rich grass grows, which is eaten with relish by the cattle. Indications of volcanic energy have appeared at two other places in the neighbourhood.

A discovery of platinum is announced from New South Wales, where it has been found in connection with gold in the Ophir district. Small grains have been found in considerable numbers in Hunter and Macleay districts, and at Wiseman's Creek, a nugget weighing more than half an ounce was discovered in connection with alluvial gold.

M. Berthelot publishes in the *Annales de Chimie et de Physique* for March a paper "Sur les Notations Alchimiques," which is accompanied by six plates describing the planetary signs, &c., by which the alchemists represented the metals.

**Gresham Lectures.**—The Mercers' Company have given notice that the lectures founded by Sir Thomas Gresham will be read to the public on the following days, at six o'clock in the evening, in the theatre of Gresham College, Basinghall-street:—Physic (Dr. Symes Thompson), April 14, 15, 16, and 17, geometry (the Dean of Exeter), April 21, 22, 23, and 24; astronomy (the Rev. E. Ledger), April 28, 29, 30, and May 1; divinity (the Dean of Chichester), May 5, 6, 7, and 8; rhetoric (Mr. J. E. Nixon), May 11, 12, 13, and 15; music (Dr. H. Wylde), May 19, 20, 21, and 22; and law (Dr. Abdy), May 26, 27, 28, and 29.

**Dr. Chandelon's Process for Detecting Strychnine.**—By this method the objects to be tested are chopped up very fine, and are mixed with an equal weight of gypsum entirely freed from water. After drying, the whole is pulverised, and thoroughly boiled with 90 per cent. alcohol, to which a little tartaric acid has been added. The alcohol is removed by distillation after filtration, the residue being taken up with boiling water, filtered so as to remove all fat, compressed to 1¼ to 1½ cubic inch, and mixed with gypsum. After stiffening and pulverising, the mass is treated with chloroform in Soxhlet's apparatus. The chloroform extract is brought to ¾ or 1 cubic inch, and there is added an equal volume of a saturated solution of oxalic acid in ether. The oxalate of strychnine becomes crystallised in needle-shaped forms, from which the strychnine can be isolated by ammonia. This method is said to have been successful in detecting minute quantities of strychnine, and to be likewise applicable to tests for brucine, narceine, papaverine, thebaine, aconitine, atropine, hyoscyamine, veratrine, nicotine, and coniine.—*Lancet.*

# LETTERS TO THE EDITOR.

*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

*All Cheques and Post-office Orders to be made payable to* J. PASSMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

## FULL MOON IN FEBRUARY, 1904: A CORRECTION — COLOURS OF SHADOWS—SCINTILLATION AND WEATHER PREDICTION—COLLIMATION—THE MAPS OF THE ORDNANCE SURVEY—STELLAR PARALLAX, BINARY STARS, &c.: A REQUEST FOR A TREATISE ON ASTRONOMY—LUNAR PERTURBATIONS — HUYGHENIAN EYEPIECE — EARTH'S LONGITUDE AT PERIHELION.

[24061.]—SEEING my letter 23998 in print in your columns on p. 77, I am lost in amazement at my own carelessness in replying to "Leo's" query (56131, p. 43). After writing my initial "March 1st" I seem to have calmly taken it for *January* 1st of the current year, and calculated from that! The calculation should, of course, stand thus—Between March 1st, 1885, and March 1st, 1904, there are 15 common years and 4 Leap-years—i.e., 15 × 365 days + 4 × 366 days = 6,939 days. Dividing this by the time of one Lunation, 29·5305887 days, we get 234·976 in the number of Lunations which will occur between March 1st, 1885, and March 1st, 1904, a number so very close to 235 that we see immediately that the Moon will be Full at the last-named date, a very little later than she was on the 1st ult.; and that hence, as during the present year, there will be no Full Moon on February, 1904. I hope sincerely that I have not misled "Leo," though it seems hard to conceive how anyone could read the + 61 days, without at once detecting the nature of the oversight and the consequent untrustworthiness of the result.

Without attempting to account for the turquoise blue shadows to which the first half of Mr. Gayler's query (56221) on p. 89 has reference, I think that the blue ones he noticed on his gas-lit paper admit of a simple explanation. Imprimis his newspaper was feebly illuminated by the steel-grey twilight, and superposed on this was the flood of yellow gaslight. Had the latter only existed as the source of illumination, all shadows would have been black; but when the overpowering light of the gas was screened from the paper, it was still sufficiently lighted to show the bluish tinge your correspondent describes. If we were to illuminate a whole wall by light passing through crimson glass we should, of course, see the wall red. If, now, though, we were to flood it with the electric light, the latter would so overpower the relatively feeble red light, that the wall would exhibit the whiteness almost of snow. It is quite obvious, however, that the shadow of anything intercepting the electric light would look *red*, and not black at all, until the first light was extinguished.

On more than one occasion I have invited attention here to the discovery made by M. Ch. Montigny, of Brussels, by the aid of his beautiful Scintillometer, that blue largely predominates in the twinkling of the stars when there is much water in the atmosphere; and that the preponderance of green, and more rarely of violet, is indicative of great dryness. In the Bulletin de l'Académie Royale de Belgique 3me serie. t. IX., No. 2, 1885, appears a paper by M. Montigny, which has been reproduced in a pamphlet form, which is well worth the perusal of all who are interested in placing meteorological prevision upon a scientific basis. The tables given in this latest work of the Belgian savant seem to render it certain that he has hit upon a law which reduces the prediction of a wet or a dry season to a very minimum of uncertainty. Perhaps the best test of the soundness of his views is to be found that his forecasts of the increasing drought in Belgium of the years 1883 and 1884 were fulfilled *au pied de la lettre.*

The Collimation error of "Rosicrucian's" Transit Instrument (query 56269, p. 112) is 1·61sec. on the Equator.

In thanking "A. S. L." for the information he has so courteously given in letter 24058 (p. 107), I may pretty confidently say that it will be of value to many a reader of the English Mechanic besides myself. But the very form in which it is given suffices to show with how much ease a sixpenny pamphlet might be prepared explaining the delineation of part of a spherical surface on a plane by de Thury's projection; the distinction between the true meridian of any given station, and a parallel to the prime meridian drawn through it, &c. By the aid of photo-zincography this might well be sufficiently illustrated, and yet be sold at the price I name. Depend upon it, very few possessors of the maps would fail to provide themselves with such a useful and, in fact, almost indispensable adjunct to their intelligent employment. I learn for the first time of the extraordinary policy of the Ordnance Department in increasing the cost of the maps to check the demand for them! I can remember nothing so much resembling this as the behaviour of the negro manager who, when pelted with bricks by an unappreciative audience, exclaimed: "If yer don't leab off trowin' dem bricks, I'll raise de prices, and den none on yer can't come in!"

I will try to deal in the best way I can with the extremely modest request of Mr. Arkwright, preferred in query 56309 (p. 113). How many hours (or even days) he supposes I am going to spend in getting the materials to reply to him in full; or how much of your space, Sir, you would of your kindness allow me to occupy, he scarcely seems to have taken into account at all. Here, to begin with, is a little table from Loomis, giving the parallax of some of the stars whose distance has been best determined.

| Star. | Mag. | Parallax. | Distance in radii of Earth's orbit. | Light interval in years. |
|---|---|---|---|---|
| α Centauri........ | 1 | 0″·92 | 224,201 | 3·54 |
| 61 Cygni ........ | 6 | 0·45 | 458,366 | 7·24 |
| 21258 Lalande .... | 8 | 0·26 | 793,326 | 12·53 |
| 17415 Oeltzen .... | 9 | 0·25 | 859,437 | 13 57 |
| Sirius ............ | 1 | 0·23 | 896,803 | 14·16 |
| 1830 Groombridge | 7 | 0·16 | 1,289,055 | 20·36 |
| α Lyræ ........... | 1 | 0·16 | 1,289,055 | 20·36 |
| 70 Ophiuchi ...... | 5 | 0·16 | 1,289,055 | 20 36 |
| ι Ursæ Majoris.... | 3 | 0·13 | 1,586,653 | 25·06 |
| Arcturus ......... | 1 | 0·13 | 1,586,653 | 25·06 |
| Procyon .......... | 1 | 0·12 | 1,718,173 | 27·15 |

On this subject the tables at the end of Newcomb's "Astronomy," and Ball's "Astronomy," should be consulted.

Here are the elements of some double stars:—

| Star. | T. | ☊ | π | i | e | a | P Years. |
|---|---|---|---|---|---|---|---|
| η Cassiopeiæ ............ | 1901·25 | 33°·20′ | 229°·7′ | 48°·18′ | 0·6244 | 8″·639 | 195·235 |
| Σ 73 ................... | 1798·80 | 57·54 | 142·9 | 41·39 | 0·6537 | 1·54 | 349·1 |
| 6 Eridani .............. | 1817·51 | 81·42 | 327·15 | 44 40 | 0·378 |  | 117·51 |
| Sirius ................. | 1843·275 | 61·58 | 18·55 | 47·9 | 0·6148 | 2·331 | 49·399 |
| Castor ................. | 1749·75 | 27·46 | 297·13 | 44·33 | 0·3292 | 7·43 | 1001·21 |
| ζ Cancri................ | 1872·44 | 150·17 | 171·47 | 36·14 | 0·3023 | 0·908 | 58·23 |
| γ Virginis ............. | 1836·68 | 35·36 | 283·42 | 35·6 | 0·896 | 3·97 | 185·0 |
| α Centauri.............. | 1875·12 | 25·14 | 45·58 |  | 0·5332 | 18·45 | 88·536 |
| ξ Boötis ............... | 1770·69 | 26·22 | 117·46 |  | 0·7081 | 4·86 | 127·35 |
| η Coronæ Borealis ...... | 1849·9 | 22·2 | 224·6 | 60·4 | 0·287 | 0·985 | 40·17 |
| μ Boötis................ | 1866·0 | 166·8 | 23·1 | 47·31 | 0·491 | 1·165 | 182·6 |
| ξ Scorpii .............. | 1859·62 | 12·15 | 68·42 | 89·16 | 0·0768 | 1·26 | 95·90 |
| σ Coronæ Borealis ...... | 1828·91 | 6·43 | 89·17 | 29·40 | 0·7502 | 6·001 | 843·2 |
| λ Ophiuchi ............. | 1803·91 | 157·21 | 94·16 | 44·44 | 0·4930 |  | 233·89 |
| ζ Herculis ............. | 1830·01 | 45·56 |  | 34·52 | 0·4239 | 1·223 | 34 221 |
| Σ 2173 ................. | 1872·91 | 152·65 | 7·26 | 80·53 | 0·1349 | 1·009 | 45·43 |
| τ Ophiuchi.............. | 1818·50 | 67·1 | 36·26 | 46·8 | 0·6055 | 1·193 | 217·87 |
| 70 Ophiuchi ............ | 1808 79 | 125·24 | 155·42 | 57·54 | 0·4915 | 4·704 | 94·37 |
| δ Cygni ................ | 1904·10 | 91.8 | 203·2 | 37·46 | 0·2858 | 2·3097 | 415·115 |
| Σ 3062 ................. | 1835·20 | 32·12 | 97·30 | 29·54 | 0·5009 | 1·310 | 112·644 |

It would be the merest idle waste of time to compute the place of Spica Virginis "in Anno Domini 0" (whenever that may have been!), inasmuch as the idea that that was the Star of the Magi is utter stuff and nonsense. I must respectfully decline to spend a week in hunting up the Proper Motion of Stars; besides, I am writing away as hard as ever I can to catch the post. None of the Companions to Procyon, so far discovered, account for the irregularity of its proper motion.

In reply to "Resultant Force" (query 56270, p. 112), there is certainly more than one misprint or error in the sentence he quotes, inasmuch as, imprimis, it obviously refers to the Moon's orbit, and certainly not to the Earth's; and, in the next place, 238,800 is the radius, and not the *diameter* of that orbit at all. It is quite evidently so employed in Fig. 12. As the perturbing action of the Sun on the Moon is a differential one—*i.e.*, his pull upon her is greater or less than it is upon the Earth according to the position she occupies in her orbit, the reason for using the numbers given (of course, with their proper designations) seems perfectly apparent.

"E. B. F." (query 56275, p. 112), must get two plano-convex lenses, one of 0·45in. for his field-glass, and the other 0·15in. focus for his eye-glass, and mount them in a tube 0·30in. apart, with their convex sides towards the object-glass. A diaphragm must be placed in the focus of the eye-lens. It ought to be a pretty good 3in. objective to bear a power of 200, though.

"J. A." (query 56281, p. 113) will find that when the Earth was in perihelion at 4 a.m. on Jan. 1 of the present year, the apparent longitude of the Sun was 280° 18′ 26·0″. Hence the Earth's longitude must have been 100° 18′ 26·0″ at that instant.

**A Fellow of the Royal Astronomical Society.**

## DOUBLE STARS — HYPERION — THE MISSING PAIR Σ 1143.

[24062.]—The new pairs mentioned by Mr. Holmes (letter 24001, p. 78) are not in any of the catalogues of Sir John Herschel, the only observer by whom such faint and insignificant objects would have been likely to have been noted. The companion to Σ 1228 has not been noticed by anyone else. The distance of the close pair of ζ Cancri is now about 1·0″. For P. xi. 111, Hall gave 0·68″ in 1879, and Burnham the same in 1882. Seagrave found 1·16″ for Σ. 2054 in 1882, and Perrotin 0·75″ for O.Σ. 175 in 1884. The present distance of ω Leonis (Σ. 1356) is about 0·60″. A gentleman writes to me that he sees O.Σ. 175 well with 350, and ω Leonis with 450 on his 10½in. With, observing near London. I do not think it probable that Mr. Holmes really saw Hyperion. The faint object he noticed was certainly near the place of that satellite, then near its eastern elongation, but I doubt if he could see so faint an object three months after opposition. In most of the Washington observations, Hyperion is called "faint," or "very faint" with 26in. I found it very faint with 18in. near opposition, and I know no instance of its having been really seen with less than 15in. Dr. Meyer failed to see it with the 11in. refractor at Geneva, though he made careful observations of Mimas on several occasions.

I am much obliged to Mr. G. Knott letter 24035, p. 101), for looking up the place of Σ. 1143. Σ. himself seems certainly to have seen A double in 1851.

**H. S.**

## TEMPEL'S COMET.

[24063.]—It is stated in your Scientific News of Feb. 20th, on the authority of M. Gautier, of Geneva, that in consequence of planetary perturbations, the comet Tempel, 1867 II., will come to its perihelion at the end of June or beginning of July. In the Scientific News also for March 20, it is stated on the same authority that the same comet will be retarded through the action of Jupiter to the amount of 148 days. Now, I am at present unable to reconcile these two statements. The past perihelion passages have been 1867, May 24th, 1873, May 9. In the following revolution the comet did not approach near to Jupiter, so that the perturbations were small during that revolution, and the comet performed its revolution with a mean motion not differing much from the osculating value at the commencement of that revolution—namely, 1873, May 9th, which was 594·2″ (the diurnal motion.)

I have not at hand the exact time of perihelion passage in 1879; but from what has been said it would be somewhere about the beginning of May, when the osculating mean motion would not materially differ from that at 1873, May 9—probably a little less. Now, a retardation of 148 days would imply that the current period would be longer by that amount than that due to the osculating mean motion at its commencement, which would bring the perihelion passage about the middle of September.

Perhaps M. Gautier found the perturbations greater than he had at first supposed. If any correspondent can throw any light upon this, I should be obliged.

**W. C. B.**

## θ AURIGÆ.

[24064.]—In letter 24002, p. 78, Mr. Holmes calls attention to the difficulty in seeing the close pair of θ Aurigæ. He will find some letters on this object in the English Mechanic for Feb. 9th, 16th, 23rd, and March 2nd, 1883; but it may not be out of place here to give a short account of this interesting pair.

The close companion was discovered by O.Σ. with the 15in. at Pulkova in April, 1870; it having escaped the notice up till then of all other observers, including Sir W. and Sir John Herschel, South, Struve, (with the 9½ at Dorpat in 1826), Smyth, and O.Σ. himself in previous observations. The following are all the measures of this object which are known to me:—

A−B. Σ.'s scale.
O.Σ. 8·7° : 1·98″ : (2ⁿ) : 1870·25. 3, 7·6 mag.
„ 3·0 : 2·24 : (2ⁿ) : 1871·24. caret.
„ 4·9 : 2·22 : (2ⁿ) : 1872·76. „
De. 3·2 : 2·05 : (2ⁿ) : 1875·88. 3, 7·5 mag.
B bright blue.
„ 0·5 : 2·29 : (2ⁿ) : 1877·02. 3, 7·8 mag.
B azure or ash.
β. 5·4 : 2·08 : (3ⁿ) : 1878·59. 3,10·5 mag.
β. 4·1 : 1·80 : (3ⁿ) : 1879·71. 3,10·0 mag.

There are two other catalogued companions, C and D; both discovered by Sir W. Herschel. The principal measures of these are:—

A−C.
♅. : 35·3″ : (1ⁿ) : 1782·67.
„ 286·0° : : (1ⁿ) : 1783·73.
O.Σ. 290·9 : 43·29 : (1ⁿ) : 1852·12. 11·0 mag.
De. 292·6 : 45·18 : (2ⁿ) : 1876·24. 10·5 mag.
Fl. 293·3 : 45.50 : (1ⁿ) : 1877·79. caret.
β. 293·3 : 45·51 : (2ⁿ) : 1879 41. 9·5 mag.

A − D.
$H_2$. 352·3° : 125.05″ : (1ⁿ) : 1823·14. (15 mag.)
Σ. 350·7 : 123·42 : (1ⁿ) : 1840·16. 10·0 mag.
O.Σ. 350·3 : 125·10 : (1ⁿ) : 1852·12. caret.
Fl. 349·5 : 127·95 : (1ⁿ) : 1877·79. caret.
β. 349·6 : 127·10 : (1ⁿ) : 1880·05. 8·8 mag.

The changes in A−C and A−D are due to the proper motion of A. It is evident that A−B form a physical object: otherwise it would have been impossible to have overlooked so obvious a pair before, as the distance would have been 9½″ in 1783, 4″ − 5″ in 1823 and 1826, 2½″ in 1840, &c., if B did not share in the proper motion of A. B is probably variable; it could not have been below 8·0 in Σs scale in 1870, 1875-6-7, or De. would not have spoken so definitely of its colour as he has, and yet Burnham rates it much smaller than C in 1878-9. In November, 1823 Herschel saw C with South's 5in. refractor, though he had missed it in February of that year with the same instrument. He rates C, 10m. and B 9m. on this occasion (he had called B 15 mag. in the spring!) and speaks of another suspected star 11−12 mag. On examining the original MSS. of H. and So. a day or two ago, I found that this suspected star was evidently the same as the one referred to by myself in the "E.M." for Feb. 16, 1883 (letter 21065), in about 340° ± 50″ ±. It is curious that this has only been seen by Herschel and myself. The very faint one (probably not much above 12·0 Σ.) in 170° ± 50″ ± found on the same evening, has not been observed elsewhere, I believe. I am pretty sure of its existence, but it was very faint with my 6¼in. Calver. Smyth gives the colour of A as "brilliant lilac," De., white, deep yellow, and deep green, 1876 and 1877.

**H. Sadler.**

April 2nd.

## JUPITER—PARTIAL OCCULTATION OF SAT. I. BY SAT. III.

[24065.]—An interesting partial occultation of the 1st satellite of Jupiter by the 3rd was observed here on March 27th. At 11h. 30m. the satellites were seen close together on the following side of Jupiter, towards which both were travelling, I. being a little to the south of III., the disc of which latter was clearly considerably larger than that of the former, and it was evident that a partial occultation of I. must take place. As the satellites were both moving in the same direction, the motion of approach was but slow, being only that due to the difference between the velocities of the two satellites.

The first contact between the limbs took place at about 12h. 2m., and at 12h. 20m. the appearance was that of an elongated and somewhat wedge-shaped single satellite, the elongation at this time being nearly at right angles to the direction of the motion. From the small amount of elongation, it was thought that quite one-third of the diameter of satellite I. must be concealed behind the disc of III.; but though the discs were of a slightly different tint, it was not possible to determine the actual amount of this by reason of the extremely bad definition and small aperture employed. In a large telescope, and with good definition, the phenomenon must have been extremely fine. Occultations of one satellite by another are necessarily somewhat rare, as they can only occur when the planes of the orbits of the satellites pass through, or very nearly through, the earth. The instrument employed in the above observation was a 2¾in. achromatic, with a single lens eyepiece magnifying 102 times. **A. Stanley Williams.**

## SOLAR ECLIPSE OF MARCH 16, 1885—MR. PEARSON'S PARTIALLY-GRAPHIC METHOD OF COMPUTING ECLIPSES AND OCCULTATIONS—MR JOHN A. BRASHEAR—SILVERING TELESCOPE MIRRORS.

[24066.]—The solar eclipse was seen here under very favourable conditions, though the high wind made the air a little too unsteady for very fine work. The day opened cloudy, but the sky cleared with the rising sun, and continued so throughout the remainder of the day. The eclipse possessed unusual attraction for me, for besides being the first one visible here for about five years, it was also the first I ever saw through a telescope. In this connection, therefore, I have been very much interested in the new method of computing eclipses and occultations devised by the Rev. James Pearson, of Fleetwood, and recently communicated to your readers in these columns. This method has answered my purpose admirably, and although I have little or no acquaintance with mathematical astronomy, I found no difficulty in computing the circumstances of the eclipse for this place, which are as follows:—

Latitude, 42° 21′ 28″ N.
Longitude, 4h. 44m. 14s. W.

Elements.

I.

| | | h. | m. | s. |
|---|---|---|---|---|
| G. M. T. of ☌ | = | 6 | 14 | 24 |
| Equation of T. | = | | 8 | 37 |
| | | 6 | 5 | 47 |
| Long. West | = | 4 | 44 | 14 |
| Sun's hour angle | = | 1 | 21 | 33 |

II.

$\rho$ cos. $l$ = 9·86929
P = 1·75572  P = 56·98′
1·62501
2·
0·37499 = 2·371
Value of 10′ of arc = 2·371 inches.

III.

$\rho$ sin. $l$ = 9·82618
P = 1·75572
Cos. $\delta$ = 9·99986  $\delta$ = 1° 27·2′ S
1·58176 = 38·17′
Diff. of decl. ☉ and ☽ at ☌ = 48·01
☽ above centre of ellipse = 9·84′

IV.

X cos. D = 29·23′
Y = 9·36 ascending
Moon's semi diam. = 15·6
Sun's do. = 16·1
Sum = 31·7

Phases.

| | h. | m. |
|---|---|---|
| Eclipse begins...... | 0 | 20. |
| Middle of Eclipse .. | 1 | 46.2 |
| Eclipse ends ...... | 2 | 56.2 |
| Magnitude.... | ·531 | |

First Contact—90° from the North Point and 97° from the Vertex towards the west.
Last Contact—38° from the North Point and 0° from the vertex towards the east.

As to the accuracy of these figures, my observations, which were carefully made with a 6½in. silvered-glass reflector, will speak for themselves:—

| | h. | m. | s. |
|---|---|---|---|
| First Contact ............ | 0 | 20 | 6 |
| Last Contact ............ | 2 | 56 | 2 |

And the points of contact were, as nearly as I could determine, correct.

But not only is this method easy and accurate, it is also extremely expeditious. In computing the eclipse for Rochester, N.Y., for Prof. Swift, I took out the elements, made the drawing, and obtained all the facts in *less than twenty minutes*. This, when compared with the usual laborious method, is a great boon, not only to amateurs but to professionals as well, and I thank Mr. Pearson for the benefit and pleasure I have derived from it.

For drawing the ellipses I use a piece of thin sheet brass, through which, at the places where the ellipses corresponding to every 2°, and the abscissæ corresponding to every 10 minutes intersect, I have made holes just large enough to admit the fine point of a pencil. By laying this on the drawing, I can mark these points, and using them for guides, by the aid of a curved rule, I can easily and quickly interpolate the ellipse required.

The moon passed over several sunspots, occulting the first and largest one at 1h. 2m. 50s.

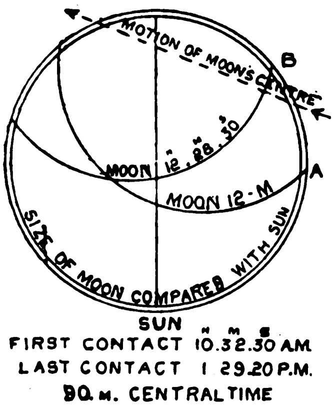
Your readers will doubtless be glad to learn of the much improved condition of Mr. John A. Brashear, who, it will be remembered, sustained so painful an accident recently. Though able as yet to do only light work, he is now recovering rapidly. He has just corrected a mirror for me; but I have had no nights sufficiently fine to try it on test objects. However, his work is too well known to need any words of commendation, especially from an amateur. I have had the pleasure of receiving a copy of his address, referred to by "F.R.A.S." (letter 23861), on "Critical Methods of Detecting Errors in Plane Surfaces," a paper replete with the most valuable information. In regard to silvering mirrors, I have tried the hints given by Mr. Brashear in letter 23533, page 238, with the best success. After taking the mirror from the bath, it was "sponged" under the faucet with absorbent cotton for five or ten minutes, then laid on its back, and the remaining water *blotted right off with clean blotting paper*. I think this a most excellent idea, and as the mirror becomes dry immediately, *there are no stains left*, and it saves lots of time.

**Chas. L. Woodside.**

Boston, Mass., March 26.

[24067.]—I inclose you a sketch of the eclipse of the sun as it appeared at our place on March 16. The first contact was observed 10h. 32m. 30s. a.m. The position of circle marked A represents the position of moon at 12m., and the other marked B is position at 12h. 28m. 30s. The last contact occurred at 1h. 29m. 20s., using 90 meridian or central time. The drawing from which this is made was obtained by using a 4¼in. equatorial refractor, with a white paper screen attached at such a distance from the eyepiece that an image of the sun was formed 9¼in. diameter. The first and last contact was observed by removing screen and looking through eyepiece giving power of 80 diameters. The inner circle represents the diameter of moon compared with sun. The moon was visible in this position to only a very small portion of our continent. **L. W. Loomis.**

Carrollton, Illinois, March 17, 1885.


MOTION OF MOON'S CENTRE
B
MOON 12. 28. 30
A
MOON 12-M
SIZE OF MOON COMPARED WITH SUN
SUN
h m s
FIRST CONTACT 10.32.30 AM
LAST CONTACT 1 29.20 P.M.
90 M. CENTRAL TIME

## EFFECT OF THE PARTIAL SOLAR ECLIPSE OF MARCH 16th, 1885, ON THE READINGS OF THE SUN THERMOMETER AT THE NEW YORK METEOROLOGICAL OBSERVATORY, CENTRAL PARK.

[24068]—At mid-day, just before the commencement of the eclipse, Draper's self-recording sun thermometer of this observatory indicated a sun temperature of 92° Fahrenheit, while the self-recording thermometer in the shade at the same time indicated 33° Fahrenheit.

When the observation was at its maximum, 1.30 p.m., the sun temperature had fallen to 69°, while that in the shade was still 33°.

At the end of the eclipse, 2.50 p.m., the sun temperature had risen to 82°, and that in the shade to 34°.

It is interesting to note from the above facts that one half of the difference between the sun temperature, and that in the shade at the beginning of the eclipse is 29½°, while the actual fall of temperature during the eclipse as shown by the sun instrument was 23°. This is as it should be, for only about one-third of the sun was obscured. It is probable that if the eclipse had been total the readings of the two instruments would have been the same. **Daniel Draper, Ph.D., Director.**

## THE SOLAR ECLIPSE OF MARCH 16, 1885.

[24069.]—It is a satisfaction to learn that the recent solar eclipse was most favourably observed at most of the astronomical stations mentioned in my recent communication on the subject. I have been fortunate in obtaining the assistance of an intelligent amateur, Mr. Charles L. Woodside, of Boston, U.S., who has adopted the partially-graphic mode of computation of these phenomena, which I have recently devised, and has sent me the results at his own point of view, and also a newspaper cutting describing the particulars as seen elsewhere. From these sources I send you the following details.

At Boston, the partially-graphic calculation gave the following—

| | | |
|---|---|---|
| Eclipse begins.... | 0h. 20·1m. | Eastern standard time (5h. later than Greenwich). |
| „ middle .. | 1h. 46·2m. | |
| „ ends .... | 2h. 56·2m. | |

In his letter he says, "I first found the point of contact, and then as the time approached, an assistant called off ten-second intervals, with this result—

| | |
|---|---|
| Began ............ | 0h. 20m. 6s. |
| Ended ............ | 2h. 56m. 2s. |

The points of contact were perfectly correct, as well as the magnitude."

At Cambridge Observatory, the eclipse appears to have been computed and observed with greater accuracy and success than elsewhere.

The following is the result of observations as regards time of *first* contact:

Computed time, as reckoned by Robert Treat Paine, of Brooklyn, 0h. 35m. 17s. mean time, or 0h. 19m. 48s. standard Eastern time; ditto, as calculated by myself by the partially-graphic method, 0h. 35m. 37s. mean time, 0h. 20m. 7s. standard Eastern time.

Observation of Professor E. C. Pickering with the East equatorial, and eyepiece 316 diameters, 0h. 20m. 9s. observed time, 0h. 20m. 7s. corrected time.

Observation of J. R. Edmunds with 3in. telescope, 55 diameters, 0h. 20m. 19s. observed time, 0h. 20m. 14s. corrected time.

Observation of O. C. Wendell, with a 6in. equatorial telescope of 70 diameters, 0h. 19m. 59s. corrected time.

The following are the exact times of the *final* contact:

Computed time by Mr. Paine 2h. 56m. 5s. standard time, 3h. 11m. 34s. mean solar time.

Computed time by partially-graphic process 2h. 55m. 57s. standard time, 3h. 11m. 27s. mean solar time.

Professor Pickering's observation, 2h. 55m. 46s.
Mr. O. C. Wendell's observation, 2h. 55m. 55s.
Mr. J. R. Edmunds' observation, 2h. 55m. 35s.

The accordance must strike the most cursory reader as remarkably perfect. The details, I may mention, are copied verbatim from the *Boston Advertiser*.

During the progress of the eclipse Mr. W. H. Pickering, of the Institute of Technology, obtained a series of 27 very perfect photographs of the solar orb. The special purpose was, if possible, to obtain representations of the corona, from which scientific deductions might be made. The process was a repetition of that employed by Dr. Huggins, in England, for the same purpose, the results of which were regarded as of value, though hardly amounting to demonstrations. The atmospheric conditions were entirely favourable.

During the progress of the eclipse Professor Cross, of the Institute, gave his class an opportunity to observe the phenomena as reflected by means of mirrors, properly adjusted to present and steadily maintain a dark image of the sun upon a white screen.

At Washington, the partially-graphic computation gave (as reported in your columns) time of beginning, 23h. 57m. Washington mean time. To this we add 5h. 8m. 12s. for East longitude, and subtract 5h. for earlier time at Greenwich. The result is 0h. 5m. 12s. standard Eastern time. The *Boston Advertiser* says:—"The eclipse was first observed at 0h. 5m. p.m. to-day, standard time. Heavy clouds obscured the sun the greater part of the afternoon, so that but few observations could be taken. A fraction more than one-half the sun was covered at one time, and this was the greatest portion concealed during the afternoon." No account is rendered of the final contact, which we may conclude could not be seen. The calculated magnitude was 0·52.

At Phelps, N.Y., Professor Brooks, of the Red House Observatory, obtained a good observation of the eclipse at 0h. 6m. 11s. standard Eastern time.

At San Francisco no observations could be made by reason of cloudy weather. At Amherst, Massachusetts, Professor Todd secured a complete record of the eclipse at the observatory. About 50 photographs were taken. The last contact was observed by Professor Esty and others.

I have given these copious details in the hope that they may prove interesting to your many amateur readers, and encourage them to adopt a mode of calculation which is far simpler and easier, and quite as exact as any other known method, and one which they each appropriate to themselves.

**James Pearson, M.A., F.R.A.S.**

Fleetwood, April 2, 1885.

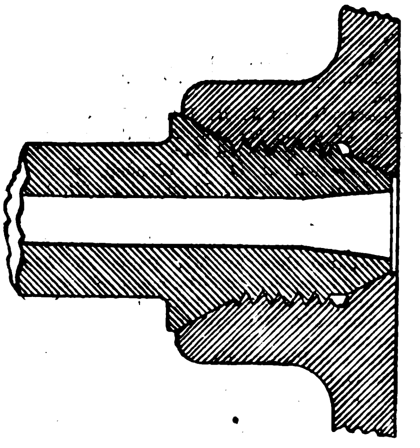
## THE SEASONS.

[24070.]—Whitaker, in his Almanack, states that spring, summer, autumn, and winter begin respectively on March 20, June 21, September 22, and December 21. There is probably an astronomical reason for this; but it seems to be hardly in accordance with popular, and to me, national, ideas for summer to commence on the *longest* day, and within a few days of Midsummer Day; for the middle of September to be regarded as in summer; or for autumn to expire only five days before Christmas Day.

I have hitherto looked upon Midsummer and Christmas Days (or to be more accurate, the longest and shortest days) to be the middle or height of their respective seasons. I shall be glad if any correspondents will give me their opinions on this subject, and if any can give hints concerning the etymology of the names of the seasons, and of the word "midsummer," they would throw useful light on the subject. **Devoniensis.**

## MANDREL NOSE.

[24071.]—I have inclosed a sketch section of mandrel nose; it shows another way in which a chuck could be made to run truly on any mandrel, provided the cones were the same. The distance from bearing to end of nose is 1¼in., but it could be made less by shifting the threaded part, if thought necessary. The cones are at the angle of 30°, and have a good biting surface in themselves, so that much of a thread is not required. Some may have an objection to this biting surface, on account of the difficulty of removing the chuck once on; this might be obviated by a coarser thread than the one shown, which is eight threads to the inch, and 1⅜in. outside diameter. This form of cones will give the chuck great solidity, as the front portion of chuck will be as firmly bedded on mandrel as the back portion.



This form of nose will also take up any wear, thereby removing the objection urged against the form of nose recommended by Dr. Edmunds.

**T. U. L.**

## LATHE MATTERS—TO MR. HINES.

[24072.]—In the most polite and respectful manner possible, I beg to suggest that it would be better for Mr. Hines to practise what he preaches in letter 23838, p. 521—viz., more carefully to read the contributions of other writers before writing himself, and in the most emphatic manner. I beg to deny that I have "*advocated* a long cylinder fit apparently as a substitute for the Edmunds mandrel faces," and beg to direct to his *more careful* consideration the remark in the first part of letter 23975, p. 61, and to remind him that he has not answered my questions therein contained. I would also ask him to show an error in the following reasoning, if such exists. Mr. Hines, in his letter 23838, says, Upon Dr. Edmunds' wide mandrel face there would be *no real wear*, nor upon his *short* but enlarged *cylinder base* (the italics are mine); but he says the wear on the *front portion* of a *long parallel cylinder*, combined with the wear upon the chuck, would be sufficient after a time to render its centrality imperfect. From this, one thing certainly can be deduced—viz., that if extra length is given to a cylinder, its life as a centring device will be shortened by reason of the wear on the front portion, combined with that on the cheek being increased; but I have pointed out before that for all practical purposes the total force with which the cylindrical portions of the chuck and mandrel are pressed against each other—in other words the origin of the friction between them—is determined by the weight of the chuck which would be increased so slightly by having its cylindrical fitting prolonged to, say, 1in., that it may be taken as constant. If the screw on the mandrel is an easy fit in the chuck, so that the cylinder is not hampered in its centring function, practically, the primary origin of the friction on the cylinder will be the weight of the chuck, and if the cylindrical fitting be increased in length, a slight augmentation in the weight will follow; but this will be so slight that we may neglect it and consider the weight constant. Now the ultimate friction will depend on the extent of surface which has to support this weight, and if the surface be *increased* fourfold, the weight, and *ergo* the friction, on any equal superfices, will be *decreased* to a like extent, so that here we have a decided gain. Can Mr. Hines prove me wrong? Since, then, it is not extra force with which the surfaces are rubbed against each other that makes the prolongation of the cylinder detrimental, what is it? Will Mr. Hines say there is only one other thing that could cause it, and that is the extra distance that the chuck has to pass over the mandrel cylinder base. If this is practically detrimental, the longer the cylinder the more would be the wear, and conversely the shorter the distance it has to travel, or the shorter the cylindrical base, the longer would it remain true, and this, if pushed to its extreme, would point to a cylinder whose length equalled only the thickness of a piece of tissue paper, as remaining true infinitely longer than that of Dr. E. This, on the face of it, is manifestly absurd, even if the weight on any determined superficies remained constant, which I have shown would not be the case, though at the same time I have not forgotten that the surfaces only gradually come into contact, and, as Mr. Hines points out, the wear on the first or entering portion—i.e., north portion of cylindrical base, and south portion of chuck, would bear the brunt of the friction, which friction never exceeds in magnitude that which the ·2in. base of Dr. E. will have to withstand. A slightly truncated cone of suitable angle would graphically depict the actions here. The slight truncation might be taken as representing the amount of surfaces in contact when, or just after, they first touch, and as these surfaces increase as the chuck is forced farther home, so the sides of the cone recede from each other till we reach the base, which might be taken to indicate the amount of surfaces in contact when the chuck was forced quite home against the face fitting; then, on the contrary, the slight truncation would measure the amount of friction on any particular amount of surface just before, or as the chuck reached its final position, &c. Working backwards, as the surfaces in contact decrease, so the friction would increase, as also does the distance of the sides of the cone from each other till the base affords us an idea of the maximum amount of friction reached simultaneously with the minimum amount of surfaces in contact; and, therefore, if the augmentation of surface to be worn away, accompanied by a diminution of friction, does not tend to *increase* the life of a lengthened cylinder, in the face of Mr. Hine's statement in letter 23838—viz., that the usage of a lifetime would scarcely affect the truth of a ·2in. cylinder, whilst a longer one, on account of its length, would, after a time, become imperfect. I consider that we are entitled to look to him for an explanation. I asked for this in letter 23975; Mr. H. has not given it; but, instead, made an erroneous statement, the result of too hasty reading and jumping at conclusions. In my letter (No. 23743, p. 431) I endeavoured to show "O. J. L." that, so far from the face fitting being so efficient as to be able to dispense with the centring properties of the cylinder, the reverse was really the case, and that a cylinder-fit sufficiently long would provide for the truth, both centrally and angularly, or in declination or equatorially; *but I did not advocate the use of it, nor have I done so since*, for, further on, I rather pointedly ask, "Of what use is it to propose for a moment a system which lacks any pretence to concentric adjustment," and concluded by voting in favour of a long cone-fitting as the proper basis of an interchangeable system. All through I have objected to the cylinder-fit, long or short, because it does not provide for adjustment for wear, and because I consider *two conical surfaces* offer less difficulty to the attainment of truth than *four surfaces in pairs at right angles to each other*. But I am glad to see that we are gradually reducing this matter to a nucleus, for a correspondent of "Ours," a very eminent lathe maker, states that he has used for over twelve years the taper, or cone, fitting as an interchangeable system for drills and centres, and *has found it to answer in every respect*, and this is no other than Mr. Hines himself. This places the cone, or taper, fitting, which *I have* been so strenuously advocating, on a very different footing, so far as regards this discussion, at once, and I am much obliged to Mr. Hines for the statement. It is now no longer a question as to whether the cone fitting will, or will not, answer. The experience of twelve years, with its concomitant friction and wear, has proved the system to answer in every respect for drills and centres; but it may be argued that it would be expedient to modify the dimensions of the cone system when applying it to larger and heavier chucks, such as increasing the diameter of the base of the cone, whilst retaining the same, or perhaps even reducing the length of it, and that under these new conditions the cone system would lamentably fail. No one would be more pleased to see this thoroughly argued to a correct conclusion than myself, and as Mr. Hines has admittedly had twelve years' experience in cone fitting, he should be well able to tackle this question in a critically scientific, and searching and lucid logical manner—not forgetting that it does not follow that because a certain angle for the taper has been found to answer for work of the dimensions of a lathe centre, that, therefore, the same angle *must* be used for all other apparatus; nor that the efficiency decreases in a ratio proportional to the increase of length, or diameter of the base, though no doubt there is a proper proportion which the length of cone should bear to its base to secure best results, and that certain different angles of conicity will be found best for different purposes—thus 4° seems to be best for one description of chuck for light work, and where the friction or jamming action alone is used to retain it in place, and the more obtuse the angle the less the friction. And here I would point out to Dr. E. that the friction of a moderately obtuse cone could be reduced much below his cylinder and face fitting by retaining the screw ferrule of "F. A. M.," or a modification of it, such as a ¼in. shoulder on the mandrel with a *left*-handed thread and boss at back of chuck, to be screwed with a right-handed thread and ferrule screwed to match, there would then be no difficulty in changing the chucks; but if the chuck was not secured sufficiently tight, the chuck, and with it the ferrule, would rotate backwards under the action of the tool, and so unscrew from the mandrel shoulder. Another plan would be to have right-handed screw threads on both mandrel shoulder and chuck boss, but of different pitches.

And now a word as to cost or trouble in making cone fittings. If work can always be turned true when mounted between centres, no matter what longitude they happen to occupy in their conical fittings in mandrel and cylinder, it can only be because the axes of both centres coincide, the prolongation of one with that of the other necessitating the truth of slot in bed, headstocks properly fitted thereto, truth of the mandrel, the centres themselves and of their conical fittings to mandrel, cylinder, and to the work. Such a conical fitting Mr. H. uses for a common, everyday chuck, like a centre may be considered to be; and yet I suppose that there would not be found one in a hundred good lathe makers who would not pay vastly more attention to the fitting of an expensive chuck, such as an oval, eccentric, epicycloidal, or geometric one, to its mandrel, than they would to that of a common centre—in other words, lathe makers would not choose an expensive system, but rather as simple and cheap a one as possible, for a *centre*, but would be more ready to lay out more time and skill on that adopted for expensive chucks. But since the cone or taper fitting as applied by Mr. Hines has answered in every respect for 12 years, it may be concluded that it is a thoroughly reliable and efficient means for the purpose, and not therefore necessarily unreliable on account of its cheapness and ease of production, else Mr. H. would not have continued to use it for so long a time. I have pointed out above the truth required in the various parts of the lathe if the truth of work is always to be relied on when turned between *centres mounted by the cone fitting*. The same accuracy would be required if the centres were mounted in any other way—say, for instance, Dr. E.'s cylinder and face fitting, and supposing that such a centre was the piece of work being turned, in addition to the above parts of the lathe, the traversing slide of slide-rest would have to be absolutely parallel with axis of mandrel and centres, and the surfacing slide as truly perpendicular to the same, else properly true cylindrical and face fittings could not be produced. On the contrary, for a male and female cone, the axis of centres must coincide in direction, but need not be parallel to the bed. Only one slide of rest will be used for the conical surface, the other being simply used to give depth for the cut as required, and one setting of the slide-rest will do for both cones, especially if the base of male cone is allowed to be north of, or farthest from, the mandrel, as then the largest diameter of hollow or female cone will be outside or north of holding chuck, and therefore its interior will be more easily getatable with the tool. Any untruth between the axes of centres and bed, or even slides of slide-rest, if such rest is not moved on bed between the finishing of both male and female cones, will affect the taper, but be equally communicated to both; and should the base of one be turned slightly less than it should be, such diminished diameter will be communicated to the whole of the cone, as the tool in slide-rest moves on, and the only result will be that the cone will have to be forced a little farther on its counterpart, and will then fit equally well. But if we had to make the chuck or centre fit up against a face, fitting as well as, and at the same time with, its cone fitting, then we should have to be very much more careful, as the slightest bit too much taken off the cone would allow the face fitting only to touch. Lack of centring means would then exist. If, on the other hand, we did not take enough off the cone, the face-fitting would never touch the chuck at all. The utmost care would have to be taken, and this extra amount of care it is that has to be taken with the Edmunds face and cylinder-fitting, as in the former case the cylinder would be too small to exercise its centring functions, if even a trifle too much were taken off; and in the latter you could not get the chuck on at all. Therefore, the cone-fitting is not only efficient, but easier and cheaper to make than the cylinder and face-fitting of Dr. Edmunds's mandrel. Then why adopt the latter in preference to the cone system?

In conclusion, if Mr. H. can construe what I have said, with reference to the cylinder-fit, into an advocacy for the use of a *long* fit of that description, then I am sure he is much to be envied; and I am proud to have engaged even his slightest attention for a moment; as undoubtedly he possesses ingenuity and inventive genius of the very highest order; but I fear he lacks an "eagle optic," and that his mind is not equally developed in the analytical direction.

As soon as time permits, I hope to write a line or two on the centring or de-centring properties of an angular screw-thread.

ERRATUM.—On page 61, column 2, line 41, for "about $\frac{3}{10}$ more pressure," read "·5858 or about $\frac{3}{8}$ more pressure." **E. J. S.**

## LATHE MATTERS.

[24073.]—IN reply to "E. J. S.," I have not written, because my practical knowledge is limited, and the theory is in better hands. A schoolmaster friend, who was talking of lathe-making with his boys, promised to help me in experimenting on Dr. Edmunds' mandrels; but as he cannot at present, I have little to say beyond that "E. J. S." and I seem to think a good deal alike, while he expresses our thoughts well enough for both. A few ideas have occurred to me; but I doubt if they are worth printing.

I do not object to the Doctor's nomenclature. We *must* define our terms, and if we had done so at first a good deal of talk would have been saved. "Angular variation" is the least obvious; but we have no corresponding astronomical term for this "axial inclination," though for variations in this angle we have, *i.e.*, nutation. After all, the nomenclature is conventional, and it little matters what terms are used, so that we use them for the same thing, and the advantage gained by using astronomical and geographical ones is that they are to a great extent defined by analogy.

As to the Doctor's mandrel, the theory is excellent; but the whole question must be submitted to the test of practice. In connection with this, I would call attention to Vol. XVI. p. 168, where is a letter from a correspondent (now dead) who proposes this same cylinder and face fit for the same purpose, and request "J. K. P." to comment on the design, which he did not do, to my great regret. In that case there was an internal instead of external screw, and one objection would be the large neck, while if used as an alternative for small chucks, I don't think it equal to the cone.

As regards the cone fitting, its great point is that it takes up wear or error in size, and so is superior to a cylinder in theory; but in practice, unless for small fittings, I doubt if it will come into use save in the disguised form of the screw-thread, which I feel sure for ordinary purposes will take some "rejecting." For centring, the cone should approximate to the cylinder; I doubt if the obtuse cone shown as a mandrel face in some back drawings has much value for this purpose; but this again is theory.

We are told that the screw is rejected as a centring agent. No doubt a cylinder pure and simple, or that series of cylinders called a cone, will enter more perfectly; but a screw centres well enough for ordinary purposes, and is the sole means of centring in the Holtzapffel nose, and that it answers as well as it does is due to its being a cylinder plus a cone, by which I mean that a square-threaded screw would centre perfectly while unworn, and a V thread does the same less perfectly, but allows for the small wear or error in fitting, which the square thread would not. We should notice, too, that the centring is done by the base of the screw, not the worn part at end, though even the base wears more than the Doctor's cylinder. I believe workshop convenience will settle this for us ultimately.

We amateurs reverence practice, and letters such as those of Mr. Wenham and "J. K. P." are as valuable as anything in the "E. M." Will Mr. Wenham say under what name (I suppose I must not say where) we should ask for it to obtain the mild steel he describes? Also, Mr. Hines might tell us if the steel with mild core is an ordinary article of trade, or is made from mild steel by carburetting, or how.

I noticed recently a small matter. In the sliding poppet, as the strain on barrel is upwards, why should the pinching screw be often placed on top or side? Whitworth's wedge is at bottom—the right place. Why, also, should not the steady pin be placed vertically upwards or downwards?

I should like to know what has been done lately in the way of systematising gauges and small screws. I borrowed a gas stock recently and got two taps, with result that I had two different threads, neither agreeing with my own. I should also like to know if the Holtzapffel lathe taps differ among themselves as much as the noses. Also, if Mr. Hines will tell us what makers finish their standard taps with laps, and describe the process? I don't doubt the fact, but ask for information.

Lastly, as regards cutting screws with circular cutters, "J. K. P." says (Vol. X. page 476), "I have used that plan on soft steel in making a pair of screws of 14 threads of 4in. pitch, with very capital results." Will he settle this point for us by a few words? **Bow.**

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[24074.]—THIS discussion has had a great interest for me, and, enthusiast though I be, I must confess I am getting tired of the correspondence, and do not believe that the numerous letters which have appeared have led to any satisfactory conclusions.

To encourage the solution of the mystery surrounding the form of the projected standard model mandrel nose, I think it would be well if someone acquainted with American machine practice could be induced to give us the benefit of his experience. One has only to pay a visit to Churchill's and see what fine tools our brothers can send over to us, and we know that to manufacture goods of the perfection attained requires the finest machinery; I am, therefore, inclined to think valuable hints are to be obtained from this quarter. Personally, I am little acquainted with American practice, but am informed that they adopt for mandrel noses a large diameter, fine-pitched V-threaded screw running whole length of nose, and with no centring agent other than the form of thread, and but very little (about ⅛in.) of a collar at the root of the thread, the mandrel and nose finished in soft steel, and the front bearing a long parallel one. Now most of these fall in with my own views, excepting that I should adopt a cone bearing and coarser pitched truncated thread. The Whitworth pitch is what I take to be about right, but the thread would not suit; the form rounded off top and bottom means anything, and could not be relied on as a centring agent as can be done with a flat top and bottom or a V-thread. I do not know of any objection to increasing the size of the nose—say, 1⅜in. or 1½in. for a 5in. to 6in. lathe, and finishing soft, thus rendering the manufacture and interchangeability easy. Certainly soft noses are liable to be injured; but careful operators are mindful of their welfare. As for the neck being hardened, I do not see the necessity of this at all; a soft steel neck, running in cast-iron or phosphor-bronze collar, makes a beautiful bearing, and is all that can be desired in point of sweetness and durability, and I venture to think that no one who has used either of the combinations would care to make a change for hardened necks and collars.

The nose proposed by Dr. Edmunds appears to be good, and finds favour with me; but somehow seems to be getting along very slowly. The suggestion of a nose with two parallel cylinder fits, one at beginning and the other at end of thread, is also good; but I scarcely think it could supersede the existing pattern.

Will anyone oblige by suggesting a good form of light-running overhead gear for ornamental work in a 6in. lathe? My present arrangement is far from satisfactory.

One other matter. I should like to know how the alleged appearance of spherical turning is attained with the dome chuck you illustrated a couple of months ago? Will anyone knowing how, or possessing a chuck of this particular kind, oblige? Is the effect solely produced by the dome chuck and a fixed tool?

March 30. **A. F. H.**

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[24075.]—I FEAR Mr. Wenham is rather inclined to make a mountain out of a molehill in the matter of Dr. Edmunds's slip.

A thread of 10 turns per inch on an inch nose, or others of like proportion, would show very little change from the angle 50° if cut by a wheel of that angle. It is not strange that it escaped observation on the samples exhibited, the which, I presume, were so finished.

Whether or not Dr. E. values the strict angle of his thread or the wheel process the more, or the latter at all, I cannot quite say; but if he values the wheel process, and is not strongly attached to the strict form of his thread, the comparative ease with which a 50° cutter can be made, and the facts that, though the threads in chucks and on nose would be different, the extra thickness would be on latter to resist wear, and also that the thread would be a little more upright, and thus perhaps preferable to the strict angle—as it has to avoid acting as a centring agent—make it appear that he has probably perpetrated an improvement. If the thread were described as one "formed by a cutting-wheel of 50° angle and truncated 7½ per cent. of its length," the position would be at least as good as before. The inaccuracies of a thread so cut might, I opine, be by comparison with the centring cylinder styled as medium finish, the centring cylinder being presumably of the highest possible.

Referring, I find I have misstated the nature of the deformation: the thread would be broader-topped, not broader-based—it is the cutter that should be the latter.

Looking at the question of forming the cutting-wheel of the true curve and shape, no particular difficulty presents itself. All that is necessary is to place the wheel, with faces roughed out, *in situ*, and to rotate it while acted upon by a tool in a slide-rest set to the angle of 50° or other desired degree in a horizontal plane, the tool-point being accurately on the line of centres, or rather, moving in the plane containing the axial centre of the disc. It would be an easy matter to make a special tool: with the disc between centres, a slide-rest of short traverse and angled to the centre line and horizontal according to the pitch of thread, and so as to occupy the same relative position as if the cutter were *in situ* and the rest horizontal, &c., would be all that is required.

Perhaps Mr. Evans intends to proceed in one of these ways. Two cutting bits would probably be required for the separate sides, one with more and the other with less than the usual clearance, &c.; but that is a trifling matter.

A screw-nose is surely a hopeless centring device; unlike the short cylinder, it is by many preferred fairly soft, and has to withstand the wear and nipping strains of all the chucks, together with the long travel over the outer end. The complexity of the surface is very great compared to the cylinder, and durability is out of the question, if transferability is not so altogether.

Dr. Edmunds, after perhaps some pretty hard hobby-riding, has well superseded the necessity for transfer chucks; other makers than those who have taken the mandrel in hand will, I fancy, be more or less necessitated to do likewise. That he has produced the best mandrel-nose, is still an open question; but if the threaded nose is to be retained, there is little, if any, room for improvement—in my judgment, at least.

I am afraid "E. J. S." would find it practically impossible to accurately run and exchange facially with the small taper of 10° he puts on his large diam. cones; it would be easier if the cones were of less diam., as the question is one of proportion of length to base for cones of such angles. I know myself from more than one uncomfortable failure.

Having some long large-flanged spindles in hand and a probability of more, the questions of annealing, forging, cutting from solid, &c., have lately been of considerable interest. Cutting from the solid could only be done economically for a short length to include bearing, &c., with a weld to tail end. I think, however, that by hardening and re-softening the mandrels in the rough before finishing for case-hardening, that swelling in patches, as is generally the case with forgings, will be avoided, as also the tendency to warp; the latter, of course, provided that the heating and dipping are done uniformly, say, in suspension. The broad-standard mandrel might be forged, and if similarly treated ought to rival the cut-out for not swelling. I have hardened steel pivots without dimming the polish sensibly, by putting them tightly in a metal hole. At first, I could not think they had been fired at all, though they were dead hard. If Mr. Wenham had offered a prize, there would have been a good chance to obtain it by these methods. **Vulcan.**

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[24076.]—WHY should not Mr. Hines use the finest and best quality of cast steel if he can produce a true mandrel, which he cannot do by lapping, and so he must use the emery wheel, or the diamond, bort, or carbonado tool. Mr. Wenham quotes Sir

J. Herschel as having used the diamond (gem) for turning up hardened steel axes for his telescope. So did Dr. Robinson, of Dublin, and in this case the diamond is, or was a few years since, in the possession of Professor Stokes's family, the Professor having married Dr. Robinson's daughter. Dr. Robinson used the diamond (gem) in 1867, or before.

When Mr. Wenham speaks of the turning by the diamond, does he mean the gem (pure or impure), or portions of it which is a crystal, or part of a crystal, or does he mean what has been popularly, but erroneously, called the black diamond (which is often black, sometimes grey), and which is amorphous, and not crystalline. **Z. Y. X.**

## INTERCHANGEABLE MANDRELS.

[24077.]—MAY not what is wanted be summed up in this way?

A cone fitting (query, what is the proper angle?) to act as a guide to the chuck.

A shoulder to prevent the chuck jamming on the cone.

A screw (not necessarily good-fitting) to hold the chuck to the shoulder.

Of course, the difficulty (but far from unsurmountable) is to get the face of the shoulder on the mandrel to be just at the proper part of the cone, so that when the chuck is on (i.e., home) it just touches the shoulder. Then the screw gives the tightening up. **Z. Y. X.**

## DIAMOND TOOLS.

[24078.]—I HAVE to thank several correspondents for specimens of bort and carbonado and for references to descriptive data. To one correspondent I am indebted for the loan of specimens and tools of great interest for the purpose of examination and experiment. The tool in question takes cheerfully to a rat-tailed file, and it turns up green porphyry, cat's-eye, agate, and other indigestible materials easily. It is not a tool to give to a man who has much beer in him; but for an intelligent master at metal-turning, it may take a place that now much needs to be filled. For the shaping of certain surfaces in hard steel there can be no question that it may answer perfectly if the stone be of the right sort, properly set, and used discreetly. £3 or £4 for one slide-rest tool seems at first sight prohibitory; but as the tool, with proper usage, is said to never wear out, its cost in the first instance will be a secondary matter. I hope in the course of a short time to complete some experiments, and collect data which will be of value to our readers, and I will lose no time in writing again on the question. I shall then have the pleasure of publicly thanking my correspondents individually for their kind help.

The real fact seems to me to be that some of these stones are good for one sort of work and some for another, just as steel requires to be tempered and managed according to the purpose for which it is wanted. Then, again, the various methods of setting need to be discussed, and the right one for the stone and for the particular work needs to be secured. Stones which are bought in the same parcel at the same price, and under the same name, seem to me to vary as much as cast-iron (with or without the foundry scale), charcoal, and other irons and steels in their various states. Anyone who attempted to use these iron materials indiscriminately would be doing just about what many workers seem to me to be doing with these diamond tools, many of which are not diamond at all, and when they come to grief they blame the diamond, instead of their own want of scientific knowledge.

For the diamond slicer, I find that the charcoal iron disc is preferred by a most intelligent and able expert who is kindly showing me his methods. He says that none of the "mild steel" which he has been able to get proves to be sufficiently uniform in quality. The nickel he has not tried as a base for carrying the diamond teeth, otherwise he entirely concurs in what I have already written on the subject of the slicer. As to the milling-wheel invention, he showed me one constructed of a wheel which he had turned up in agate by means of a diamond, and had fixed in a slide-rest frame or handle precisely like the ordinary hand-milling tool. This he made eleven years ago; but it cut into a groove precisely as I predicted, and he threw it aside and reverted to a mass of agate held in his hand. At numerous points along the edge of his favourite slicer, I could feel with my nail fine diamond crystals sticking out of the metal, and these, when examined by a lens, were seen to be set just as definitely as the large diamond used by the plate-glass cutter is seen by the eye to be set. He laid great stress upon the fact that if a point ever gets set awry on the edge of the slicer, or if a point gets set on the side of the slicer, the instrument is spoiled, inasmuch as it will always work itself out of of line. He had found it next to impossible to get such points out of the slicer when once they had got wrongly imbedded. In using diamonds for cutting glass, he regards it as very important that the diamond should never be led a second time over lines which it has once cut. He says that the margins of the newly-cut furrow tear out the sides of the boat-shaped edge, and rapidly destroy the diamond. All intelligent glaziers keep, I believe, to this rule, but it is interesting for us to know *the reason why*. On examining with a lens a diamond crystal that has been taken over the cut a second time, we can see the abrasions which its side have undergone.

"Z. Y. X." is quite right in the points on which, in the "E. M.," he lays stress. He kindly writes me that the *Engineer* of Sept. 27, 1867 (p. 267) describes Dr. Robinson's turning up of his hard steel telescope pivots by means of a gem diamond. Will he kindly publish the extract in the "E. M.," and favour us with any further data he may have on the subject?

The questions we have to settle are, How far can the use of diamond cutters for hard steel be developed beyond the conditions of a laboratory experiment? and on what points does this possible development depend. **James Edmunds.**

Grafton-street, Bond-street.

## CUTTING SCREW-THREADS.

[24079.]—IN a question of grave practice, when a person resorts to coarse and senseless banter—as "red herrings" and the like—he heralds the weakness of his case. Further, I am said to be trying to "save myself from the dogs." What dogs? The application of this term to the writer of the sentence as one of the pack must be so evident, that it is inexpedient to disturb its significance.

I do not "run away" from my point. I selected the square and also the multiple thread of the "screw" or "skew gear" because the model of a milling tool turned to a template the counterpart of a section of the thread interval, on being tried therein, would at once demonstrate the cause of error to a screwcutter of the dullest comprehension. Similar causes of error will exist more or less in all screws cut with a circular cutter, whether V-threads or otherwise. Though I begrudge every word that I write on this point, so obvious to everyone familiar with workshop practice, yet I will quote a sentence from column 3, page 103, of last issue: "Instead of the revolving cutter being liable to give a distorted thread, it is the fixed tool that involves that liability, because it is difficult to keep its cut exactly upon the line of centres." (It must be a very indifferent workman that cannot do this.) It would be excessively difficult to adjust the inclined axis of the milling cutter in the line of centres. If in a right-handed screw it is set above the work, the thread will be lopped over to the left; if set under the centre, the cutter will lop the thread over to the right. Let anyone trace a spiral on a cylinder—say, a cedar pencil—hold a coin with its edge to the incline of that spiral, then shift it above and below the centre of the pencil, and he will realise what I mean, and the wretched abortion of a screw-thread produced by a wheel cutter is liable to this additional error! If the V milling cutter is employed to cut a concentric groove round a cylinder having the axis parallel thereto, it is of no consequence if the cutter is set high or low; but when it is inclined and employed for cutting a spiral, the conditions are entirely different.

I am invited to show where error is. Very well. The "beautiful screw-thread" of the "model mandrel," and also the collar bearing, are to be trued-up with laps or skives charged with diamond powder. This is another blunder arising from mere paper theorising. The gem particles are at once driven deep into the metal of the grinder, which also soon gets choked up with the abraded steel, just as a fine file does with lead, and ceases to abrade. I wish joy to the patience and pocket of the man that would constantly keep up a feed of diamond. In an emery wheel consisting of coarse particles, the abraded steel is thrown off and consumed as a shower of sparks, and so energetic is the action that under a deluge of water sparks are still there. Diamond in large pieces would be sufficiently strong to take a good shaving off hard steel; but for mere trueing-up heavy cuts are not required. The diamond will pare off the hard steel in fine, hair-like curls, and, more curiously still, I have seen a curled shaving taken off a surface of polished glass by a keen diamond splinter. A diamond turning tool may be sharpened on a lap or wheel, charged with the same material, like a steel tool on a grindstone. In this country there are but few workmen in the toolshops who know how to mount, or have any experience in the use of diamond cutting tools. Mr. Hines does not use them, and we must rely on the practice of those who do. I do not consider him answerable for all that he writes, for, to apply the suggestive metaphor heading this, he is hunting in couples. In the tenour of his writing he naturally strives to convey the impression that his house is the fountain-head of all that is excellent in practice; but it appears that he needs something more, for if in any form or detail he has hitherto been helplessly groping in darkness, a new light has now appeared to him in the shape of a "model mandrel," and it is to be hoped that his anticipated "clients" to be attracted thereby will have reason to rejoice at the change, for an ornamental lathe requires to be well considered. The late productions of foreign makers show that for substantial design and accuracy of finish they are quite up to the mark, and are turned out at prices that are not prohibitive.

Finally, as this screw-nose talk is likely still to drag on its weary length for months to come (if we are to judge from precedent), I have to say that, as every hour of my time is now occupied, I can only take notice of it at a convenient period when the eternal paraphrase on this small idea has become somewhat exhausted. In the mean time, if a V-thread screw of a size to be easily seen—say, eight threads on an inch barrel—is offered for my inspection, having been cut up with a milling cutter, together with this cutter, and which screw will bear the usual reverse and counter test, and have straight-lined angle faces, or the threads not hollowed by the cutter or lop-sided, then I shall have to admit that there may be something in it. This is a certain proposal for me to make, because, for practical reasons, a perfect thread produced by these means will not be forthcoming.

**F. H. Wenham.**

## DIAMOND FOR CUTTING TOOLS.

[24080.]—Mr. WENHAM must have heard or seen the carbonado almost immediately after its introduction into England. He says it came into the market *about* 35 years ago. That would be 1850. The first trace of its mention which I have seen is in 1852, only two years difference from the date given. **Z. Y. X.**

## METEOR.

[24081.]—LAST evening (April 3rd) I saw a fine meteor at 8h. 21m. G.M.T. ($\pm$ 1$^m$). I was walking along the street at the time looking at Algol, and so only saw it during the last few moments of its apparition. Its path, as observed, was from $\alpha$ 80° North $\delta$ 2° to $\alpha$ 76° South $\delta$ 4°, when it disappeared behind houses. Duration about three seconds. It seemed quite twice the brightness of Jupiter, and about 3′ diameter; colour, chrome yellow. No train seen.

Clapham, April 4. **H. Sadler.**

## LUNAR GLACIATION.

[24082.]—I HAVE to thank "F.R.A.S." for his remarks in 23774, page 472, of January 20th, even though they do not endorse my views, for I have the greatest difficulty, so far, in getting the theory examined by experts at all. I may also say there is often serious misapprehension over it.

An instance in point is where "F.R.A.S." believes I do not "sufficiently appreciate the extent to which the diffusion of aqueous vapour would take place in any sort of lunar atmosphere."

Properly speaking, the diffusion of aqueous vapour, in any lunar atmosphere, however rare, is a radical necessity of this theory, though the amounts and limits might not be identical on the moon and on our earth, in consequence of the different densities, due to the great difference in gravitation on the two globes.

But the absorption and diffusion of aqueous vapour would go on even at a temperature below zero, inasmuch as ice evaporates if there is air. The steady and slow decline of heat, and also of atmosphere, appears to have gone on simultaneously, and one feature of this theory is, that it seems to be a really beautiful demonstration of this decline, the air being viewed as the transporting medium for the aqueous vapour diffused in it.

Thus we see that the aqueous vapour raised largely (as in our case also) over equatorial seas, has been deposited on the Polar regions to form vast ice caps and the raised S.W. quadrant.

Eventually, as heat and transport failed, this aqueous vapour was deposited more closely around the equatorial seas, to form the vast raised regions around Mare Crisium, to north of Sinus Iridium and the great littoral highlands, such as the Carpathians, Alps, Apennines, Caucasus, &c.

Eventually, as heat and air as transport, still further declined, the aqueous vapour, raised from the lagoons left, or kept liquid by heat vents (as on our earth), was deposited still closer around, forming the ramparts of the walled plains and crater plains.

The circular lagoon formations gradually becoming smaller and smaller, as the ice crust thickened, the later ones often opening near those already laid and frozen, melted away their segments where they overlapped, and so on down to the "craterlets," about which time heat-energy was much reduced, and atmosphere very attenuated.

But contraction of the crust would still open deeper vents, by which some moisture from the warmer interior would reach the surface, and, failing to liquefy the crust, would simply pile as condensed deposit, often filling in old crater vents, as Linné, or even piling up cones like Pico, until at last the exterior would be so destitute of air as to become a practical vacuum, and aqueous vapour escaping would (steam-like) flash out into the void at enormous speed, and form the well-known haze or cloud of ice spicula, which, on subsidence forms the peculiar "rayed nimbus."

Whether this has been carried on yet another stage, to form the great ray systems, I cannot so far say; but it seems probable.

So that all through we see the diffusion of aqueous vapour in the lunar atmosphere, even when very attenuated, is a necessary element in the theory.

With regard to the question of the temperature of the lunar surface, after fourteen days' exposure to the direct solar rays, I can only infer it to be very low, and this part of the question, *i.e.*—the disproof of Lord Rosse's conclusions, is in far abler hands than mine. Both Professors S. P. Langley and C. A. Young are of opinion that the lunar surface temperature never rises as high as the melting point of ice, or even of mercury; and it should be borne in mind that Lord Rosse himself was not quite satisfied of the accuracy of his own conclusions.

The theory of lunar surfacing by glaciation seems to fairly well solve most of the peculiarities we see—*i.e.*,

1st. The absence of distinct Polar caps.

2nd. The difficulty *re* the total disappearance of the lunar seas.

3rd. The distinct relation (except in the case of nimbi) between the brilliancy and the inclination of surface in the detail, as though gravitation removed a darker coating on inclines.

4th. The very suggestive arrangement of the "clefts" around, or near, areas of presumed subsidence, as though they were cracks.

5th. The extraordinary coincidence of eight distinct features, held in common by the circular forms, from Mare Crisium down to the smaller craterlets, detailed on page 198 of "Ours," Oct. 31st.

6th. That the mountain ranges should be so generally littoral and segmental in plan.

7th. That craters and crater plains, and walled plains, are really all excavated forms, the material in some cases 5,000, 10,000, or even 20,000 cubic miles, being removed and piled around to form the walls, leaving the deeply-depressed inclosure a plain and level.

It also offers a fair explanation as to the formation of strings of craterlets, terraced craters, bays of all kinds; and the fact that craters near a sea margin have the wall on the land side the highest. It also explains the ridges on the so-called seas.

Apart from these, it also seems to offer a more reasonable termination of the life-history of a globe, a solidification due to the dissipation of its heat, a surfacing by glaciation, and where the Polar ice-caps have closed over the equator, instead of a final surfacing by igneous phenomena, and volcanic outbursts, and lava lakes.

I trust that "F.R.A.S." will yet give the subject some attention—it is a question of absorbing moment. For ages men have pondered over the great problem of "the end of the world." What is it to be? What, in the far future, is to be the end of our race, and the end of all life on the earth?

It seems to me we may read the answer on the face of our satellite, far off, no doubt, but certain in the end—universal death; while the great hymn of life will be taken up by other worlds, and sung in other words, the great sun itself at last teeming with life, in utter darkness, as the will of the great "All Father."

"It maketh and unmaketh, mending all;
What it hath done, is better than hath been;
Slow grows the splendid pattern that it weaves,
Its wistful hands between."—("*Light of Asia.*")

**S. E. Peal.**

### PROPER FORM FOR BED-FRAMES.

[24083.]—ON reading the letter of "Calm Repose" (23789), I thought the idea seemed so rational that I determined to try his plan, and accordingly I raised the head of my bed about 7in. (by means of bricks under the legs). Since then I have certainly been less troubled with vivid dreams, or indeed, any at all worth mentioning. I find it necessary to have a firm support for my feet (I use three or four volumes of the "E.M." as the most *solid* things I can lay hands upon), as otherwise I find there is a tendency to slip further down the bed than is quite comfortable.

As an invalid, I am not in a position to judge fairly the sleeping merits of the arrangement; but I find that I am able to get off to sleep much quicker now than I used to.

**Devoniensis.**

### AMATEUR MICROSCOPE CONSTRUCTION.

[24084.]—VALUABLE instructions have appeared from time to time in the "E. M." for making almost everything within the range of amateur work; but, with the exception of some articles (to the best of my recollection incomplete) in the older volumes, no full detailed instructions have been given on the construction of the microscope. Whether this arises from the fact that the mechanical exactness and optical knowledge required are practically beyond the skill of any but a professional workman, or from other causes, I do not know. I do not suppose that even the most skilled amateur could successfully make one with high powers, or of a complicated kind; but I should think that a serviceable plain instrument would be within the power of one who is fairly skilful at the lathe and metal work. I feel sure there must be many of our readers who would be glad to be in possession of this useful instrument; but who do not possess, or who do not care to spend, the money to buy one, but who have both time and the means to attempt its construction, if it could be done with a fair chance of success.

Would Mr. Wenham or others who have practical knowledge on the subject enlighten us upon this point, and if considered to be within the range of amateur work, may we venture to hope that shortly a series of articles on the "Construction of the Microscope" may appear in these columns?

**Nemo.**

### THE CASSEGRAIN.

[24085.]—DR. ROYSTON-PIGOTT'S letters are giving information which is not to be found in books, and which I had sought for in vain, so it is needless to say they are of special interest. As regards the distance of the convex from the concave, it becomes obvious why their sidereal foci ought not to coincide, if we remember that the sidereal focus of the small mirror is for *parallel* rays, whereas when in position in the telescope it receives *converging* rays, and this, of course, applies to the Gregorian as well as to the Cassegrain.

I do not, however, remember to have hitherto seen any formula such as Dr. Royston-Pigott gives for determining this distance. I have not my note-book at hand with the results in actual figures; but I have found that even in small instruments the distance apart of the mirrors differed very sensibly from the sum (or difference) of their foci.

It will be observed that, by omitting the divisor in the first term of the formula, we obtain the equivalent Newtonian focus irrespective of the eyepiece.

$$N = F \times \frac{f}{x}.$$

This in one of the cases given is—

$$N = 129 \times \frac{25 \cdot 8}{4 \cdot 96} = 671\text{in. (nearly)}$$

Or practically 56ft., as mentioned in the last paragraph but one.

I would ask Dr. Royston-Pigott if he can kindly give a formula to determine at what distance behind the great mirror the conjugate focus of the small mirror falls, or, in other words, where would the image be formed if the eyepiece were removed?

**A. S. L.**

### MINERAL-OIL LAMPS.

[24086.]—I DO not pretend to any scientific knowledge, so I only wrote of mineral oils as a practical man, having in the first place verified by actual experiment all I advanced. Very possibly I confused the terms, and I am much obliged to Col. Shakespear for setting me right. My meaning, however, must have been patent to every reader.

I never desired to convey "grave dissent from Sir Fredk. Abel's opinion," being convinced that the deliberate conclusions of such a master must be accepted. Nor did I at all question the principle he advocated; I only stated that "while lamps are made in their *present form*, a general adoption of his views might, in ignorant hands, lead to disaster."

Theorists cannot always as easily submit their views to a practical test as in the present instance is open to Col. Shakespear. He will confer a favour on all interested by providing his "*two* lamps in all things *identical*"(?), and after burning them at full combustion—say, for four hours—inform us of the then respective temperatures of the remaining oils.

As to his "6d. lamps of tin," the use of such is no proof that the principle is either right or safe. I have been familiar with the form of every kind of lamp, here and on the Continent, commercially made during the last 40 years, from the old camphine to the newest lamps of the present day, and I am convinced that the cheap (?) lamps have brought discredit on mineral oils. They are used by the poorest and least instructed. They are often charged with the lowest priced and worst oils, and to their structural imperfections must be added the gross ignorance and carelessness of the majority of their users.

I have also had great experience in the use of these oils, and have always found them (when properly managed) the best, cheapest, and cleanest domestic lights; and when Sir Fredk. Abel and Mr. Redwood have concluded their investigations, I have not the least doubt that from their instructions lamps will be constructed so simple and so safe that the use of these illuminants will be almost universal.

**J. Hughes.**

### CURIOUS OPTICAL EFFECT.

[24087.]—I HAPPENED to have a new smooth-bore breech-loading fowling-piece in my hands, and in looking through the barrel to see if it was well bored, I noticed an optical effect which interested me, and which I supposed to be an excellent example of diffraction bands.

The barrel was very smooth and well polished, the far end appeared as if terminated by a blunt cone formed of two concentric rings, leaving an opening of about one-fourth the real size. Following these two rings were four others the full size of the bore, alternately dark and light, sharp and well-defined.

If I am wrong as to the cause, perhaps some fellow-reader will take the trouble to set me right.

**R. S. Culley.**

### THE EMPLOYERS' LIABILITY ACT.—NOTICE OF INJURY.

[24088.]—I HAVE so often been consulted by injured workmen, anxious to claim compensation under this Act, but who, by omitting to give the necessary notice, had lost all chance of so doing, that I think a few words upon the point may be of practical utility. It is a needful principle in the administration of justice that everyone knows the law, for if ignorance of the law could be a valid plea, no one would ever be convicted. But in cases like this, where a statute makes a technical point and imposes a condition precedent to the support of a just claim, hardship is often worked because of this ignorance. Nowhere has this been proved more plainly than in regard to notice under the above Act. A Bill has several times been brought into the Commons by Mr. Burt and others to give judges some discretion where this notice has not been served within the stated period; but it has hitherto failed to pass, although some such amendment is certainly needed.

The Act provides that no action for the recovery of compensation for injury shall be maintainable unless notice of that injury is given within six weeks, and the action is commenced within six months, from the date of the accident. If the workman dies, then the time within which the action may be commenced is extended to twelve months from the date of the death. With regard to notice also death makes a great difference, for while the workman's action for injuries is gone entirely unless the notice is given within six weeks, yet if he subsequently dies the right revives. This results from the provision that in case of death the want of notice shall be no bar to the maintenance of the action if the judge is of opinion there was reasonable excuse for its omission, which appears to be entirely left to the judge's discretion. If this clause applied also to the case of injury without death, no harm could be done to employers, and some injustice would be prevented.

I am now dealing only with the ordinary case of injury when it is not fatal. Within six weeks from the day of the accident the workman must give notice to his employer. This time is to be reckoned in the usual way, and exclusive of the day in which the act was done, from which it is to be dated. Thus, if the accident occurred on Monday, 30th March last, the notice must be given on or before Monday, the 11th May, and that would be the last day in which it could be given. The notice must be in writing. Verbal notice is useless; the facts that the employer was present at the time of the accident, or knew it from his men, or even offered, or has actually paid, some compensation, are each and all of no avail. Written notice must be proved by the workman before he can begin his case; unless, indeed, this is waived by the employers at the trial. Although the notice must be in writing, it need not be actually signed nor follow any special form. But the Act provides that it shall give the name and address of the person injured, and shall state in ordinary language the cause of the injury and the date at which it was sustained, and shall be served on the employer. The name and address should be full and true. It is as well to set out the Christian names, but initials would be sufficient. The address should be the residence, and not merely a place of employment. By the "cause of the injury" the Act really seems to have meant the cause of the accident, because that is the true point, and the actual proximate cause of injury is not so material. It has been held that it is not essential to set out the exact cause of action, even if it were a paper drawn by a pleader, but that the notice must show the employer what occurred in such a way that he may be able to make proper inquiries, and so come to trial prepared to meet the plaintiff's case. Then the true date must be stated, but a mistake in this point would not be fatal. The Act, indeed, declares that a notice shall not be deemed invalid by reason of any defect or inaccuracy therein, unless the judge who tries the action thinks the defendant was prejudiced in his defence by such defect, or that it was for the purpose of misleading. This clause thus confers a discretion upon the County Court judges, before whom all these actions must be brought, as to the form and contents of the notice, although it does not enable them upon any statement of fact to dispense with it altogether.

Thus the notice must be served upon the employer, and this service must take place within the six weeks mentioned. It may be served by delivering it at the employer's residence or place of business. But this should be done in such a way that it will come to his knowledge in the ordinary course, and it should be left at a shop or office during business hours. But the other plan given by the Act, of service by registered letter, is safer where there is likely to be any dispute or confusion. To do this, the notice must be placed in an envelope addressed to the employer at his last known place of residence or business, and then registered and posted. Upon proof that it was properly addressed, and upon production of the ticket of registration, the notice will be considered as legally served at the time when it should be delivered in ordinary course of post, even if it never reached the employer at all. A company should be addressed at its registered office; although any one of the offices of a company or corporation that had several would seem to be sufficient. It is always wise for the workman to keep a copy of the notice he sends and of the envelope as addressed, and he should sign the notice as he would a letter. It is also wise to let the notice be drawn and delivered as soon as possible after the accident, as the time allowed soon slips away, and unforeseen circumstances occur causing it to be forgotten or overlooked until too late. I have known cases in which injured workmen have been kindly helped by their employers during the first seven or eight weeks after the accident, and then dismissed, the poor fellows only then finding out why they were thus treated, and only learning after the time had gone by that it was too late for them to give notice, without which their claims were irretrievably barred.

I hope soon to return to other practical points upon this Act, of interest to both sides; and can now again answer ordinary legal questions.

**Fred. Weatherfield, Solicitor.**

2, Gresham-buildings, Guildhall, E.C.

### GREAT WESTERN RAILWAY.

[24089.]—Mr. John F. Lawrence is wrong in thinking that the G.W.R. main line west of Bristol is wholly broad gauge. The 4ft. 8½in. gauge has been laid for some years now as far as Exeter. It has been and is largely used for running narrow gauge trains over.

About a year ago a loop line of about three miles was formed between Bleadon and Puxton (which are on the main line, about twenty miles west of Bristol), taking in Weston-Super-Mare, which had, before, to rest satisfied with a junction line between it and the main line, about a mile distant. The loop itself is laid narrow-gauge only, while the original line remains both gauges, and is used chiefly by two or three broad-gauge expresses each way daily, while most of the narrow-gauge stopping trains use the loop line, thus putting Weston partly on the main line.

The line west of Exeter is broad-gauge, with exception of a part of the branch line from Plymouth to Launceston, over which the S.W.R. main-line trains have running powers. **Devoniensis.**

### NEW MIDLAND ENGINES.

[24090.]—Thanks to "Helvellyn" and "Vortex," p. 84, for their opinions on the "big" engines. A sudden change has been made in the working; the Scotch expresses from London are now worked with the old engines 63 and 101, in place of 1675, 1676, and it is now admitted that the "big" engines can't work these trains. They have tried every move to get steam with the small boilers. Inspectors have ridden with them, even Mr. Johnson, jun., has been with them, and the final result of it all is that they are taken off Scotch traffic at the present. I expect the engines will do no good till they have new large boilers.

**Locomotive.**

### ANOTHER BRAKE FAILURE.

[24091.]—Would "Meteor," or any other railway correspondent, kindly explain the cause of a recent failure of the vacuum brake? The Midland 5 p.m. express from Manchester to St. Pancras, due in London at 9.45, 27th March, was made up of two engines and a very long train. Instead of stopping at Kentish Town it ran completely the whole length past the station, and had to be set back. It was a good thing there was nothing in the way; but such cases are very risky.

**Anxious to Know.**

### LEICESTER AND SWANNINGTON RAILWAY.

[24092.]—Since my letter appeared, p. 58, letter 23966, I have received several communications from correspondents asking for more minute details relating to the gradients and height above the sea, &c. I therefore inclose a copy of the Company's Official Table, which I made at West Bridge Station, Leicester, June, 1867.

**Clement E. Stretton,**
Hon. Mem. A.S.R.S.

Leicester, April 2nd.

(Copy.) Leicester and Swannington Railway.

Table of Gradients, Levels, &c., 17th July, 1832.

| Names of Localities where a change of gradient takes place. | Distances. | | | | Levels. | | Gradients. | | Height above low water mark at Liverpool in |
|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Inter-mediate. | | Rise. | Fall. | Per Mile | Ratio. | |
| | Miles. | Chains. | Miles. | Chains. | Feet. | Feet. | Feet. | | Feet. |
| Commencing at Leicester Station near West Bridge ............... | — | | — | | — | — | — | — | 190·05 |
| To Weighing House Road Crossing | 1 | 30 | 1 | 30 | 49·06 | — | 36·00 | 1 in 147 | 239·11 |
| To Glenfield Road and Station..... | 2 | 60 | 1 | 30 | level | level | level | level | 239·11 |
| To near Glenfield Parish Boundary and Groby Branch .............. | 3 | 72 | 1 | 12 | 8·00 | — | 7·00 | 1 in 754 | 247·11 |
| To Ratby Road, Station and Wharf | 4 | 40 | | 48 | 6·95 | — | 11·00 | 1 in 480 | 254·06 |
| To Kirby and Newtown Road Crossing.......................... | 5 | 32 | | 72 | 13·01 | — | 14·50 | 1 in 364 | 267·07 |
| To beyond Desford Station and Road | 6 | 64 | 1 | 32 | 35·00 | — | 25·00 | 1 in 211 | 302·07 |
| To beyond Merrylees Lane Level Crossing....................... | 8 | 10 | 1 | 26 | 51·00 | — | 38·50 | 1 in 138 | 353·07 |
| To Bagworth Station and Foot of Incline .......................... | 9 | 64 | 1 | 54 | 74·94 | — | 44·50 | 1 in 119 | 428·01 |
| To Top of Bagworth Incline ....... | 10 | 27 | | 43 | 96·09 | — | 180 00 | 1 in 29 | 524·10 |
| To Bagworth Colliery Branch Junction ........................ .. | 10 | 56 | | 29 | level | level | level | level | 524·10 |
| To Ibstock and Stanton Lane (summit) ........................ | 11 | 30 | | 54 | 36·97 | — | 54·50 | 1 in 97 | 561·07 |
| To near Ashby Turnpike Road Crossing, Bardon ..................... | 13 | 28 | 1 | 78 | — | 50·98 | 25·75 | 1 in 203 | 510 09 |
| To Top of Swannington Incline and fixed engine ...................... | 15 | 26 | 1 | 78 | — | 41·06 | 21·00 | 1 in 251 | 469·03 |
| To Foot of Swannington Incline.... | 15 | 74 | | 48 | — | 182·92 | 304·00 | 1 in 17 | 286·11 |
| To Termination of Railway at Turnpike road, Swannington ......... | 16 | 5 | | 11 | level | level | level | level | 286·11 |
| Total............ | — | | 15 | 5 | 371·02 | 274·96 | — | — | — |

(Original Table Signed) Robert Stephenson, Engineer.

### "ENGINE-MAKING AT HOME."

[24093.]—Permit me to offer my thanks to your esteemed correspondent, "J. H.," for his interesting and able instructions concerning the making of small steam-engines by amateurs. Numbers of us are desirous of possessing a motor sufficiently powerful to work at least one lathe, and would go to considerable trouble and expense to attain that object in a suitable way; but a difficulty generally presents itself beyond the engine altogether—namely, the raising of steam. Of course, this can be done in the usual way by means of a coal or charcoal furnace; but has it not occurred to us all that coal firing is extremely troublesome. I think it is dirty, and the smoke is not easily disposed of. Can it be done by gas—that is, a gas fire or stove? Would not gas firing be extremely clean, ready, and free from trouble? Would it not, in fact, render a steam-engine almost as manageable as a gas-engine. I suppose it has been and is done. Then why do so many of us use coal at all? As we have had described to us the construction of the cylinder for a small engine, I would like to ask "J. H." a question or two on this point. Why is it that the simple double-action oscillating cylinder *without slide valve*, so much used in models, is not used for larger engines—say, for an engine of ½ or 1 h.-p.? Is it not cheaper to make? How does it stand wear? Will your obliging correspondent say what rate of speed a small engine—say, 1½ × 3in., could be caused to attain? Could it be driven by a moderate pressure—say, 10 to 30lb. square inch, at a speed of 1,800 revs. per minute? Is there a limit to the velocity attainable, pressure being provided in any required degree? If an ordinary cylinder could not be driven at this high rate of speed, what kind of a cylinder would be suitable for that purpose? Would someone who possesses an engine approximately of the above size kindly try the experiment so as to ascertain whether a speed of even 1,000 could be attained? **X.**

### DYNAMO.

[24094.]—I shall have much pleasure in giving "Anglo-Dane" (letter 23996) all the information he may require. I am very glad he is not going to make the machine, of which Mr. Bottone gave him some particulars, as it would most certainly have been a failure. "Anglo-Dane" will grasp my meaning when I tell him that the resistance of the armature would have been from 80 to 100 times too high. Apart from the question of resistance, the form of armature described is quite unfit to be used in a large dynamo: to be of any practical use, it must be laminated, and even then the vibration of the armature, caused by the jerk which it receives as each cog passes the ends of the pole pieces, is very annoying if the machine is in a workshop. With regard to "Anglo-Dane's" query (55839) he must remember that if the dimensions of a dynamo are doubled it will hold eight times the weight of wire. A machine to be self-regulating must have shunt and series winding in a certain proportion, which proportion must be determined by experiment; but if the resistance of the armature is low, a shunt-wound machine will be self-regulating within certain limits. For instance, if 25 per cent. of the lamps were turned off, the rest would not be materially affected with the addition to the machine of a resistance the amount of which could be varied by an attendant. The machine could be made to light any number of lamps, from one to the largest number the machine will light. I will next week send some leading dimensions of a machine which will light any number of 20-c.p. lamps up to thirty, which number might be easily carried to fifty or even sixty if the dynamo is only required to run a short time—say, for two hours; but, of course, in practice it is not usual to run a dynamo up to its full power, and I only mention the fact to show that I do not overrate the capabilities of the machine in mentioning thirty lamps as its useful output. I may mention now that the armature will be 8in. diameter by 8in. broad, and that it will have only one layer of wire on it. The core of the armature and the iron of field magnets will be very massive, so as to obtain an intensely powerful field in which to rotate the armature. I have been much amused by the correspondence which has taken place in connection with laminated armatures. I can assure the readers of the "E. M." that after taking into consideration the extra trouble required to wind it, the laminated Siemens H armature is still by far the best armature to use either as a dynamo or as a motor. Mr. Chaster, in letter 24041, is no doubt very funny; but at the same time not very scientific. Mr. Walker evidently made a mistake, either in the number of discs on the shaft, or, what is more probable, in their thickness, and out of this slight mistake Mr. Chaster tries to make a case against laminated armatures. Readers must be aware that the 150 discs would not be perfectly flat, and so, when put on the spindle, would be springy, and would naturally require a considerable amount of screwing up before they would be perfectly flat and square one against another. In his last article on motor construction, Mr. Chaster makes two statements I should like explained—first, what is carburetted annealed iron. I always understood that the purer the iron the less carbon it contained; and also, what is this battery that ran Mr. Jones's armature for several hours without suffering any diminution of strength. Perhaps it will be described in an early number, and then we shall probably read that this wonderful battery is manufactured by So-and-so, by Mr. Chaster's kind permit.

Coventry. **W. H. Eaves.**

## LAMINATED ARMATURES.

[24095.]—I am very sorry to see letter 24041, by Mr. J. Chaster. In the first place, referring to my letter, 23410, Vol. XL., the 150 discs mentioned therein should have read 110: this is probably a misprint, which had certainly escaped my observation until Mr. W. Chaster called my attention to it. I have also overlooked the query 54934, Vol. XL., and the reply of "Cyrax." I take this opportunity of apologising to these gentlemen, as a serious illness at that time prevented me from exhausting the pages of the "E. M." so completely as it is my usual custom to do.

Now, as to the 1in. compression, I will endeavour to render the mystery so palpably clear that even Mr. Chaster may admit the *possibility* of the established fact that such compression is not only necessary, but easily performed. The discs, or strips, forming the armature according to my design, were stamped out of best charcoal sheet iron, and everyone who has had any experience with such stamped pieces of metal, knows that although the thickness of each disc may be $\frac{1}{20}$in., it requires considerable pressure to force 20 discs within the space of one inch, by reason of the distortion of the iron during the operation of stamping.

I find, in practice, that 110 discs $\frac{1}{20}$in. in thickness, occupy 6½in. to 7in. of spindle before screwing up. Perhaps the makers of some of these small laminated armatures may verify my assertion. I still maintain that the cross form of armature, when wound with four coils, is highly efficient as a motor, and wound with two coils is a good dynamo, certainly far more efficient than the solid H form, and with either method of winding holds sufficient wire for the purpose. I believe I am the originator of the lamination of these small armatures; and, according to Mr. Bottone's recent test, it appears to have been a step in the right direction.

I am compelled to deal with that portion of Mr. Chaster's letter which reflects upon me personally in a somewhat sterner manner. He, taking advantage of the coincidence that Mr. Harcourt apparently resides in the same district as myself, insinuates that we are in collusion, and hints at the existence of a "clique." I can assure Mr. Chaster that, to the best of my knowledge, I have never seen nor spoken to Mr. Harcourt; and, further, that any matter contributed by me to these pages during the past sixteen years has been of a *purely disinterested* character, and not *directly or indirectly as a means of gain to myself*. My purpose has been simply to contribute my humble quota to the mutual good fellowship that has so long existed between the readers of "Ours," and has justly earned for the English Mechanic that familiar appellative.

My professional reputation as a practical engineer of considerable experience does not require the support of a "clique," and I am thankful to say is established upon a basis too firm to be shaken by Mr. Chaster's innuendoes.

**Fredk. Walker.**

36, Spondon-road, Tottenham, April 6.

## THE MUSICAL SCALE.—TO "A. S. L."

[24096.]—You have misunderstood the tables of intervals given by me on p. 11. They are the complete set of notes required for just intonation in the major, and all the minor scales on the keynote C. When these intervals are remeasured from other keynotes, three new sounds are required in the scales for every flat or sharp remove, and for this reason about forty-two sounds in the octave are required by the musical ear for all the keys in modern use. Our instruments with but twelve sounds in the octave cannot, therefore, give the notes with "the ratios as determined by the musical ear," and here equal temperament is called in that all keys may be played in with equal facility and incorrectness, and this is a method of pretending to play in all keys, and, in reality, playing in none, simply to save trouble. What would be said of a sculptor who made the fingers of his models all the same length simply to save trouble?

Before some of the great composers advocated equal temperament, these imperfect instruments (piano, harmonium, organ, &c.) were only used in a very limited number of keys, being tuned on an unequal temperament principle where some five or six keys were much nearer perfection, and the rest left with errors so intolerable that they were seldom used. I suppose no one would go so far as to say that these masters of song would have advocated equal temperament, had they had the choice of just intonation on these instruments; but they felt their genius bound down and restricted when writing with such a limited number of keys at command. It might be that, having a faith in the achievements of mechanical science in the future, they were content to put up with the errors of equal temperament, knowing that some day their music would be interpreted by just intonation. Is not the time at hand when just intonation can compete with equal temperament for facility of execution and completely outrival it in every other musical requirement?

This equal temperament consists in taking for the note used as C sh. and D fl., a measure which is such a fraction of C that its square will give the measure of D, its cube the measure of D sh. or E fl., its fourth power the measure of E, and so on until its twelfth power gives the measure of upper C, which must be exactly one-half of the lower C, and this octave is the only interval musically correct. It naturally follows that these notes are in most complicated relations to each other, and so do not fulfil the first requirement of true music—viz., simplicity of ratio between the notes of the scale; but this is secured if the scale be evolved by the process set forth on p. 10, No. 1,041.

Another way of putting it is this: Thirteen notes from C to C, or from any other keynote to its octave, are made to stand at the following proportions:—1, $\sqrt[12]{\frac{1}{2}}$, $(\sqrt[12]{\frac{1}{2}})^2$, $(\sqrt[12]{\frac{1}{2}})^3$, $(\sqrt[12]{\frac{1}{2}})^4$, $(\sqrt[12]{\frac{1}{2}})^5$, $(\sqrt[12]{\frac{1}{2}})^6$, $(\sqrt[12]{\frac{1}{2}})^7$, $(\sqrt[12]{\frac{1}{2}})^8$, $(\sqrt[12]{\frac{1}{2}})^9$, $(\sqrt[12]{\frac{1}{2}})^{10}$, $(\sqrt[12]{\frac{1}{2}})^{11}$, $(\sqrt[12]{\frac{1}{2}})^{12}$, or ½, and it would appear that your intermediate curve ordinates are identical with these; but it would be interesting to inquire why the measure for E flat shows a difference from $(\sqrt[12]{\frac{1}{2}})^3$. You will note that the measure for F sharp, the tritone both in the curve ordinates and equal temperament is an attempt at the square root of ½ or $(\sqrt[12]{\frac{1}{2}})^6$, but the musical mission of F sharp is not thus to lie intermediately between the extremes of the scale; but in its nearest relationship to the key of C to act as the leading note to the scale on G, and so must be $\frac{8}{15} \times \frac{4}{3} = \frac{32}{45}$ or ·7 $\pi$.

The following table contrasts the true notes in the key of C, with the equal-temperament notes, and your curve ordinates. The flats correctly have a place in the minor scales; but the sharps do not belong to the key of C, being signs of modulation into other keys, so in every instance I give these as the measures of the leading notes to the natural tones above:—

| | True measures. | Equal temperamnt. | Curve ordinates. |
|---|---|---|---|
| C .......... | ·5 | ·5000000 | ·5000 |
| B .......... | $\cdot 53\dot{3}$ | ·5297316 | ·5297 |
| B fl. acute .. | ·555 | ·5612310 | ·5613 |
| B fl. grave.. | ·5625 | | |
| A sh. ...... | $\cdot 56\overline{88}$ | | |
| A .......... | .6 | ·5946036 | ·5946 |
| A fl. ...... | ·625 | ·6299605 | ·6299 |
| G sh. ...... | ·64 | | |
| G .......... | ·666 | ·6674198 | ·6674 |
| F sh. ...... | $\cdot 7\overline{11}$ | ·7071068 | ·7071 |
| F .......... | ·75 | ·7491535 | ·7491 |
| E .......... | ·8 | ·7937005 | ·7937 |
| E fl......... | $\cdot 8\overline{33}$ | ·8408964 | ·8404 |
| D sh. ...... | $\cdot 85\overline{33}$ | | |
| D acute .... | ·888 | ·8908986 | ·8909 |
| D grave .... | ·9 | | |
| D fl......... | ·9375 | ·9438742 | ·9438 |
| C sh. ...... | ·9481 | | |
| C .......... | 1· | 1·0000000 | 1·0000 |

I notice that "W. H.," page 478, No. 1036, sets A sharp above B flat, and so with all the other sharps and flats; but I hold his method of arriving at the measures by a succession of perfect fifths (or by inversion fourths) to be inaccurate, as no number of perfect fifths can exactly equal any number of octaves. Compare his thirds and sixths with the equal temperament, as given by himself, and you will see the errors are increased rather than diminished; or, better still, tune to his measures, and hear how they sound.

I am so interested in this subject that I have advertised my address this week, and shall be happy to correspond with yourself or any other gentleman similarly interested, as far as my limited time will allow. Our Editor is very kind; but he has many other subjects that equally claim the space he has at disposal.

**S. E. Hunt.**

[24097.]—If this correspondent will compare the curve-ordinates he gives on page 58 with the corresponding monochord-lengths for the scale of *equal temperament* given by Mr. Elphick on page 434, and myself on page 478—both in previous volume,—he will find that they are almost identical, the differences being so slight that they may be set down to error in calculation, or more probably to the inevitable incompleteness of statements in decimals.

March 28. **W. Hardie.**

## CUTTING SCREW-THREADS.

[24098.]—Dr. Edmunds will see from my last note (acknowledged only in No. 1,045) that I agree with himself as to the importance of the deformation, or, as he objects to the term, the abnormal form, of his proposed thread. I still think that the position Mr. Wenham conceives himself to have taken up is the same as my own (23973), though it was originally, and is still really, too general and erroneous in being so.

I mentioned the chaser only as an illustration. The main cause of uneven working with a chaser is not quite as Dr. E. (24038) supposes, but is due to the large contact surface or cutting edge. It would, of course, be better to fit the wheel to the bit that cut the chaser, the which would probably (Mr. W. notwithstanding) have been finished by a rotating lap. The chaser acts as an illustration, on account of its being axial on its cutting edge, not normal, as a V-point tool.

The variation from the normal to the axial in base width, though I had thought of it, was not the matter I wished to point out; quantitated, it is very slight. And I also agree that the stress on thread on a mandrel nose is normal. My long phrase simply meant "axial section."

The point with myself is that, whereas the thread is spoken of as 50°, neither section—axial or normal—is truly so; but the section of the groove or nut-thread has a true 50° normal section. If nut and nose are to be alike, it is necessary to have the 50° or other angle *axial*.

If the *nose* is preferred with the true angle normal, the cutter may easily be shaped as mentioned in my last, or a 50° *grooved* lap to operate *on* the nose thread, and not in the space, may be used—perhaps the simpler-made tool. But, as also before stated, the abnormal original thread has its advantages of being more upright and thicker-topped, the nuts being many, and the nose one to wear.

Dr. E. will, perhaps, see that it is not by any means necessary that "the normal cross section of a spiral thread will, in all cases, be a portion of a spiral surface;" it is easily in nut or screw made a straight line. The *normal* is, of course, spiral when the *axial* is straight, as should be the case for both.

In saying that "the stress borne by a screw-thread is not axial but normal, inasmuch as it is resolved into its component parts," it appears to myself that a reversal of the reason has been made. The theoretical stress on a screw-thread is, no doubt, normal; but the reason is that the longitudinal and transverse stresses compounded have a resultant coinciding with the normal. Practically, however, the stress is reduced by friction to a longitudinal one; this I have often seen in bolts broken or stripped in situ, no trace of torsional action being observable, or shifting of the nut or bolt taking place before rupture. Perhaps the grain of the material is largely the cause.

**Vulcan.**

## ALARUM CLOCKS ADAPTED TO THE USE OF EXPERIMENTERS AND OTHERS.

[24099.]—I am desirous of calling the attention of manufacturers of alarum clocks and watches to a great *desideratum*. Ordinary alarum clocks are made with a view to sounding a lengthy and startling noise many hours after being set, and with a rough approximation to correctness—that is to say, such a clock would not be judged defective though it went off a few minutes before or after the time intended. But an immense boon to most of us would be a form of the instrument which, though only capable of being set for moderate intervals of time—say, less than half an hour—could be depended upon to go off within a few seconds of the intended time. A loud, long-continued sound would be quite unnecessary in such an instrument; one stroke upon a small bell would be sufficient, as the object is to call attention, not to awaken the sleeper.

It would be an endless task to attempt to point out the various uses of such a time-warner or *monitor*. The experimentalist, the photograper, the astronomer, each so often requires that his attention shall be directed to an operation, say, in 3, 5, 7 or other number of minutes. Afraid of overlooking this, he, in the absence of such a *monitor*, has simply to waste these minutes, for he feels the danger of settling to any engrossing work; but had he the "monitor" by his side, or in his pocket, no minute need be unemployed. And even to the non-scientific individual the monitor would be a boon. How often, for instance, we have everything ready, it may be, to start from home to fulfil an engagement; but find we have ten minutes or so to wait. These we probably squander by glancing over a newspaper, or, it may happen, we light upon a subject so interesting that the minutes fly past unheeded, and we start up to find we are too late. Descending to a still commoner illustration, how tiresome to watch the clock, or even the sand-glass, when boiling an egg! I fancy it is sufficient to propound the question of the usefulness of such a companion to have acquiescence all round.

The "monitor" might be brought out in two or three useful forms:—

1st. A cheap one to stand on a table, or hang on a wall, of a size to provide for good rough workmanship.

2nd. A portable instrument like a watch.

3rd. Watch and monitor combined. **Abacus.**

## REPLIES TO QUERIES.

*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[54825.]—**Salt, &c.**—"Backwoodsman," in reply to this question, seems to dispute "Dens's" assertion as to the non-reproduction of the cereals from their own seed in their wild and uncultivated state. I have before me (*Sunday at Home* for 1878, p. 520) a very interesting and instructive paper on this subject by Alexander Harvey, M.D., Professor of Materia Medica in the University of Aberdeen, which deserves "Backwoodsman's" perusal. It is compiled under the following headings:—1. What are the Cereals? 2. The Cereals are all Annuals. 3. The Cereals, Artificial Plants only Produced under Cultivation. 4. The Original or Uncultivated Form of the Corn-plants Unknown. 5. The Cereals do not Revert to any Natural or Uncultivated Type. 6. The Cereals do not Reproduce Themselves and Multiply by Natural Agencies. 7. Cereals Speedily die out if not Under Culture. 8. The Cereals being Artificial Plants, require Artificial Soil or "Agricultural" Help. 9. The Cultivation of Cereals not a Natural Discovery, but Taught to Man and Continued by Tradition. 10. The Cereals given by God to Man for Food, and their Cultivation Appointed. It is, I think, clearly proved from this, and supported by authorities, such as Prof. Balfour, Mr. A. Stephen Wilson, Prof. Lindley, Prof. Bentley, and others, that the cereals are dependent, next to the increase from a higher power, upon the will and efforts of man, and man, too, in his civilised and enlightened state; and this, too, will probably go far to meet the question now going forward in the pages of "ours" upon "The State of Man." Prof. Harvey says: "Nature alone sufficeth for all the brute orders around us, but not for man. This is, physiologically, demonstrable; and it is as certain as anything can be (because it could not have been otherwise), that the primitive ancestors of our race came into the world civilised, or became, or were made civilised from the first. The savage races now existing are, as Archbishop Whately has shown, the remnants of races once civilised, but long since degraded, and now incapable of themselves of taking the first step towards regaining the lost civilisation."—Marienberg.

[55219.]—**Edges of old Violin Splintering.**—Give the edges a coat of thin glue, rubbing it well into the interstices. Sponge off the superfluous glue when dry. I treated an old Cremona in this way very successfully.—Thos. Lisle.

[55723.]—**Gramme Dynamo.**—To Mr. S. Bottone.—Wind the ring with about 1½lb. No. 18 double cotton covered, and the fields with about 6lb. of No. 16. A wooden hub is keyed to shaft, this is slightly coned down, and forced into wound ring, and cemented with good electrical cement. Probable lighting power at 1,400 revolutions, about 6 ten-candle lamps.—S. Bottone.

[55843.]—**Photo-Micrography.**—Now you are able to get clean plates, the rest is comparatively easy; in all probability you do as many other amateurs, and develop too quickly. Begin by giving 8 or 10 seconds exposure with your ¼in. objective, proceed to develop; notice whether the picture appears nearly directly and "greys" all over, or whether it takes more than one minute to appear. In the former case, diminish the exposure to 5 seconds; in the latter increase it to 20. Now, in developing, leave the plate in the solution until the image is visible at the back of the plate; rock continuously. By such treatment the plates should require no redevelopment.—S. Bottone.

[55870.]—**Optics with the Lantern.**—To Mr. L. Wright.—I am much obliged to you for your offer. I am sorry to say I am far from London, but expect to be there in a week or two. May I then call on you in person, if the Editor will allow me to have your address by calling at the office of English Mechanic? I am anxious to see "Excelsior's" promised letter.—S.

[55932.]—**Plating Dynamo.**—If you wish to overcome your difficulty you must go to work methodically: 1, ascertain the resistance of your plating bath in ordinary working condition; 2, test the exact resistance of dynamo; 3, measure its E.M.F. at the speed most convenient for you to run it at; 4, divide the E.M.F. by the entire resistance. This will give you the actual current in ampères. If the current is not sufficient, remembering that electromotive force of the dynamo increases with the number of turns of the coils, while the current diminishes with the resistance, and bearing also in mind that the most economical work is got out of the machine when the external resistance is equal to that of the entire dynamo, it will be easy for you (with a table of conductivities of different sized wires before you) to decide what alteration you must make in the winding of your dynamo to give the required number of ampères.—S. Bottone.

[55980.]—**Electric Bells.**—This question really refers to the use of the galvanometer. I am not quite sure whether the book issued by Gent, of Leicester, describes the method of testing the work by the galvanometer; but "Novice" would do well to get it, and then look up his back Nos. Culley's "Handbook of Practical Telegraphy" gives full particulars of the methods employed for locating the position of faults. I should think it most likely that those who sell this "Bellfitter's Galvanometer" supply "directions for use" with it.—Nun. Dor.

[55984.]—**Polishing Wood in Lathe.**—This query is not definite. Polishing wood in lathe means putting a very smooth surface on it; but I suspect the querist means varnishing wood in lathe. Brush polish is the article required, and apply it with a piece of cloth or with a brush, if the parts cannot otherwise be reached. I believe some people make it by mixing two parts of French polish with three parts of brown hard varnish.—Essar.

[55986.]—**Battery for Sewing-Machine Motor.**—Use a solution as follows:—Bichromate, 3oz.; sulphuric acid, 9oz.; water one pint. Dissolve the salt in the water, and add the acid very slowly. The battery will, of course, fail after a short time; but to make it do constant work you can arrange the cells so that a circulation of the liquid is kept up. Whether the battery described would work the motor named is quite "up in the clouds," for you see, the motor may be of any size for all you tell us. The best way will be to try.—Nun. Dor.

[55989.]—**Lathes.**—If "Belgian" wants to fit up an overhead motion, he ought to get Vol. XXII., which contains a series of articles by "D. H. G." on the subject. There are several overheads described in back volumes. Perhaps one in No. 586 will suit him.—T. M.

[55999.]—**Elliptical Chuck.**—See illustrated article by Mr. Evans, in No. 850, on oval chuck, and several others in back volumes.—T. M.

[56015.]—**Steam Hammer Valve.**—I am afraid that there are not enough readers anxious to make steam hammers to warrant me in asking the Editor to append sketches of the valve-motion, which anyone can obtain by procuring the patent specifications. In the automatic hammer the motion to work the valves has been obtained by means of inclined grooves, diametrically opposite each other, which work a brass yoke, whose line of vibration is through central axis of bar. A supplementary valve throttles the exhaust below the piston, and thus provides a cushion of steam, which stops the hammer, if necessary, in the "middle of the stroke." Indeed, it is possible to put an egg into a wineglass, and just break the shell without injuring the glass; but it needs practice.—Essar.

[56025.]—**Trueing Grindstone.**—Let me premise a few words. "E. M." says: "The action is more important than the name"—i.e., than the name of the material to be used as the point of the turning tool. This is far from being so—for, 1st, he would find the cost of the diamond (gem) prohibitive; and, 2nd, he would "rate" me roundly if I mixed up the two things, especially when he found that the expense was so great in the one case as to render the idea "practically useless"; whereas if he had attended to the proper name of the point for the tool, he would find it effective. Again, let me say that I have seen a diamond (gem) used for turning emery wheels to size, truth, and shape. In this case the diamond was set in the end of a soft steel bar, and held by the soft steel bar being pressed on to it (I forget the name for this operation), in the same way that the gold in setting a diamond ring is pressed on to the diamond to hold it in. Again, speaking from my own observation, I have seen the extraordinary action of the emery cut off by the diamond (gem) tool—viz., it actually, by the friction of the emery flying off from the velocity of rotation, cut the steel tool away! Again, the diamond (gem) tool for "trueing up" the emery wheels was advertised and sold by the emery-wheel manufacturers. Now I believe that as carbonado *will*, from my *own* knowledge—

1. Cut hardened steel.
2. Cut millstone grit.
3. Cut out the teeth of a file from end to end.
4. When powdered act almost as well as the powder of the gem diamond or the powder of bort (the impure gem),

it will, without a doubt, turn a round or hollow face on an emery wheel. The tool would be used dry, unless the operation made the emery wheel soft by heat, when water could be used without detriment to the tool. In other words, water might be necessary for the thing operated on, but not for the tool. "E. M." asks as to speed. Surely this is not very important—I mean the speed of the emery wheel. Again, it depends on the size, for "E. M." does not ask "surface speed," and if he had done so I should have given the same answer, but with this caution, "Recollect, you have a brittle tool." Where can carbonado be obtained? says "E. M."—Answer: Advertise in the "E. M." "E. M." says "selection." This I have adverted to in a former letter. Get, if you can, the small natural pieces, and not pieces of a larger piece; you want the natural crust. "E. M." asks price. It used to be about 2s. 6d. to 3s., the size of a pea—a small one. Present price I cannot say; but as it is much used for rock drills instead of the diamond (gem), I daresay the price has gone up. I will now give my plan of 1869 for holding the carbonado in the tool, which I used for turning hardened steel—hardened as hard as fire and water could make it. In 1869 I said, in a letter to "Ours": "Take a piece of steel or iron, size and shape of an ordinary slide-rest tool. At the end (or at the side, if for cutting inside a cylinder), bore a hole very little larger than the piece of carbonado to be used (I made use of a small piece of irregular shape). Then heat the end of the steel or iron. Having put in soldering liquid, add solder till it is full, and nice and liquid, then insert the carbonado, taking care to leave a point uppermost, and protruding very slightly beyond the steel or iron. Cool whilst holding the carbonado." In "Ours" of January, 1869, "Use as an ordinary tool, but with care, as the tool is brittle." I used the tool in 1869 to true up a hard, close-grained Welsh grindstone. An ordinary grindstone, as I stated in 1869, it makes short work of. I have intended to fully answer "E. M." If I have not done so, if he will write again, I will endeavour to answer more fully if I can; but I think I have given about all the information I possess.—Z. Y. X.

[56025.]—**Trueing Grindstone.—Patent Law.**—It is evident "Z. Y. X." does not understand why I wrote the reply on p. 66, for he thinks it was specially written for his benefit. Nothing of the kind; it was written for the information of all who cared to read it. If it had been merely a reply to his expressed opinion on p. 40—"there has latterly been a great tendency in 'Ours' to get at trade secrets and the mode of getting round a patent," and his explanation of the prohibition clause in the Letters Patent—it would have characterised the former as nonsense and the latter as incorrect. For the information of those who do me the honour to read and understand what I write, I quote the actual words of the prohibition clause:—"We," &c., "strictly command all our subjects," &c., "that they do not at any time during the continuance of the said term of 14 years, either directly or indirectly *make use of* or put in practice the said invention, or any part of the same, nor in anywise imitate the same, nor make or cause to be made any addition thereto or subtraction therefrom, whereby to pretend themselves the inventors thereof, without the consent, license, or agreement of the said patentee." It will be seen that this is not exactly "Z. Y. X.'s" "making, using, vending, or exercising."—Nun. Dor.

[56041.]—**Gun Metal.**—Thanks to "Nun. Dor."; but, with great deference to him, I still doubt iron being, or forming any part, of true gun metal. I am aware to-day, if not before, that many metals can be mixed together, though the melting power of each is vastly different. I knew (may I add, of course) that when copper and zinc had to be mixed, the copper was melted first, and then the zinc added; but then, as "Nun. Dor." says, special precautions must be taken not to lose zinc. Now, iron does form part of the component parts of "Delta metal," and, as "Nun. Dor." says, of many other alloys. Now, my letter was confined to gun metal, and not to alloys generally. I must repeat as to back volumes, I cannot refer to them, though I have been a subscriber since before 1869, and pay for an extra copy for a country coffee house. My copies go to the hospital, near my house, for the amusement of the patients.—Z. Y. X.

[56087.]—**Dynamo.**—1st. A shunt-wound dynamo, with fine wire, would give a current of high E.M.F. with a small current. This would probably be the cause of the failure of "Naval's" dynamo in producing large sparks from his coil, also the high tension of the current would be liable to produce leakage. 2nd. The position of the brushes should be such that when the iron cheeks of the armature are opposite the faces of the pole pieces of the field-magnets, then the brushes should be resting on the slit of the commutator.—S. Bottone.

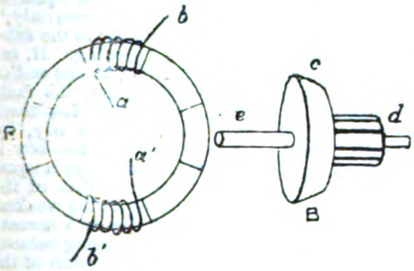
[56102.]—**To Mr. Lancaster, or Mr. Bottone.**—Use about 50 sheets of tinfoil, 4in. by 5in., separated by sheets of paraffined paper. Connect 1, 3, 5, 7, &c., all together on one side, and 2, 4, 6, 8, &c., on the other. Join one set to the pillar supporting the vibrating hammer, and the other to the pillar carrying the platinum screw.—S. Bottone.

[56112.]—**Testing for Arsenic in Wall Paper.**—In reading Mr. J. Kean's reply to the above query, I observed that he overlooked the fact that the presence of antimony would give almost, I may say exactly, the same results; that is to one who had neither made the experiment or seen it performed. I think Mr. Kean should have pointed out this fact; and also how to distinguish one from the other. Of course, a practical man would know that arseniuretted hydrogen burns with a bluish flame, whilst antimoniuretted hydrogen burns with a bluish-green flame; also that the mirror in the tube would form, in the case of arsenic, at a greater distance from the heated part of the tube (owing to it being more volatile than antimony) than the antimony, the antimony mirror being formed close to the frame, whilst that of the arsenic is some distance off; but I don't suppose that any chemist would care to give a certificate of analysis showing the presence of arsenic on the strength of the black stain as described by Mr. Kean, even when coupled with the preceding observations; but would, at least, substantiate his results by at least one confirmatory test. The simplest and readiest way to distinguish arsenic from antimony is to add a few drops of sodic hypochlorite to the black film on the porcelain, when, if the film is arsenic, it will be rapidly dissolved. If antimony, it will remain undissolved.—R. FORREST.

[56112.] — **Testing for Arsenic in Wall Paper.**—Let "J. K." take a piece of the suspected paper, about 2in. square, and soak it in as much strong liquid ammonia as will cover it, then, after removing the paper, add a crystal of nitrate of silver, and if it turns a distinct canary colour As is present. I think "J. K." will find the above much simpler than the test given by J. Keen, owing to the difficulty of obtaining zinc free from arsenic. —STUD.INST.C.E.

[56114.] — **Electro-plating Dynamo.** — Your question is rather ambiguous. Do you want to know what E.M.F. and what number of amps you ought to have for plating? or do you want to know what E.M.F. your dynamo as wound will give? In the latter case much will depend on the speed at which you drive; but such a machine would give from 30 to 60 volts., and a current (on short circuit) of from 60 to 120 amps.—S. BOTTONE.

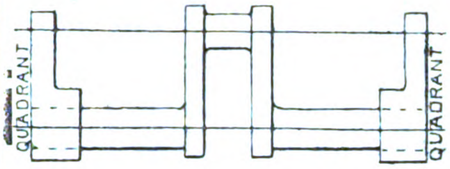
[56117.]—**Pacinotti Ring.**—To MR. BOTTONE. —Suppose your ring is to be wound in eight sections. Start all your windings on the same side of the ring, as shown at R. Let your endings all look the same way.



When all the sections are wound, a shaft *e* (see B), to which is keyed a hub *c*, and an eight-leaved commutator *d*, is driven in the ring and cemented to it. The ends of the wires *b b'*, &c., are connected to the strips on the commutator, while each beginning wire *a a'*, is connected to the wire diametrically opposite to it, and not to the commutator at all.—S. BOTTONE.

[56123.]—**Wire for Dynamo.**—To MR. BOTTONE.—About 4lb. on each leg would do very well. E.M.F. about 40 volts; current about 16 ampères. You might light six tens in parallel.—S. BOTTONE.

[56127.] — **Turning Small Cranks and Setting Lathe Heads.**—In crank forgings, that part intended for the pin and crank is usually forged as a solid web. The forging is next marked off as follows:—Scribe a centre line along one side and across the ends of the shaft, and a second one across the web for the centre line of pin. Mark off the size of pin and width between "jaws" of crank upon the web; then cut away the part not required out of the web. Perhaps the best way to accomplish this in such small cranks would be to drill a hole through the "web" near the pin, and then saw the piece out, taking care, however, to keep well clear of the marks, so as to allow for machining. Next, mount the shaft in the lathe, and turn down to about "three-sixteenths" above finished size; after this fit a "quadrant" (as we call them here) on each end of shaft, and fix them firmly by means of keys or set bolts. Now, mark off and carefully drill a "centre" in each "quadrant," measuring from "centre" of shaft—the distance between the "centres" in the shaft and those in the quadrants being equal to the "throw" of crank; and take care that the two centre lines are truly parallel with each other. The whole is then mounted in its new "centres" in the "quadrants" and the pin turned. (I presume it is needless to occupy space to tell you what kind of tools to use in turning the pin?) After turning pin, the "quadrants" are taken off, and the shaft mounted in its own "centres" and finished. But before doing this it will be necessary to fix a "stay" between the "jaws" to prevent the shaft springing out of truth when the back centre is screwed up. I append small sketch, which will doubtless render my remarks somewhat clearer.



I think the easiest way for you to line up your lathe heads parallel with each other would be this:—Start with fixed head; mount a piece of work in chuck, and adjust your lathe head until it turns parallel; then put liners on tenons to suit. For the back head.—Mount a plain cylinder between centres, and adjust headstock so that your lathe will turn it parallel, and notice that it turns parallel both when back centre is well screwed out and also when it is "home" before fixing liners on tenons permanently. If the above information is insufficient, I will supplement it through the post should you care to advertise your address.—AN ENGLISH MECHANIC, Newcastle-on-Tyne, March 29.

[56132.]—**Cutting Iron Pipes.**—I must thank Jno. M. Adams for pointing out an error in my reply to this query. In transcribing the figures I put a 2 for a 6, as one may see by working out the equation. The correct answer should be 24·269ft. Mr. Adams's an wer is in error, as well as his method, and I may return the compliment of being "a' vrang thegither," as "one good turn deserves another," or in Scotch language, of which Mr. Adams is so fond, "you scratch my back and I'll scratch yours."—GEO. F. WALTON.

[56132.]—**Cutting Pipes.**—On page 67 Geo. A. Walton gives an answer to this query which seems founded on a mistake. He assumes that the length of B E (in "M. B. M.'s" diagram, see page 43) is equal to that of B F; but a glance at the figure shows that B E must be shorter, the angle at E being a right angle. But even if the length of B E (which is what "M. B. M." says he wants) were correctly stated, it would not by itself much help in cutting the pipes. In fact, if the diagram represents the way in which "M. B. M." proposes to join the pipes, he is simply trying to accomplish an impossibility. If the pipes are to be cylindrical the two portions could not be joined at the section indicated on the diagram by the line B C. A B C D being "square," the jointing top edge of that piece of pipe is, of course, a circle. But the lower end of the upper pipe which joins on to this being cut slantingly, its section must be an ellipse or oval whose length is B C, and its breadth equal to E F, which is shorter than B C. Now an oval cannot, of course, be fitted on to a circle so as to join all round. If two cylinders are to be joined end to end at an angle, neither of the joining ends must be cut square across, but both must have an equal slope. Having had occasion to cut pasteboard tubes for the purpose of joining the ends at an angle, I have found the following method answer perfectly:—Let A F G D (Fig. 1) represent the tube uncut, A D being equal to the diameter of the tube, and let the angle F C D show the amount of bend we wish to give it at the point C. Measure off F B equal to F C. Draw B C, which will bisect the angle F C D; also B E parallel to F C and equal to C G; then join E F. A B E F C D now represents the longitudinal centre section of our bent tube. Upon and beneath the base A D draw a semicircle and divide its arc into a convenient number of equal parts (the more numerous the better). From the dividing points draw lines 1, 2, 3, &c., parallel to A B, crossing A D, and ending in B C. Now wrap a piece of stout paper tightly round the tube and prick a pin-hole through the two overlapping edges. Then lay this sheet flat, and draw a straight line upon it from one prick-hole to the other. This line is the length of the circumference of the tube (A A, Fig. 2). Divide it into equal parts, twice as many as the semicircle in Fig. 1 was divided into, and upon the division points erect perpendiculars. Of these, make the middle one, D C, equal to D C in Fig. 1; the two next it (one on each side) equal to line No. 1; the next pair outside these equal to line No. 2, and so on to the extreme end perpendiculars, which make equal to A B. Now draw a curve joining the tops of all these perpendiculars, and carefully cut the paper through this curve. If the paper be now wrapped round the tube so that the pinholes again coincide, its curved edge will define the line and plane through which the tube must be cut, which line can be easily marked on the tube by tracing with pencil or otherwise along the curved edge of the paper. When the tube is cut, and one portion turned half-way round, the cut ends will be found to fit exactly when placed together, and the two parts will make the required angle with each other. The measurements of the perpendiculars need not be taken from the line A D (Fig. 1). The same curve will be produced if they are measured from any other line which is parallel to A D. I trust "M. B. M." will be able to adapt the above process to the cutting of his wrought-iron pipes. In the particular case which he states (or, I believe, intends to give) in his diagram, the length of E B is very nearly 24·27ft.; A B should be 9·27ft. (not 10), and the whole length of pipe before cutting need not be more than 34·27ft., not including flanges or overlaps at joinings (see Fig. 1). —W. HARDIE, Joppa.

FIG. 1.

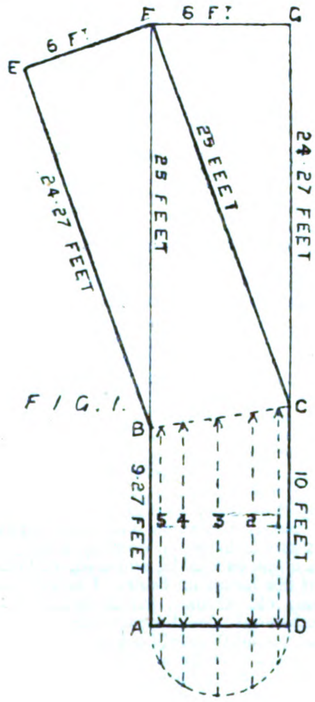
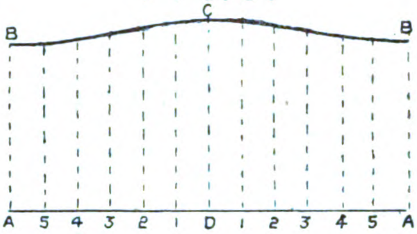
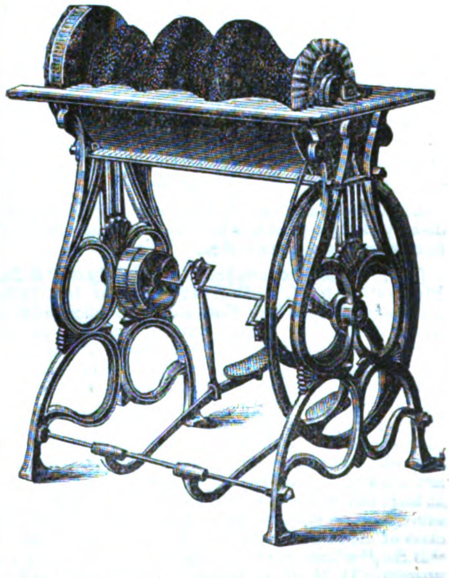


FIG. 2.



[56139.] — **Boot-Cleaning Machine.** — The following, from a French paper, may give the querist an idea; but I believe he can see boot-cleaning machines at work in some of our large hotels:—The principle of an apparatus for polishing boots and shoes dates back to 1838, the epoch at which a machine of this kind was put into use at the Polytechnic School of Paris. Since then it seems that



not many applications have been made of it, notwithstanding the services that a machine of this kind is capable of rendering in barracks, lyceums, hotels, &c. M. Andoye, an inventor, has recently taken up the question again, and has proposed to the Société d'Encouragement a model that gives a practical solution of it. The use of this will allow a notable saving in time and trouble to be effected. This brush (see engraving) revolves on a horizontal axle, supported by a cast-iron frame similar to that of a sewing machine. Motion is communicated to it by a double pedal, which actuates a connecting rod and a system of pulleys. The external surface of the brush contains three channels, in which the foot gear to be polished is successively placed. In the first of these the dust and mud are removed, in the second the blacking is spread on, and in the third the final polish is obtained. In order to guide the blacking to that part of the brush which is to receive it, M. Andoye protects the lower part of the latter by a half-cylinder of sheet iron. On this there is placed a vessel containing the blacking, and into which dips a copper cylinder having a grooved surface. The horizontal axis of this cylinder is movable. When at rest it is so placed that the cylinder is an inch or so below the brush; but when the operator pulls a button that is within reach of his left hand, the axis is lifted, a contact takes place between the brush and the cylinder, and the former is thus given a rotary motion. As the cylinder still continues to dip into the blacking, the latter is thus spread over the brush.—ESSAR.

[56142.]—**Wheatstone's Bridge.**—The querist is quite right; it is an expensive matter to have three sets of resistance coils, and of course if it is for outdoor work, they are really necessary. But for indoor or experimental work they are not; although you must have one or a set to begin with, to make the others by; the same set would be used afterwards to balance the resistance to be measured. I have frequently used uncoppered carbon rods as resistances, same as now cheaply sold for arc lighting. Fix a clamp on one end, and move the other clamp along until the desired resistance is obtained, or if several clamps are fixed on at different distances from the end one, many resistances can be introduced as needed, by merely securing the wire by the binding screw. I have heard that the resistance of carbon varies after the passage of a current through it; but I have never noticed this variation myself. Perhaps it requires a very delicate galvanometer to detect it. If the querist cannot afford German-silver cotton-covered wire, he should get some copper cotton-covered of various sizes, winding reels in different directions; that is to say, one 5ohm left-handed, and the other 5ohm right; when these are joined together as 10ohms, no induction would take place, being differently wound. When not wanted for resistances they could be used for magnets, and a variety of purposes. If he cannot get covered wire he should get several glass tubes varying in length and about $\frac{1}{2}$in. internal diameter. To the one end of each tube fit a cork, first passing through it a copper wire, then fill with water, and put a cork in the other end; before pushing it in, make a hole through the cork so that a stout copper or brass wire will slide tightly through it. When this tube is put in circuit with a battery and galvanometer, moving the wire in or out varies the deflection of the needle, showing the resistance is increased or otherwise; in fact, these tubes are made exactly like the water-regulator to a medical coil. These water resistances I do not think would do for measuring high resistances, because such a number of cells would be used as to cause gas to be given off at the electrodes. In such cases (I think "Sigma" says), turpentine or alcohol have to be substituted. I shall be pleased to give further information, or to answer any question concerning the above.—A.S.T.E. AND M.S.E.

[56165.]—**Weevils.**—Try carbolic acid: it entirely destroyed some insects which appeared in a table of mine some time since.—ASA.

[56170.]—**Microscopical.**—The reply of "B.Sc. Plymouth," to H. T. Barnett is, I fear, but little calculated to give him that sound practical advice which he desires. "B.Sc." surely ought to know, and had he had practical experience would have known, that the people who "make condensers, test plates, and diatoms their hobby," are the very people who do *not* go in for binoculars, for the simple reason that in nine out of every ten cases they are of no earthly use to them, working, as they almost exclusively do, with high powers which are not suitable for use with the binocular at all, at least not with the usual Wenham form; and the same remark holds good with histologists and the class of men like Pasteur and others mentioned by "B.Sc.," whose work lies almost entirely with high powers. If H. T. B. intends to confine himself to either of these lines of study, then, no doubt, a monocular is the stand for him; but if he desires to study with his microscope in a more general way the beauties of natural history—such, for example, as the foraminiferæ, which subject Dr. Carpenter has made so much his own, the eggs of insects, the pollens, the lichens, the ferns, the mosses, and the thousand other objects requiring chiefly low or medium powers (and much useful work has been done with such powers), then, like Dr. Carpenter, he will find the binocular a comfort, a pleasure, and a help. H. T. B. would do well to keep before him the fact that, possessed of a binocular, he can in a moment convert it into a monocular by an adjustment of the prism, and will so be enabled to follow the whole range of microscopic observations, using his instrument as either a binocular or monocular, as may be best suited to the particular object he wishes to examine. One piece of advice, however, which "B.Sc." offers, I highly commend —viz., study Carpenter and Beale on the subject. In the last edition of the former author's book, he will find, at page 81, the following: "The value of stereoscopic binocular vision in scientific investigations being now admitted by all who have really worked with it upon suitable objects, the author would earnestly recommend everyone about to provide himself with even a second-class microscope, to incur the small expense of the binocular addition." This expense, from a catalogue of Crouch's student's binocular now before me, amounts to just 40s. over the monocular form of the same instrument, and I may say from long experience, that after he has once adjusted his instrument to the width of his eyes, it is not only not troublesome to use, but is much more comfortable in use, by an avoidance of the strain upon the left eye whilst looking down the right tube with only one eye. In the earlier chapters of Carpenter on the microscope, he will find the question of binocular vision discussed in a calm and scientific manner, and with an entire avoidance of that most undesirable practice of sneering at one class of observers because forsooth they do not happen to follow the particular line most favoured by another class. Let such sneerers remember that the honoured president of the Royal Microscopical Society, Dr. Dallinger, was, and is, one of the school who make condensers, test slides, and diatoms their hobby, and that to the patience and manipulative skill acquired in that school is largely due the wonderful discoveries he has made in a field of inquiry lying on the very boundary line of life, and also that the requirements of that school have largely contributed to the marvellous improvements in our modern object-glasses.—W. P. OLDHAM.

[56170.]—**Microscopical.**—"B.Sc., Plymouth," divides microscopists into two classes, the brass and glass school, and those who use the instrument as a means to an end; and he defines that end as "knowledge with a view to benefiting the human race," which is, to say the least of it, a philanthropic view of the aims of the gentlemen he names. But let that pass. I venture to state there is another class much larger than either or both of the others, who also use the microscope as a means to an end, and that end is the pleasure derived from the acquisition of knowledge. To this class belong the great army of all-round microscopists—those who delight in investigating the secrets of nature, not in one direction only, but in many directions, and not with any direct expectation of benefiting mankind by their studies, but with the (I must admit) inferior aim of deriving pleasure and instruction for themselves. To this class I maintain that a binocular microscope is of as much importance as a pair of spectacles with two glasses instead of only one is to a person whose sight is failing. The latter can read with one glass perfectly well, but certainly not with anything like the same degree of comfort or pleasure. So with the monocular microscope. You can see objects perfectly well with it, and when using high powers must perforce convert your binocular into a monocular for the time; but when examining larger objects, such as insects and botanical objects, I maintain that the use of the binocular gives a far juster conception of the object as it is than the monocular. In fact, there is exactly the same difference between the two as there is between viewing a large object, such as a house or a table, and a perfectly accurate picture of the house or table. I know I am only going over old ground, threshing matters pretty well threshed out; but I see no reason why we all-round microscopists should not enjoy our binoculars in peace, leaving to those whose delight is in the resolution of a diatom marking, or the discovery of the flagella on a microbe, the pleasure of using monoculars only, if so disposed. Neither do I think we are worthy of the sneers often implied—I do not say by "B.Sc.,"—because we have neither the desire, nor, if we had the talent, the means, to pursue with success special investigations.—A BINOCULAR M.D.

[56170.]—**Monocular v. Binocular.**—It seems to me that "R. D. R." and "B.Sc., Plymouth," are mistaken in thinking there can be two opinions about this matter. Each is best in its own department. The question is similar to a horological one of chronometer and lever escapement. The lever is by far more suitable for the pocket; but no one would think of fitting it in a ship's watch. Wenham's binocular is more suitable than the monocular for low powers up to 1in. or $\frac{2}{3}$; but no one would think of examining the cholera bacillus with it. I do not say there is no loss of definition with the binocular; but I do say that such loss is quite inappreciable in that class of objects which is suitable for a binocular, and for which the stereoscopic effect is of paramount importance. I confess that I "make microscopes, condensers, test plates, and diatoms my hobby," but I should as soon think of carrying a regulator on my back, instead of a watch in my pocket, to tell the time by, as of investigating the surface-markings on diatoms with a binocular. With regard to "R. D. R.'s" last paragraph, I should think that the excellent work achieved by the Rev. Dr. Dallinger, F.R.S., is in some measure at least due to his having devoted himself in no small degree to the diatom and test object work. Several letters have appeared in these columns advocating the use of short tubes à la Continental model. In the first place, an object-glass corrected for a long tube will not perform correctly in a short tube, and vice versâ. Secondly, in order to maintain the same magnification with a short tube as with a long one, a deeper eyepiece must be used—e.g., it takes Zeiss's Nos. 3 and 5 eyepieces on the short tube to equal the A and C on the English standard respectively. There is no doubt about the disadvantage of deep eyepieces. It is this which handicaps small telescopes and dumpies so much. Just imagine comparing a 12ft. telescope stopped down to 3in., and a 3ft. telescope of 3in. aperture. In order to get a power of 144 in both cases, you would have to use a 1in. eyepiece in one case and $\frac{1}{4}$in. in the other. If the two telescopes came out alike, it would only show how much superior the small one was in reality. Speaking of telescopes, I saw a very remarkable old telescope the other day. Aperture of object-glass, $\frac{5}{8}$in.; focus, 12$\frac{1}{2}$in.; object-glass, a single lens unequal convex (nearly plano-convex). The eyepiece consisted of three bi-convex. The mount the old-fashioned mahogany polygonal tube.—EDWARD M. NELSON.

[56183.]—**Force in Motion.**—In the "E. M." of March 27, "Yama" says, "The rope with a horse pulling at each end will be strained equal to the pull of the strongest of the two horses only," and as I do not see that mistake noticed in the subsequent number, I venture the following. If, instead of horses, we place a little boy at one end of the rope and a strong man at the other, the facts may perhaps be more easily traced. Let them both pull, and the man will drag the boy, by exerting a fraction more effort than the boy is capable of doing, and the strain on the rope is equal to the boy's strength only, and not that of the man. Should not "Yama" have said the weakest instead of the "strongest" of the two horses? Again, his illustration by means of a spring balance is good, but he seems to have miscalled some of the parts. Should not the wall to which the apparatus is hooked represent the strong horse, the spring the rope, and the limited weight of 112lb. the weaker horse? Then we have: 1st, the weight (weak horse) doing all it can; 2nd, the spring (rope) indicating a strain equal to the weak horse or weight; 3rd, the wall (strong horse) capable of resisting much more strain, but unable, in this case, to do so, because the weight, or weak horse, is incapable of exerting it.—ACIER.

[56186.]—**Gum for Micro. Slides.**—Querist asks what is the cement used for postage stamps. I believe it is dextrine, a product obtained by heating starch in the dry state. It is obtainable at the chemists, and is much more convenient for use than gum, being more readily dissolved in water.—M. D.

[56187.]—**To Mr. Bottone.**—By rewinding with finer wire, you have placed more resistance in the way, hence have rendered greater battery power requisite, and will suffer from greater heating effects. Better fill your armature channel with 4oz. or 6oz. of No. 20 double cotton covered, and from 1lb. to 1$\frac{1}{2}$lb. of No. 16 c.c. on the fields. Be careful that the insulator is perfect. Six quart bichromates would give about $\frac{1}{2}$ h.p.—S. BOTTONE.

[56207.]—**Clock Repairing.**—Get a piece of watch mainspring the width of the pallets, and of ordinary thickness, grind away the faces of the pallets a little more than the thickness of the mainspring, then tin-solder the pieces of mainspring to the pallets, square off the edges, and polish the faces.—PENWITH.

[56214.]—**Christofle** — Is German silver, an an alloy of copper, tin, zinc, and a little arsenic. No silver enters into its composition; but Messrs. Christofle, in Paris, used it as the basis of their electro-plated ware: hence the name.—S. BOTTONE.

[56206.]—**Teeth of Wheels.**—Having drawn the pitch circle, and divided it into the number of teeth required, draw from one of these divisions a radius, as A B in Fig. 1. Bisect A B in C, and with C B as a radius describe the semicircle A D B. Bisect C B, in E, and from centre B, with radius B E, draw an arc cutting the semicircle

A D B in F. From A, with radius A F draw the circle G F H, from which the faces of the teeth are to be drawn, with a distance equal to F B. The instrument to which you refer is shown in Fig. 2.

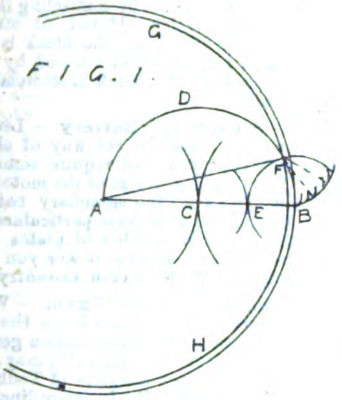


FIG. 1.

The angle is one of 75° 30′, and one of the sides is divided into quarter-inches as shown. To use it, place the plain side upon the radius, with the point touching the pitch circle. The radius for the circle of centres, and the radius for the profile of the tooth

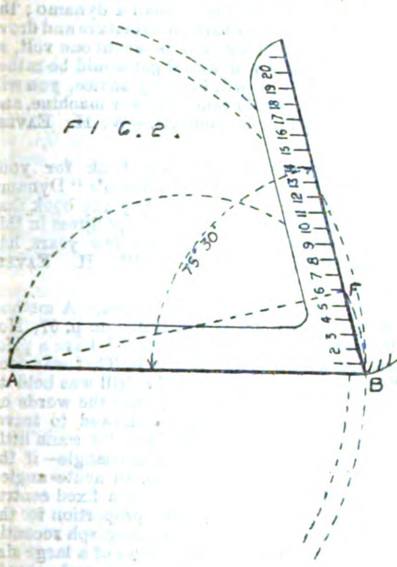
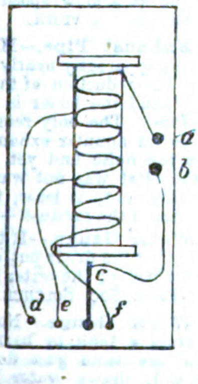


FIG. 2.

will be found on the graduated edge *e g*. If the radius A B equal 6in., the point F will be found at the sixth mark from B. I don't know the cost of this instrument here; but in the U.S. they cost 2 dols. 50 cents. I made the one I have at a less figure than that; but I seldom use it, as the above rule is so easily applied.—AREFES.

[56219.]—**Edges of Old Violin Belly Splintering.**—Here is a recipe I think will suit you very well. I had it from an old violin maker. Take of gum juniper 4oz., seed-lac 2oz., mastic 2oz., choice benzoin 2oz., Venice turpentine 2oz., rectified spirits of wine 1 quart. Put the whole into a bottle and let it stand for three days, giving it a shake up as often as you like, and it will then be ready for use.—JIM.

[56220.]—**Medical Coil.**—In answer to "Electric" about his coil, he must have two binding screws *a* and *b* for the handles of his coil to be connected to. The beginning of the secondary coil goes to one of these *a*, the other, *b*, goes to the switch *c*. The three studs *d e* and *f* are connected in the following manner: *d* is connected to the middle of the secondary coil, *e* is connected three quarters of the way through secondary, and *f* is connected to the end of secondary, thus enabling "Electric" to alter the power of his coil. The sketch only shows roughly the winding of the secondary coil. Of course, there is much more wire.—TOBY.



[56221.]—**Blue Shadow.**—Presuming that the light of the obscured sun or of the gas flame was reddish yellow, and that what light there was in the shadows was faint white, three possible explanations occur. 1. The shadows appeared blue by contrast. 2. The eye was fatigued to the yellow, and was therefore more sensitive to its complementary, the blue component of the white in the shadows. 3. In faint light the eye is said to be naturally more sensitive to rays of the higher degrees of refrangibility; hence the blue component would be more conspicuous in the faint white of the shadows.—J. BROWN, Belfast.

[56223.]—**Dynamo.**—TO MR. BOTTONE AND OTHERS.—See reply 55723.—S. BOTTONE.

[56227.]—**Vacuum.**—"Nearly a perfect vacuum" is only practically to be obtained by an air-pump—i.e., an exhaust pump. There are other means of doing it, but the above is the most practical. The outside pressure will be (according to the barometric pressure at each moment of time) 15lb. per square inch, or somewhat less. Barometer at abnormal height of 31in. then just 15lb.; if at 28in., then much less than 15lb. Pressure equal on all sides of vessel, top, bottom, and sides. A square vessel of 1ft. cube, with a nearly perfect vacuum, would collapse unless very strongly made. Each side would have a pressure of, say, 2,160lb. thus: 12 × 12 = 144 × 15 = 2,160lb., or nearly one ton. The area of each side, if increased to 13in., would give 2,535lb., or much more than one ton, which is 2,240lb. I cannot enlighten (or darken) "One Who Wants to Know" in his other query.—Z. Y. X.

[56227.]—**Vacuum.**—Either the Sprengel or the Geissler mercury pump is used to obtain the best vacua; but a good ordinary air-pump will reduce the pressure to less than 1oz. per square inch. The pressure on the outside of any vessel is, of course, that of the atmosphere at the time, 15lb. per square inch, more or less. Indiarubber would not make a good joint unless the plates were bolted or pressed together so as to compress it. Greased leather might do better; but a true metal joint well ground or fitted by scraping, and then greased, would be better still. It is difficult to understand what is meant by a "friction of 5lb. per square inch."—J. BROWN, Belfast.

[56228.]—**Storage Batteries.**—I have seen a small storage battery of the following dimensions: 5in. long, 3in. wide, and ¾in. thick. It consists of the following: a cell of lead foil is made of smaller dimensions than those given, and is coated with peroxide of lead, made into a paste with dilute sulphuric acid; inside this cell are a number of thin lead plates, also coated with peroxide of lead, and covered with parchment paper to prevent their touching the lead cell. They are separated from one another by small bits of wood (matches do very well), and the whole of the plates fastened together by an elastic band. In cutting the lead plates you must leave a tongue on one end for connections; the tongue ought to be 4in. long and ¼in. wide. The lead cell must be covered with indiarubber varnish where it is soldered, and when the plates are fixed inside the lead cell a leaden lid must be soldered on, leaving two circular holes ½in. in diameter, one for pouring the liquid into the cell, and the other for the tongues of the lead plates, which should be bound up together so as to form, as it were, one wire. Care must be taken not to let the tongues touch the leaden lid, by inclosing them in a piece of indiarubber tube. The lead cell will form one pole of the battery, and the plates will form the other. The liquid put in the cell is one part of sulphuric acid to 15 parts water. The hole left for the liquid may be closed with a cork after it has been charged, and the holes left for the tongues may be plastered round with guttapercha cement; the whole thing is then put in an ebonite cell of the dimensions given before, having a cover with holes for the terminals to pass through. I don't know whether you can charge it with five granule cells.—TOBY.

[56236.]—**Boring Mill.**—To "INVICTA."—The foundation of the whole machine consists of a casting of a cup shape, the rim of the cup being cast with slots to drop over the studs in the cylinder flange, and the recessing or cupping of the casting being equal to a little more than the thickness of the boring head. The boring bar is a hollow cylinder with a slot cut through the side, so that a screw passing down through the hollow centre engages a nut carried on an arm which passes through the slot and connects the nut and the boring head. Briefly, the whole machine is this—a hollow bar turned on the outside carries the cutter head, which slides a good fit on the outer turned surface of the bar. The one end of the bar has a centre fitting into a bush, which is made to fit the back cylinder cover gland. The other end of the bar passes through the cup-shaped casting, bolting to the cylinder flange, from which the cover has been removed. The piston and rod are, of course, withdrawn. A worm-wheel which, by means of a feather fitting in the slot, already mentioned, in the hollow boring bar, gives the means of turning, a handle being fitted to the screw gearing with the worm-wheel. The internal feed screw is actuated by the well-known star feed, so that the whole machine is of the simplest form. As to cutters, I prefer to, if necessary, take two cuts—a coarse and a finishing cut. I don't think that it would be well to use rough and finishing cutters in the same boring head. Not only so; but it would not be practicable in that case to carry the finishing cut as far as the rough cut in the cylinder bore. A job such as this pays to expend a little time on to do it well.—INVICTA.

[56237.]—**Cylinder.**—I am sorry to have to tell you that the most practical advice I can give you is to discard the cylinder in question altogether. What is worth doing at all is worth doing well, and your cylinder, as it is, is simply useless for any practical purpose. The ports are too small. The steam ports should be at least ¼in. by 2in., or, even better still, ⅜in. by 2in.; the exhaust ¾in. or 1in. by 2in., not less. If you have not bored it, alter the pattern and enlarge the ports to the sizes I name. With the larger ports you could estimate it at nearly 1 h.p. nominal. With the small ports, I should be afraid to say anything about power at all. How is it possible to fill a 3½in. by 6½in. stroke cylinder with anything like a pressure of steam at any speed? It cannot be done. I would feel happy in helping you; but do not ask me to advise on an impossibility. Let me know if you will go in for a new cylinder and proper size port, and I will give you dimensions of every part needful to make the cylinder really useful.—INVICTA.

[56238.]—**New Steam Motor.**—I much regret that the motor in question, not being my property, and also being a patent, I am unable at the moment to give him what he wishes. I have asked the patentee to allow me to forward a set of tracings for publication, and am promised the same shortly. I hope to be able to lay the matter before the readers of this journal in a new form—that is, that I fully hope to be able to say that a special license to make for their own use only, on a nominal royalty, will be at the disposal of bonâ-fide readers of the "E. M.," as I think the invention one likely to be of real practical service to amateurs.—INVICTA.

[56239.]—**Filtering Acids.**—This is a large question. No particular kind of acid is mentioned. Cotton wool would be out of the question for some acids. I would suggest a filter as follows: 1. Bottom layer, asbestos or slag wool, either being nearly "strong-acid" proof; this a good thickness. 2. Fine well-washed river or silver sand. N.B.—"Well washed" means thoroughly washed, till no impurity or salt remains, and should be washed with acid. 3. Fine (very fine) stones also well washed in acid, and then with water. 4. Layers of stones increasing in size by degrees till, 5. Top layer small stones (well washed) less than ¼in. diameter. Every means should be taken to prevent solid matter getting to even a filter made as above, and even above. Filter will have no chance of working well save for a short time, if the matter to be filtered is at all gelatinous, or of that nature.—Z. Y. X.

[56240.]—**Tug.**—I should make such a model into a paddle-boat, not a screw; and from the shallow depth a screw could not be used to utilise the greatest engine and boiler that could be fitted. (For boiler see page 110.) Engines might be paddle ones—oscillators, 2½in. bore and 3½in. stroke—and two cylinders inclined may be used; the paddles may be with advantage 10in. diam., and with floats 4½in. or 5in. wide. If, as you say, the model has fine lines, the engines I name will do all that can be done; and the slides being made to cut off early, the boiler I mention would supply plenty of steam. For such a boat, a pair of slow-moving paddle engines will do better than a screw. And I would just say in passing. Do not in these days think of gearing up the screw shaft of a steamer: direct-acting engines are a long way better than any kind of gearing. I will, if wanted, give you any further assistance in advising on the fittings of your machinery for such a boat.—INVICTA.

[56242.]—**Dynamos.**—The E.M.F. of a given dynamo will depend on the softness of the iron and the ampère turns of wire on it. But having obtained the E.M.F. of a given-size dynamo from a given sample of iron with a given-sized wire, the E.M.F. when the saturating point of the iron is reached is proportionate to the speed; and if the machine be doubled in every dimension (section of wire also, but not number of coils) its efficiency becomes 32 times as great.—S. BOTTONE.

[56242]—**Relation of Electromotive Force of Dynamos to the Size and Speed of Rotation.**—The E.M.F. of a dynamo depends on—1.

The number of turns of conductor on armature. 2. The speed of rotation of armature. 3. The intensity of the magnetic field. If two of these conditions remain constant, the E.M.F. is proportional to the third. The E.M.F. remaining constant, we can alter any of these conditions by altering the others so that the product shall remain the same—that is, the product of the number of revolutions per minute multiplied by the number of turns and multiplied by the intensity of the magnetic field. For example, in a dynamo giving, say, 60 volts—

Let M = Intensity of magnet field = 1
,, R = Revolutions of armature per minute = 900
,, N = Number of turns of conductor on armature = 240;
Then M × R × N = 1 × 900 × 240 = 216,000.

This number may be called a constant for 60 volts in that particular dynamo. Now, if we double M we can halve either R or N, or doubling either R or N can halve M, the product remaining the same. In generators where the intensity of the magnetic field is constant, as in separately-excited dynamos, compound dynamos with constant external resistance, or magneto machines, the E.M.F. is proportional to the speed; but in "shunt" or "series" wound dynamos the E.M.F. increases in a greater proportion to the speed owing to increased current round the field magnets and the consequently increased magnetic field, and is much more complicated. With reference to size of dynamos, according to Gordon, when we know what a machine of a particular type will do we can easily calculate other sizes. If larger, it is safe to consider that the strength of the magnetic field, the proportions of the magnets remaining the same, is proportional to their weight, and that the proportion of armature to magnets remains unaltered; if smaller than the typical machine the magnets must be somewhat larger than the above rule. If the E.M.F. of the larger machine is to be the same as the typical, the wire on armature must be proportionately shorter and thicker, the simplest way of working is to calculate what would be the E.M.F. if the wire had been the same as on the typical machine, and then calculate the proper size of wire by the following rules:—1. With the armature coil carrying a given volume of wire, then, all other things being equal, the E.M.F. is proportional to the length of wire. 2. The volume of wire on the armature coil is proportional to the length of the wire multiplied by its section; whence, with a given armature coil, the E.M.F. will be inversely proportional to the section of the wire. Professor Thompson has demonstrated theoretically the relation of size to efficiency, assuming that the size of the machine be increased $n$ times in every dimension, and that though the dimensions are increased the velocity of rotation remains the same, and the intensity of the magnetic field per square centimetre remains constant. If the linear dimensions be $n$ times as great in the larger machine as in the smaller, the area it stands on will be increased $n^2$ times, and its volume and weight $n^3$ times. The cost will be less than $n^3$ but more than $n$ times. If the same increase of dimensions in the armature coils be observed, the number of layers and of turns remaining the same as before, there will be on the armature coils a length $n$ times as great, and the area of cross section of the wire will be $n^2$ times as great as before; the resistance of these coils will be $\frac{1}{n}$th part of the original resistance. If the field-magnet coils are increased similarly, they will be only $\frac{1}{n}$th the resistance of those of the original machine. The E.M.F. will be increased $n^2$ times, the speed of the armature being the same. If the larger machine is "series" wound, an E.M.F. $n^2$, working through $\frac{1}{n}$ resistance, will give a current $n^3$ times as great as before. In this respect, as the iron of our field magnets is $n^3$ times as great in mass, we need not so nearly saturate it as before to gain the same magnetic field, or to get $n^2$ times the area of surface magnetised to the former average intensity per square centimetre. Hence the number of coils may be reduced in the proportion of $n^2$ to $n^3$, or to $\frac{1}{n}$th of its already diminished value, correspondingly reducing the resistance on which work has to be done. As in the larger machine, therefore, the E.M.F. is increased $n^2$ times, and the current $n^3$ times, the work of the machine will be $n^3 \times n^2 = n^5$ times greater than with the smaller machine, or, a machine doubled in its linear dimensions will not cost eight times as much, and will be electrically thirty-two times more powerful than the smaller machine. If the machine be "shunt" wound, then to produce the field of force of $n^2$ times, as many square centimetres area will require (if the E.M.F. be $n^2$ times as great) that the absolute strength of the current remain the same in field magnet coils. This can be effected by using wire of the same size as before, and increasing its length $n^2$ times to allow for $n$ times as many turns, of $n$ times as great a diameter each, in the same number of layers as before. The current being the same, therefore, in the shunt circuit as before; but under $n^2$ the E.M.F., the work here is only $n^2$ times as great, whilst in the whole machine it is $n^5$ times greater than the smaller machine. According to Gordon, in practice the result does not much exceed the third power, or cube, of the linear dimensions, and a practical rule is given that the output will be proportioned to the weight of the machine.—Eugene Brown.

[56254.]—**Netting Square Mesh.**—Commence from a single loop, out of which you will make two, by going twice round the mesh stick, and tying a knot each time; slip off, and go on again repeating the "letting out" at each end until you have got your width. To keep the net equal in width, you will now let out one side only, and "draw in" the other. By "drawing in" I mean take two meshes into one. When the length is obtained, measuring from the very beginning, you will have only to put on the other corner, which is done by taking in two meshes into one on both sides (in fact directly opposite to the manner in which you began) until you have netted yourself out. Now find your four corners and pull out straight, when you will find your meshes are square, although you made them as diamonds.—R. H.

[56256.]—**Valve Gear.**—I would refer the querist to my replies to Nos. 56104 and 56171, pages 87 and 89. Anything further I can do to assist him or others in a practical direction I will do most willingly: but I do not want them to spend their money uselessly. I have had some experience that cost me very dear, and I would gladly save others the outlay I have myself gone to.—Invicta.

[56258.] — **Reflecting Galvanometer.**— The reels of my galvanometer are of boxwood, $2\frac{3}{8}$in dia., by 1in. wide; but I might, perhaps, have made them larger with advantage. No. 1 has 57 turns of No. 14 wire; No. 2 is of No. 24 wire; and No. 3 has about 4,000 turns of No. 35 wire. The wire should be silk covered, baked dry, and run through melted paraffin in winding on. There is about $\frac{1}{2}$lb. of wire on each reel. Using coil 2 the instrument will detect a difference of ·000013 in one ohm with the Wheatstone bridge. Of course the best size of coils, wire, &c., depends on the work to be done.—J. Brown, Belfast.

[56261.]—**Selenite.**—This substance is sulphate of lime: the quantity mentioned would be equivalent to about 12 degrees of hardness.—Asa.

[56261.]—**Selenite.**—Is "Bennett" correct? Is plaster of Paris selenite? I do not think so. Again, has J. H. Hurst, of Salford, given its true chemical composition? I think not. He has left me the aqua which so pleased the servant when the doctor had prescribed for her, saying that her prescription was like her master's, and therefore she had faith in the doctor. Mr. Hurst should have stated how long it would take for 25 barrels of water to take up 2lb. weight of selenite, and under what conditions.—Z. Y. X.

[56264.]—**Mechanics.**—The total resistance is 500lb., and this is overcome at the rate of 1,760ft. per minute: hence the total work done in that time is 880,000ft.-lb., and dividing this by 33,000, we obtain 26·6 as the h.p. of the engine. The data given are, however, not very accurate, for the resistance of a train running 20 miles per hour is 15·5lb., not 10lb., and trains usually weigh more than 50 tons; the engine and tender alone frequently weigh 60, and of course their weight has to be included.—Wm. John Grey, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[56264.]—**Mechanics.**—The friction being 10lb. to the ton, the engine must exert a traction of 500lb. Now 500lb. 20 miles an hour

$$= \frac{500 \times 20 \times 3 \times 1760}{60} \text{ ft.-lb. per minute.}$$

This, divided by 33,000 gives $26\frac{2}{3}$ horse-power.—Geo. A. Walton.

[56264.]—**Mechanics.**—Total frictional resistance = 500lb. Work done per minute

$$= \frac{500 \times 5280 \times 20}{60} \text{ foot-pounds.}$$

$$\therefore \text{ horse-power} = \frac{500 \times 5280 \times 20}{60 \times 33000} = 26{\cdot}6.$$

—Jno. M. Adams.

[56268.]—**Shocking Coil.**—To "C. J. R."—Doubtless the two joints in your secondary wire are the cause of your inability to obtain shocks from that end of the coil near to which are the joints, on account of the increased, and therefore too great, resistance offered by them, owing, perhaps, to their being not good, electrically speaking. The only way that seems to me to thoroughly overcome the difficulty—but at the same time a very annoying way, especially if the joints are at the end where you commenced to wind on the secondary wire—is to unwind the wire as far as necessary, cut off the joined portion, and so have the secondary wire entire throughout its length. If this does not give the required result, write again, and I will see from experiment what can be done, as I have a half-built coil on hand.—J. Kean, Northampton.

[56268.]—**Shocking Coil.**—This looks as if the secondary was broken near the end which gives the small effect, and that the discharge passed by some badly insulated path to earth from the broken end, and so through the body of the operator. Try if the secondary is continuous by connecting it with a battery and galvanometer. If not, of course, it will have to be unwound till the break is found. The fault might, I think, also be caused by a good earth connection without a break in secondary.—J. Brown, Belfast.

[56273.] — **Secondary Battery.** — Leclanché cells will not do much in the way of charging secondary batteries; you will require some quart Bunsens. You do not give size of the motor or the length of time you want the secondary battery to work it. If you will give these particulars, I will tell you the size and number of plates for the secondary battery, and also the power you will require to charge it.—W. H. Eaves, Coventry.

[56274.]—**London Int.Sc.Exam.**—Wilson's "Solid Geometry" (Macmillan) is, on the whole, the best book to get up the mensuration generally, and the "Geometry of the Sphere"; may supplement with the first three chapters of Todhunter's "Spherical Trigonometry." In co-ordinate geometry the best book for the purpose is Le Sueur's "Straight Line and Circle" (Ballière's Cheap Aids Series).—B. A.

[56283.]—**Small Dynamo.**—I am sorry to inform you that when you have made your dynamo with a Catella armature it will be quite useless, as near as I can calculate, for so small a dynamo; the E.M.F., if you had 100 bars on armature and drove it at 3,000 per minute, would be about one volt, so the amount of light you would get would be rather microscopic. If you will take my advice, you will buy the castings of a 30 candle-power machine, and fit it up and wind it yourself.—W. H. Eaves, Coventry.

[56284.]—**Dynamo.**—The best book for your purpose will be Prof. S. P. Thompson's "Dynamo Electric Machinery." Do not buy any book that is more than two years old, as the progress in this branch of science within the last few years has been something enormous.—W. H. Eaves, Coventry.

[56285.]—**Drilling Square Holes.**—A method of drilling square holes is illustrated on p. 57, No. 705, the patent of Mr. J. Hall, and I have a piece of brass rod with a square hole in it. That was done by allowing the part in which the drill was held to slide slightly on the chuck, or to use the words on the page mentioned, the drill is allowed to travel automatically in a horizontal plane for some little distance. The drill in section is a triangle—if the longest side is taken as the base, an acute-angled triangle, and it does not rotate on a fixed central point, but diverges somewhat in proportion to the size of the hole. I have seen a paragraph recently about a drill for boring square holes of a large size in wood. It is an American invention, and according to the description, little saws attached to it clear out the corners.—Nun. Dor.

[56285.] — **Drilling Square Holes.**—I have also received particulars; but no piece of the metal with the hole cut. It certainly is very clear that if we cannot make it, we can obtain it at a price. If this should meet the eye of Mr. Bateman, of Greenwich, perhaps he would send illlustrations of the one he makes or supplies.—Fell. Soc. Science.

[56288.]—**Crank Shaft.**—1. Even for a model I like plenty of metal in the crank; therefore, let the round part of crank shaft be $\frac{5}{16}$in. diam.; webs of crank, $\frac{3}{8}$in. by $\frac{3}{8}$in. Do you mean to cut out of the solid or build up in parts? If properly done, the last is far the easiest for an amateur; and at best it is a troublesome job to turn up from the solid a crank. 2. If a horizontal engine, it is not necessary to balance the crank; but if a vertical engine, the crank and all the motion work should be balanced, or at a slow speed the engine will work spasmodically.—Invicta.

[56289.]—**Exhaust Pipe.**—Many plans have been tried; but apparently nearly all fail from the fact that with the reduction of the noise, the blast is also lessened, and the boiler is not able to keep steam as before. The only remedy I could suggest would be an annular exhaust, which would partly reduce the noise and yet not decrease the draft. If the blast was not wanted to urge the fire, I could tell you of, at least, two good remedies for the noise of the exhaust.—Invicta.

[56290.]—**Water Gauge.**—If the water is left "turned on" after the fire is put out, a vacuum is produced in the boiler; the water in the tank will rush into it.—Fell. Soc. Science.

[56290.] **Water Gauge.**—No doubt you feed the engine from a tank or barrel of good size. Hence, when the steam goes down, the partial vacuum formed, draws water from the tank through the pump valves into the boiler, thus filling it up to a height much beyond the proper level. Owing to your engine being no doubt steamjacketed, the additional volume of water does not produce any marked effect. Remedy: Have a good stop valve or plug cock on the suction, and if a part of the exhaust is returned into the water tank to heat the feed, have a cock on this also. I have had a horizontal boiler that was guilty of the same trick, and once or twice with most annoying results. If this is not the cause, write again.—INVICTA.

[56290.]—**Water Gauge.**—I think the reason why the water in the gauge glass rises out of sight every night is that as the steam in the boiler condenses during the night, and thus forms a vacuum, the water from the feed tank or barrel is forced by the pressure of the atmosphere up the indiarubber feed pipe, raises the valves of the feed pump, and fills the boiler until the equilibrium is restored. Remedy: Take the suction pipe out of barrel or tank.—G. B. P.

[56294.]—**Chemical.**—The formula, when chlorine is passed through milk of lime, is—

$$2CaH_2O_2 + 2Cl_2 = 2H_2O + CaCl_2 + CaCl_2O_2$$

Both calcium chloride and calcium hypochlorite are, therefore, formed.—R. A. R. BENNETT.

[56294.]—**Chemical.**—When chlorine is passed into a solution of calcic hydrate (milk of lime), calcic chlorate and calcic chloride are formed according to the equation:

$$6\ CaHo_2 + 6Cl_2 \left\{\begin{matrix} OCl \\ O \\ O \\ OCl \end{matrix}\right. \!\!\!\! CaO'' + 5\ CaCl_2 + 6\ OH_2$$

Calcic chlorate. Calcic chloride.

By which it will be seen that no calcic hypochlorite is formed.—J. KEAN, Northampton.

[56294.]—**Chemical.**—When chlorine is passed into *cold* milk of lime, calcium hypochlorite and calcium chloride are formed thus: $2CaH_2O_2 + 2Cl_2 = Ca(ClO)_2 + CaCl_2 + 2H_2O$. This solution is used in the Lancashire bleach works for bleaching, under the name of bleaching liquor. When *hot* milk of lime is used, calcium chlorate and chloride are the products, thus: $6CaH_2O_2 + 6Cl_2 = Ca(ClO_3)_2 + 5\ CaCl_2 + 6\ H_2O$.—GEORGE H. HURST, Salford.

[56294.—**Chemical.**—When chlorine gas is passed into cold milk of lime, the following reaction occurs:

$$\underset{148}{2CaH_2O_2} + \underset{142}{2Cl_2} = \underset{143}{Ca(OCl)_2} + \underset{111}{CaCl_2} + \underset{36}{2H_2O} \quad \underset{290}{}$$

On boiling the liquid the hypochlorite decomposes thus:

$$\underset{429}{3Ca(OCl)_2} = \underset{207}{Ca(O_3Cl)_2} + \underset{222}{2CaCl_2}$$

And on the addition of potassium chloride double decomposition occurs between it and the calcium chlorate, resulting in the formation of potassium chlorate and calcium chloride, which are easily separated by crystallisation. If chlorine be passed through boiling milk of lime, calcium chlorate is formed thus:

$$\underset{444}{6CaH_2O_2} + \underset{426}{6Cl_2} = \underset{207}{Ca(O_3Cl)_2} + \underset{555}{5CaCl_2} + \underset{108}{6H_2O} \quad \underset{870}{}$$

—WM. JOHN GREY, analytical chemist, Newcastle-on-Tyne.

[56296.]—**Sand Blast.**—"An Old Subscriber" does not say for what purpose he wishes to use the sand blast. Steam is used when sharpening files, and compressed air for glass; the latter has been tried on my hand, which, being soft, had a very different effect to what it has on glass. It felt not very unlike an electric shock.—FELL. SOC. SCIENCE.

[56298.]—**Records of the Past.**—There are English translations of the Assyrian and Egyptian monuments; there are six volumes of translations of Assyrian texts, and as many of Egyptian (published by Sam. Bagster and Sons), each volume, 3s. 6d., may be had separately; they are all of great interest and value. The Assyrian series includes annals, legends (some of which touch the Biblical history), poetry, charms, exorcisms, omens, hymns, prayers, incantations, proverbs, public documents, &c.—G. J. W.

[56300.]—**Violoncello.**—The dimensions are as follows:—Divide the length of back into 72 parts; at the 42nd division from the top strike a circle with a radius of 4½ parts, the wood within this circle is reduced to 1 part in thickness; from the same point describe another circle, with a radius of 12 parts, and reduce wood gradually to ¾ part; from this circle reduce gradually to ½ part at the edges of back. The belly is slightly thinner. Ribs, head, and neck, must be purchased. Wood is bent after steaming, or on hot irons. Moulds are of various kinds. Length of bass bar 36 parts, or if belly is thin, longer. Cut soundholes out with a fine fret saw. The above are the dimensions given in Otto's book. I have generally made the figure of the thick part of the tables of an oblong shape in preference to a circle.—T. LISLE.

[56301.]—**Flowerpots.**—In steel-pot making I have seen the mould washed over each time with what appeared to be a thick oil. It seemed to be a strongly carbonaceous oil. All this disappeared when the pots were, after drying, burnt.—Z. Y. X.

[56301.]—**Flowerpots.**—Presuming the moulds are of hardened cast iron, you will best be able to see how plastic clayware is caused to leave such moulds (using paraffin) if you pay a visit to any of the spur works in Staffordshire. The very fine points of the spurs and stilts used in placing glazed earthenware are thus easily liberated from the iron mould, the plunging die working at a terrific rate, and a spur is made completely at every two strokes downward. Accept my thanks for the information as to red ware. Pardon me asking further how the flowerpots are placed in the kiln? Also what is the time of firing, the maximum temperature, and the means of ascertaining when this is reached.—POTTERY TECH.

[56302.]—**Japan.**—This can be stripped off with an old plane iron. That is what japanners use; finish off with coarse emery cloth.—T. LISLE.

[56305.]—**Albo-Carbon.**—It is naphthalene $C_{10}\ H_8$, and boils at 218° C. It melts at 79° C., and has a peculiar odour; burns with a white smoky flame, and in the gaseous state is not inflammable in the absence of oxygen or common air. In its melted state, however, it absorbs air largely, and added to common gas produces a whiter and more luminous flame. Gas companies would like to keep as much as they can in their gas, but, as a matter of fact, it condenses out and helps to block the pipes. A full account of the original patent in No. 706.—NUN. DOR.

[56306.]—**Boring Mill.**—To "INVICTA."—This query appeared on page 90, under No. 56236, and which I have noticed under that number.—INVICTA.

[56309.]—**Parallaxes of Stars, &c.**—Would this querist kindly explain which year is to be considered A.D. 0? His query is a very nice one as it stands; but it would be interesting to learn what the year 0 was like.—NUN. DOR.

[56310.]—**Coil.**—The condenser is usually attached to coils which have primary and secondary layers, otherwise called induction coils. If your coil is of this class, you can certainly attach condenser, and it will give you more shock than you desire; but it has been repeated again and again, that condensers are never used for giving shocks. 2. The melting heat of nickel is about the same as that of wrought iron.—BOBADIL.

[56310.]—**Coil.**—Yes; a condenser can be attached to a shocking coil, and if "Melts" will refer to the "E.M." for March 20 last, No. 1,044, and in reply to query 56037, p. 66, he will find my diagram and description, which will, I think, give all necessary information. Yes, again; a condenser does materially increase the strength of a shock; and should "Melts" require the theoretical explanation of its action, I shall be pleased to give it. Referring to the second part of his question, Buckmaster's "Advanced Chemistry" gives nickel as rather more fusible than iron (i.e., fuses at a lower temperature), while Dr. Thompson says: "Nickel fuses at a very high temperature, about 3000° F.; iron fuses at about 2760° F.—J. KEAN, Northampton.

## UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information hey can for the benefit of their fellow contributors.*

55768. Regrinding Cutlery, p. 483.
55780. Cardiff Railways, 484.
55782. Steel Castings, 484.
55788. Bookbinding, 484.
55795. G.N. Locomotives, 484.
55798. Stove, 484.
55799. Bending Angle Iron, 484.
55800. L. and N.W. Engines, 484.
55808. Bischopp's Gas-Engine, 484.
55809. Dynamo Construction, 484.
55811. Cement Analysis, 484.

55972. Glass Working by Lamp, p. 569.
55973. Dyeang, 569.
55979. Lathe Bed, 569.
55985. Flange Iron, 570.
55992. Vertical Drilling Machine, 570.
55993. Screw Cutting, 570.
55994. Telephone Stations, 570.
55995. Pirn Winding, 570.
55996. Planishing Machine, 570.
55998. Rose-Engine Turning, 570.
56009. Matriculation Examination, 570.
56011. Portable Iron Folding Music Stand, 570.
56012. Microscopic Tests, 570.
56018. Photo Lenses, 570.
56019. Copper on Silvered Glass, 570.

## QUERIES.

[56311.]—**Chemical.**—Will some chemical friend inform me what amount of barium nitrate should be theoretically produced from one ton of sodium nitrate, and what quantity of sulphuric acid, of 1,840 gravity would be required to convert the ton of soda into nitric acid, and what quantity of nitric acid, of 1,420 gravity, should be theoretically produced?—IGNORAMUS.

[56312.]—**Distempering.**—Will some of our decorator friends give me their opinion as to distempering ceilings, and recipe for same, also as to what books there are published on decorating and painting, as to colours?—E. BUTLER.

[56313.]—**Cylinder.**—Will any fellow-reader kindly inform me what alloy of gun-metal would be suitable for a steam cylinder of 3in. bore, 5in. stroke, to work at 50lb. to the square inch, and 100 revolutions per minute, also the thickness required?—W. W. P. R.

[57314.]—**Strength of Gear Wheels.**—Will some of our practical readers inform me of the strength or pitch of gear wheels, necessary to swing 5cwt.; big wheel to be about 15in. diameter, small 3in.? I want them made as light as possible, and can be made with side cap or solid edge.—C. B.

[56315.]—**Anemometer.**—Will some kind reader describe the simplest train of wheels, with or without screw, to register the revolution of anemometer, and if it could be started from zero at pleasure? What I have seen, is something like the index of a gas meter, and I should like to know the maker of them.—WIND.

[56316.]—**Eight-inch Spark Coil.**—At p. 389, of the "E.M." for 4th January, 1884, there is a description of a very successful coil, giving this spark with five pint Groves. As its maker, Ernest Baugh, stated he was going to try quarts instead of pints, may I ask him what was the result, as I intend, when I have time, trying to construct a similar coil with his for a model?—B. HARCOURT.

[56317.]—**Royal Exhibitions and Scholarships.**—Will Mr. W. J. Grey, F.C.S., or any other kind reader, please say what situations, and the salaries attached to them, are open to royal exhibitioners, &c., who have obtained the associateship of the Royal School of Mines? I am contemplating making an effort to obtain one of the scholarships, but before doing so, would like to know my future prospects in case of success.—ELDHIN.

[56318.]—**Owls.**—Being completely over-run with rats, mice, and moles, and finding cats quite insufficient to exterminate them, I have been recommended by a friend to keep a pair of barn owls in a convenient spot. He had no practical experience in the matter, so I wish to inquire whether any correspondent can give any hints on the subject? Are these birds easily domesticated, and should they receive any food besides what they can themselves procure? I suppose there would be no difficulty in getting them.—AGRICOLA.

[56319.]—**Expansion Valve.**—I should be obliged if some reader will give me an explanation, with diagram, of a simple method of determining a variable cut-off.—SLIDE.

[56320.]—**Dynamo.**—Will some one kindly say about how long it would take the small dynamo, described by Mr. Bottone in former vols. ("The Dynamo: How Made and How Used"), to charge the accumulator shown on p. 28, Vol. XL., sufficient to illuminate the lamps, also shown, for three or four hours?—MICROSCOPIST.

[56321.]—**Indicator Diagram Paper.**—It will be a great favour if any of your scientific correspondents can inform me as to the chemical composition of the substance used in the preparation of the paper employed in taking indicator diagrams? I have had occasion to use the above very much of late, and would like to know the action which takes place between the brass pencil and the prepared paper.—VALLEYFIELD.

[56322.]—**Miranda Pianista.**—There is being formed a company to work or manufacture the "Miranda Pianista." Has anyone heard it or seen it, and is it a modification of "Thibouville's Pianistas" for playing the piano? Would some one who knows give me some particulars, and oblige others as well as—VULCANITE.

[56323.]—**Vegetarianism.**—I have adopted a vegetarian diet, and would thank some experienced reader to supply (through your journal) a vegetarian fare that would admit of, at least, two or three changes in the week, and allow of substitutes for vegetables that do not remain long in season; also the manner of cooking by which they are most easy of digestion? The name of a book or books that give the information sought would oblige.—A REGULAR READER.

[56324.]—**Sunlight at Great Depths.**—Is it known at what depth in the sea sunlight is wholly wanting? Are there any data, from actual experiments on the light-absorbing qualities of water, whereby this question may be answered with a fair approach to exactness?—B. A.

[56325.]—**Gyroscope.**—Can and will anyone kindly inform me of the approximate initial and terminal operative velocities of a Foucault's gyroscope, and also of the weight and diam. of disc usually made, or of best advantage? The lowest velocity at which a given disc will show the earth's rotation is the point most desired to be learned. How would 10,000 revs. per min. on a 3in. disc of 2lb. rim be for an approximation?—GYRO.

[56326.]—**Sketching.**—Can anyone favour me with a description of a small portable instrument which will enable me to measure approximately the size of distant objects as seen with the naked eye? It is not necessary to indicate the exact dimensions, but only the relative size. I want it for sketching purposes.—ARTIST.

[56327.]—**Transferring Pictures to Glass.**—Will any reader tell me how I can transfer pictures to glass, such as chromo or oleographs? I have seen them as if they were painted on the glass.—C. P.

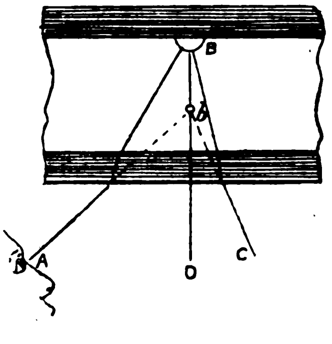
[56328.]—**Vertical Boiler.**—The top plate of a 4 h.-p. vertical boiler is very rusty, and scaled round about the chimney base; it is worked at 60lb. pressure. How can I find the thickness of the plate? Would it be wise to drill a hole or not? I am afraid it is not quite safe.—Tom.

[56329.]—**Crank Throw.**—I have a cylinder 6in. stroke, my crank being 2½in. in webs from centre to centre. I wish to know if that crank would suit cylinder, or must it be 6in., the same as cylinder? Will some kind reader help me in the same?—H. B.

[56330.]—**Soluble Oil.**—Ordinary soluble oil, when mixed with Epsom salts and China clay, for the finishing of grey goods, and boiled, forms an insoluble magnesia soap, which causes the whole mixture to become curdy; but there is a soluble oil in the market which, when boiled with Epsom salts and China clay, forms an even emulsion absolutely free from curdy particles. Can any reader inform me how this soluble oil is prepared?—An Inquirer.

[56331.]—**Chimney Pipe.**—A 4in. cast-iron flue-pipe from a small heating stove, passes vertically through a 4in. hole, cut in one of the slates of the slanting roof above said stove. Rain beating against part of pipe outside, runs down its side and through the hole in stove, and so within doors. Wanted to know how to make a tight joint in roof? Soldering on a zinc or copper sheet won't do, because of heat melting solder; putty won't do, because slight vibration of pipe with wind, causes cracks in putty.—H.

[56332.]—**Optical.**—The sketch represents part of a glass spirit level. B is the bubble. If looked at from A, the bubble appears to be in the line A *b*, cutting the normal B D in *b*. Am I correct in assuming that if viewed from any other point C, the line of sight will apparently cut B D in the same point *b*, as shown? Also please show me how to calculate the position of *b*?—Glatton.



[56333.]—**Scale Scoops.**—Will some of your mechanical correspondents kindly assist by giving hints upon the above? How they are dished? I have got some boxes to make similar to scale scoops, they have to be made out of sheet iron 1/16in. thick, 1ft. 10in. long, 9in. wide, and 5in. deep, they must not be hammer-marked. If they have to be pressed, please to send sketch of castings, and say if could be done with hand-power.—J. W.

[56334.]—**Launch Engine.**—To "Invicta" and Others.—I have a pair of 4½ by 5 diagonal launch engines that I wish to put into a new boat, but am afraid they will not drive her at a reasonable speed. Could I increase the power by introducing a third cylinder to utilise the exhaust? Is it practicable?—Medlock.

[56335.]—**Potter's Kiln.**—I am desirous of building a potter's kiln about 4ft. square inside to burn terra-cotta. Will Mr. S. Arlidge or "Pottery Tech." give me a sketch or any advice upon the subject?—J. Townley.

[56336.]—**Glucose.**—Would any reader kindly give me the simplest process and test for the identification of glucose when combined with other substances?—Simon Fairfax, Glasgow.

[56337.]—**Electrical.**—Will any reader kindly inform me if I can ring two bells on one circuit—viz., one bell at top, one at bottom, with two brushes, the battery at one end with two wires? I can do it with the reversible pushes with battery at each end, but it is inconvenient.—Crutesta.

[56338.]—**Pattern-Making.**—Will "J. H." or any other kindly let me know the way to make the patterns for the carriage and slide-rest combined of a 6in. self-acting sliding, surfacing, and screw-cutting lathe, with independent back shaft, the carriage to have cross-slide cast on it, and the horizontal slide to swivel round for turning cones; the rack to be in front of bed just below the carriage, and the leading screw below the rack; and what number of threads per 1in. on leading screw, and whether V or square threads are best, and what diam. of screw? And how can I put in the back shaft of running head, as it has oblong holes 2in. by ¾in., and my wheels are bored out 1⅛in.; and the way to put on pinion on mandrel?—Busby.

[56339.]—**Stops to Photo. Lenses.**—As Mr. Pumphrey recommended, I procured the "Year Book," but can make nothing of the diagram of stops contained therein. Seems to be a misprint in the directions. See second line from bottom, printed matter. Again, I do not know what is the "equivalent" focus of my lens. I only know that the solar focus is 5in. Will Mr. Pumphrey kindly make the matter plainer?—Gwent.

[56340.]—**To Mr. Bottone or Others.**—I am making small dynamo, of which the F. magnets measure 2¾ high, by 3½ wide. Where wire is wound and small laminated armature, 3¼, by 1¾; I am going to wind d.c.c. on F.M.'s, and 6oz. of 20 d.c.c., on armature. Will you kindly say if that is right, and whether there is a particular way in winding F.M.'s? If I commence at bottom and finish at bottom, will it be right? and whether I connect the first parts of wire on fields to brushes or parts, and I suppose either the first or last two ends are connected together of fields? I want to light as many 2½ lamps as I can. Kindly say how many, and what speed to run at, and how many volts lamps are to be? The armature, is, I suppose, wound, and the two ends connected together; is that right, or is it wound any particular way, so as to get the current to run to the commutator? Do I screw any binding screws into pillars supporting brushes for connecting wire to lamps, I want the same for lighting small cottage?—A Plumber.

[56341.]—**Cheap Gas.**—To "Invicta."—On p. 61 you use the phrase "compared with coal gas, it does not cost me 9d. a 1,000 cubic feet." If the gas costs less than 9d. a thousand (whether compound with coal gas or not) we should be very glad to have more particulars. Will "Invicta" give them, or refer to the makers of the apparatus?—Glatton.

[56342.]—**Public Lighting.**—Could any readers of the "E.M." furnish me with the names of any places which use petroleum for street lamps instead of gas, either from want of gas, or inability to agree with the gas company?—Surveyor.

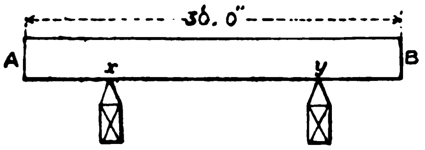
[56343.]—**Electrical.**—To W. H. Eaves.—Will W. H. E. kindly reply to query 56114 in "ours" of March 13, entitled "Electro-plating Dynamo"? Will he also state how to make a galvanometer to give a comparative idea of the strength of current, as the one I have is deflected from north and south to east and west, and the needle remains at E. and W., whether I send a current through it from one cell or from twenty cells?—Faraday.

[56344.]—**Rubber Belting.**—What is the best method of joining ends of the above? If I rip a 4in. belt down into two or more, will its efficacy as a narrower strap be affected? What is the best manner of cutting it?—J. J. H.

[56345.]—**Legal.**—A., B., C., and D. are executors under a will. B., C., and D. had a reversionary interest in £12,000; C. has had to sign away his interest owing to a debt, and insists on the securities being placed at a bank or in some place of security. A., B., and D. wish that A. should keep them in his possession. Can C. insist on his wish, or does the opinion or wish of the majority over-ride that of one executor?—J. C. B.

[56346.]—**Seller's Screw Thread.**—Will any of our readers oblige with a description of this screw thread?—Screw.

[56347.]—**Centre of Percussion.**—A beam A B is supported in two places *x y*, and each of these supports alternately rises and falls, causing vibration to beam. It is required to know the two points of support at which the vibration is the smallest degree felt by beam?—R. J.



[56348.]—**Colouring Terracotta.**—Can any of your readers inform me by what simple process I can colour bricks or terracotta, so that the face will burn red? What chemical is used, and how is it applied? The natural clay burns a light red colour, and we want a deep red for the face. Also how are red roofing ridge tiles made?—X. Y. Z.

[56349.]—**Portland Cement Concrete.**—Can any of your readers inform me how the red colour is given to the red Portland Cement concrete slabs now in use, and whether the same means would answer to give a permanent red colour to Portland cement used in coating the exterior of a house? Also, whether the mixture of the cement with crushed red bricks, instead of the usual washed sand, would be of any use, and if there be any means of making a permanent red rough-cast or pebble dash?—Portland.

[56350.]—**Electro-plating.**—Will some reader kindly tell me how I can prevent the silver peeling off from some terminals, &c., which I have been silver plating? I used a small Daniell's cell and ½oz. of pure silver on anode, and have put a piece of wet string into the circuit to lessen the current. Also, how long ought the articles to be silvered be left in the solution?—Cyanide.

[56351.—**Worm in Mahogany.**—I am making a bookcase, and some of the wood I have bought is slightly perforated with worm holes. Is the worm likely to spread, and should the wood be discarded on this account?—G. S.

[56352.]—**Lacquer for Lamp.**—I have a lamp consisting of an old tin moderator reservoir with a modern paraffin burner attached, which gives a fine light. The lacquer is worn off the tin body, leaving it very shabby. What can I coat it with to make it presentable? I have tried Brunswick black, but the paraffin washes it off.—G. S.

[56353.]—**Orrery or Planetarium.**—Is there any work in which I can find the number of teeth in the various wheels required for a planetarium, so as to give the correct motions of the planets and their satellites? Or can any reader give me the numbers?—Planetarium.

[56354.]—**Turning Cannel Coal.**—How can I make fancy hollow goods from cannel coal? I have the use of a lathe, but find the cannel so brittle that it breaks off in large pieces, and I do not know of any cement that will hold the broken parts together.—Ryhope.

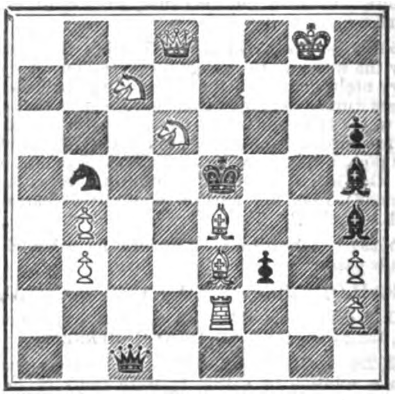
[56355.]—**Legal.**—Would one of our legal correspondents kindly answer the following? Can a man, on leaving a situation, claim references that had been written for and obtained by his late employer? Or are the references considered a private communication and not recoverable? Whether the original document is bound to be produced, or whether a copy can be substituted?—Engineer.

## CHESS.

All Communications for this department must be addressed to J. Pierce, Llandwrog, Carnavon.

### PROBLEM DCCCCXXXIV.—Tyro.

*Black.*



*White.* [11+7

White to play and mate in three moves.

Solution to 932.

| *White.* | *Black.* |
|---|---|
| 1. K-R 6 | 1. Anything |
| 2. Q, R, or Kt mates | |

(Four variations.)

### NOTICES TO CORRESPONDENTS.

Correct Solutions to 932 by Rev. W. Anderson (Old Romney), E. Stanley Follwell, and A. O. E. Lecluse; to 431 by H. Culmer (second solution).

A. O. E. Lecluse.—Your first move in solution of 931 is correct, but you have not given Black his best defence, which is 1. P-K 3. Name entered.

M.—929 is a *two*-move problem, and is quite sound. If 1. K-Kt 3, 2. Kt-B 4 mate; if 1. Kt takes Kt, 2. Q-Q Kt sq; if 1. K-K 5, 2. Kt-B 3 mate.

J. E. Piper.—In 932, if 1. R takes B, 1. B-Kt 4, and there is no mate.

E. S. Follwell.—We have entered your name for Tourney.

E. Hughes.—In 932, if 1. Q-K B 8 there is no mate, if 1. B-K 3 or B takes Q R P.

H. A., Harlesrood.—Far too easy and simple.

Mr. H. F. L. Meyer, the composer of problem 932, proposes to make it right by adding B P at K B 4, to P at K B 3, and removing B P at K-Kt 4.

The following Tourney problems have been duly received:—"Measure for Measure," "Ariadne," "Beware of the Dog," and "Salutation."

Check.—Revised No. 5 has been substituted.

Mr. A. Briggs has been kind enough to offer as an additional prize in Problem Tourney a Chess Diagram Stamp—vulcanised indiarubber, mounted on brass, box pad, ink, &c.—value, 5s. 6d.

## ANSWERS TO CORRESPONDENTS.

⁂ *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

### HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

⁂ Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, April 8, and unacknowledged elsewhere:—

R. Lloyd and Co.—J. H. Thompson.—X. Y. Z.—H. H.—Epworth.—A. W. H.—Pedestrian.—Boilermaker, Sunderland.—Tyro.—W. Habgood.—G. L. T.—E. P. Read.—P. Ward.—Ora et Labora.—Snooks.—Urgent.—Bike.—Micro.—Meteor.—Wear.—Phono.—In the Dark.—Fred Hunt.—A. F. Miller.—Beginner.—R. Inwards.—Chemical Work.—Clement H. Wragge.—S. E. Hunt.—Invicta.

G. H. B. (As you do not say what the query was about we cannot pretend to remember it. Perhaps it was answered to "G. U. B." in this column for March 13.)—Rustic. (Tracing-paper, or any varnished paper, will do.)—M. (Given many times. See list of Back Numbers last week, and answer to "T. B." on p. 114.)

—Amateur. (First query unsuitable; second incomprehensible. See indices.)—C. S. (Question much too wide. Procure some of the dealers' lists, and look up back volumes, Vol. XXVI., for instance.)—W. Butler. (Why do you allow your back numbers to be destroyed? A bichromate will do excellently, but you must use steel bars, and put them into a coil of insulated wire while current is passing. Quoting from Mr. Sprague's book, which is the best you can have, a short coil of stout covered wire should be made with an opening wide enough to take the bar. Then, while a powerful current is passing, the coil should be moved along the bar both ways several times, allowing the ends to enter half-way into the coil. Bring the coil back to the centre of the bar before stopping the current. The action is facilitated by slightly tapping the bar so as to produce vibration.)—Subscriber. (See previous answer.)—Pro Bono Publico. (Query 56079 will probably be answered in time. Perhaps this note will direct attention to it.)—W. W. W. (Recipes for staining billiard-balls have been given frequently under that head and also under Ivory Staining. The ivory must be first cleansed by washing well with soda solution or ammonia, and is then "quicked" by immersion for a minute in acid water, either nitric or hydrochloric; it is then transferred to the dye. For black use logwood decoction, and afterwards acetate of iron; for blue, a dilute solution of indigo, to which some potash has been added; for green, boil in a solution of verdigris in vinegar; for yellow, steep for 24 hours in strong solution of neutral chromate of potash, and then plunge into a boiling solution of sugar of lead; for red, first treat to a bath of tin salt, nitro-muriate of tin, and then plunge in a hot decoction of Brazil wood or cochineal, or both mixed; if a cherry red is required, place the ball dyed scarlet into a hot solution of potash; for brown, use weak solution of nitrate of silver. The simplest plan of all is to use aniline dyes. They fade, it is true; but they are cheap, and the balls can be restained as often as necessary with very little trouble.)—J. M. (See previous answer.)—Novice. (Unless very large quantities are required, it is cheaper to buy lacquers and varnishes. However, a good lacquer is made by putting a ¼lb. of turmeric, 3oz. of gamboge, 1lb. of sandarac, and ¼lb. of white shellac into two quarts of alcohol. When dissolved, add a gill of turpentine varnish and shake thoroughly.)—Desideratum. (Under those circumstances, why do you not procure a list of the tools sold by the dealers, and so learn what can be had? For putting mainsprings in watches, see Nos. 889, 892.)—Apprentice. (Query too wide. "Making" would include cutting up the wood. You must ask definite questions.)—Shalford. (For methods of treating eczema, see pp. 109, 114, 135, 156, 178, 201, Vol. XXXVII.)—Striving. (Certainly, they are of practical application, and are used for many purposes in calculation—by engineers and others.)—J. Jones. (We gave the address—J. and A. Churchill is sufficient; but their place of business is in New Burlington-street, W. We do not know the price. 2. The *Analyst* is published by Bailliere and Co., King William-street, Strand, price 6d.)—X. Y. Z. (Drop the tea and coffee and feed on porridge with milk. For the rest, be guided by a medical man who has an opportunity of seeing the child.)—Anxious. (No better places than the Surrey hills.)—Purifier. (The best thing is to destroy them by fire; but the only safe disinfectant is baking at a high temperature.)—Veritatis Quæstor. ("Better definition" of what? It cuts off superfluous light. See the indices.)—Coup d'Œil. (How can any one say whether your sight is likely to be permanently injured? You must wait and see. In future, be more careful in looking at the sun without a dark cap, or, at least, a piece of smoked or coloured glass.)—G. W. Rothwell. (For directions as to fitting up horizontal bar, see p. 218, No. 633, where there is an illustration. You must have a good ash bar 2¼in. thick, and it would be well to purchase one with a steel rod run through it.)—J. B. Hopkins, Telegraphist. (In type.)

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**Lathe**, 2½in. centres, faceplate, and rests. 25s., carriage free.—Hancock, 81, Peter's-road, St Albans.

**Bell Wire**, double-cotton covered and paraffined, 110 yards, 3s. 2d, complete. List free.—Maw.

**Magnesium Ribbon**, 4 yards 1s., post free.—MAW, 8, Claylands-road, London, S.W.

First-class Astronomical **Telescope**, by Solomons and Cooke; equatorial, by Grubb, Dublin; 3½in. o.g., action and condition perfect.—Apply at once, D. Milligan, 21, Spencer-road, New Wandsworth, London.

What price and weight per foot 80ft. **Chain** up to guaranteed strain 8 tons.—C. B. A. Long, Melford, Suffolk.

**Polish** for Nickel, Brass, Silver, &c.; brings up the article equal to new. Surpasses all other polishes. Sample box, post free, 4d.; larger, six times as much, 1s. 2d.—F. Smith, 6, Westborough, Scarborough.

**Thought Reading**.—For 8 stamps will forward instructions which will teach anyone to become a thorough thought reader.—Below.

**Mesmerism**.—All can mesmerise. Instructions 8 stamps, never fails.—Below.

**Clairvoyance**, or Second-Sight.—Instructions 8 stamps. All three, 13 stamps.—G. Marquis, Allhallowgate, Ripon.

**Lathe**, back-geared, 6in. to 8in. centre, 7ft. bed, with traversing screw, slide-rest, and saddle, back centre, face plate, 11 change wheels, and overhead motion, £13.—79, Dudley-road, West Bromwich.

½ H.-P. Vertical **Steam Engine**, cheap, 50s. Stamp. —H. Calderbank, Vale-road, Bowdon, Cheshire.

**Electric Bells**, double, silk coils, mahogany case, &c., 4s. each, free.—Sledge, Wyatt, and Co., Clapham.

**Pendulum Indicators**, 3-hole, 15s.; 6-hole, 22s.; over 6, 3s. 6d. per hole.—Sledge, Wyatt, and Co.

**Hand Dynamos**, £2 10s. each, work small lamps, &c.—Sledge, Wyatt, and Co., 95, Wirtemburg-street, Clapham.

**Sounder and Key**, 30s.; single-needle instrument, 30s. (for learners).—Sledge, Wyatt, and Co., Clapham.

**Galvanometers**, highly finished, brass case, silvered divided dial, 1½in. diam., 20s. each.—Sledge, Wyatt and Co.

**Model Boilers** from 7s. 6d. each. Send stamp for list to J. N. M., 41, Cross-roads, Upper Wortley, near Leeds.

50in. Emperor **Bicycle**, suitable for learner, price £1. —B. Davis, 23, Brunswick-street, Ramsgate, Kent.

**Gas Engines**, simple, cheap and reliable, 1 M.-P. to 1 H.-P.—W. and J. H. Hill, York.

Steel **Tricycle**, specially designed for mechanical power, cost £35. What offers? Must sell.—W. H., 46, Newbro-street, York.

**Induction Coil**, 1in. spark, discharging pillars, commutator, and condenser, ebonite reel ends, on ornamental mahogany stand, price 50s.—Williamson, 61, Derby-street, Bolton.

**Cyanotype Paper**, 4d. per sheet. Specimen Print free.—Humphries, 5, Esher Villas, Shadwell-road, Holloway, London.

**Hull** of Steam Launch, 33ft. by 6ft. 6in., by Forrestts, of London, capital sea boat, decked, cabin aft, propeller, shaft, mast, spars, sails, anchors, chain, &c., price £60.—Apply, Robt. Jones, Shipbuilder, Rhyl.

**Launch Engines**, suitable for 25ft., 35ft., and 50ft. launches; boilers, propellers, and fittings complete.—S. Smith, 11, West-street, Soho, W.C.

Locomotive **Photographs**, job lot, cartes, six, all different, free 1s.—W. Algar, Stonard-road, Winchmore-hill, N.

**David Copperfield**—Lantern Photograph Blunderstone Church, 1s. P.O.—Geo. Waller, 2, Middlegate-street, Great Yarmouth.

**Launch Engines**, new, some second-hand, cheap. Please state requirements.—John Middleton, 16, Hope-street Glasgow.

**Lathe**, 4in. centres, self-acting, screw-cutting, new, a bargain.—John Middleton, 16, Hope-street, Glasgow.

**Cassell's Illustrated Travels**, Nos. 1 to 19, published at 2s. each, price £1.—J. H. G., 100, West-road, West Ham Park, E.

"**English Mechanics**," Vols. XXVI.—XXXVII., inclusive, ten newly handsomely bound, price £2.—27, Mount Pleasant-road, Lewisham.

Bichromate **Battery Cells** (flint glass) Bottle form, quart, 3s. 6d., complete 10s. Other sizes, larger or smaller much below list prices.—Wm. Whitham, Parker-street, Barnsley

24 **Microscopic Slides**, in box, very cheap. List sent for stamp.—Well, Dalmain-road, Forest Hill.

Silver-on-Glass **Mirror**, 7ft. focus, beautiful definition, flat to match, mounted.—S. Cooper, Charminster, Dorchester.

**Engine and Boiler** combined, 2-horse, £17. Boiler, vertical, 1-horse, £6.—79, Dudley-road, West Bromwich.

Powerful **Horizontal Engine**, cylinder 2in. by 1in., price £2.—Particulars and photograph from F. D., Brooklands, Dorchester.

**Lenses**, to form best quality of Panoratic Terrestrial Eyepiece, post free, 5s. 6d.; ditto for astro. eyepiece, free, 2s. 6d. —Wm. Nicholl, Roslea, Clones.

**Binocular Telescope**, 50s. Large Field Glass, by Steward, 35s. Elegant pearl Opera, 15s.—99, City-road.

Valuable Photographic **Apparatus**, by order of executors, Ross and Dallmeyer Cameras and Lenses.—99, City-road.

Powell and Lealand **Microscope**, 2 eyepieces, 3 objectives, accessories, glazed cabinet, only £7.—99, City-road.

Astronomical **Telescope**, 3 inch achromatic, three eyepieces, garden-stand, and case complete. Price £9 10s.—K., 33, London-road, Maldon.

**Photographs**, Scottish Scenery, cabinet size, extraordinary value, 4d. each.—Address, Photo, 182, Trongate, Glasgow.

**Gelatines** for tracing Magic Lantern Slides, 3¼ size, 4½d. dozen.—Address, Photo, 182, Trongate, Glasgow.

**Incandescent Carbon Lamps**, low resistance, 3s. each; Fairy Lamps, 3s. 6d.; Platinum Lamps, 1s. 3d., post free.—Todd, 14, Wentworth-road, Manor Park, Essex.

**Incandescent Lamp Holders**, new pattern, best in the trade, 12s. dozen; sample, post free, 1s. 3d.—Todd, as above.

**Formulas Worked Out** for winding Dynamos from 10 c.-p. to 500 c.-p., 8 stamps each.—H. Jones.

**Dynamo Castings**, 100 c.-p., cog armature, Gramme fields, 9s. a set. Motors with patent armature, 3s. a set. —H. Jones.

**Dynamos**, patent improvements, No. 2,192. 70 c.-p. machines, £5. 32 volts, 7 ampères.—H. Jones.

**Dynamos**, best small machines in the trade, and cheapest double-covered Wires to 20 gauge, 1s. 8d. 1b.—H. Jones.

**Dynamos** for Home Lighting.—5 lights, or arc of 500 c.-p. Price £6 10s., approval. Warranted.

**Dynamo Castings**, with laminated armatures, 8 c.-p., 5s.; 16, 5s. 6d.; 20, 6s. 6d.; 30, 7s. each.—H. Jones.

**Dynamo**, laminated armatures, no heating, ventilating; 70 c.-p., 16s. a set; finished, £5. Warranted.—H. Jones.

**Dynamo Machines Repaired**. Motors, with wire, 5s. 6d.—H. Jones, 48, High-street, Lambeth, S.E.

**Lathe Heads**, Slide-rests, Beds, Standards, Flywheels, Cranks, Chucks, and Accessories, rough or finished. See list.—W. R. Smelt.

**Machine Work Done** on customers' materials, best workmanship, at moderate prices. Estimates free. Send particulars.—W. R. Smelt.

**Turning**, Boring, Planing, Screw-cutting, Forgings, Patterns, &c. No charge for estimates or advice.—W. R. Smelt.

6in. centre single-speed **Lathe**, V and flat bed, slide-rest, Chucks, &c., equal to new, £13.—W. R. Smelt.

**Enlarged and Revised Price List**, 1 stamp.—W. R. Smelt, Engineer and Tool Maker, 7, Goldsmith's-row, Gough-square, E.C.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
*FRIDAY, APRIL* 17, 1885.

## WATCH AND CLOCK MAKING.*

THERE cannot be much doubt of the decadence of the clock and watchmaking trade in this country during the last twenty years; but it may be questioned whether that decadence is altogether due to the entire absence of any system of technical education, although the want of some means of technically training the rising generation of mechanics and artisans must exercise a potent effect on the future of any trade. Mr. Glasgow would probably agree with us that for the very highest class of work Clerkenwell still retains its place, and it is mainly because the trade has been too conservative—too much attached to old practices—that other countries have taken the lead in the production of the commoner kinds of watches, while the manufacture of cheap clocks seems never to have formed a portion of the trade of this country. A change has, however, been brought about within recent years, and there is rising up a generation of watchmakers who, while skilled in all the necessary manipulations, will possess that technological knowledge of the subject which should place them in the front rank of horologists. So many books have been published on watch and clock making that Mr. Glasgow felt some hesitation in accepting the task of writing this work, which forms one of the "Manuals of Technology" issued by Messrs. Cassell; but his desire to promote the educational movement now going on overcame his hesitation, and we have as the result a textbook which, in a moderate space, contains a vast amount of theoretical and practical instruction. Commencing with a chapter on Time Measures, the author briefly but very clearly points out the difference between a sidereal and a solar day, explains the use of the transit instrument, quoting Latimer Clark's instructions for applying it in the determination of time, and Ferguson's directions for tracing a meridian, giving also a short account of Bloxam's dipleidoscope. The historical notes on sundials, clepsydræ, sand glasses, and clocks are necessarily brief, but Mr. Glasgow has contrived to give an epitome in a few paragraphs. Referring to the English clock trade, he tells us that with the exception of turret clocks, it never has attained to any importance, while of late years the manufacture of house clocks may be said to have almost entirely left us. The French took the "drawing-room clock" trade out of our hands, their taste and artistic education having enabled them to produce goods which have entirely superseded the English clocks of that class. With the exception of turret clocks, first-rate regulators and quarter clocks, and a few eight-day and school clocks, the manufacture is practically unknown in this country, because, as Mr. Glasgow puts it, English makers used no efforts to supply obvious public requirements either in the way of cheapness or elegance. Even the eight-day kitchen clock is being hard pressed by the cheaper importations from Holland, Belgium, Germany, and America. The quarter clock has, however, never been rivalled by any foreign production, although a number of imitation quarter and other old English clocks have been imported from France. The imitation article can, however, be readily detected, it seems, by noticing the distance apart of the winding squares, for in the English clock the movement corresponds in size to the dimensions of the case, whereas in the foreign imitation the movement bears but a small proportion to the large and showy exterior, and the winding squares are consequently comparatively close to one another. Regulators and astronomical clocks are not in sufficient demand to become a wholesale manufacture, and in that line we have actually a small export trade, for with the exception of some inferior productions from Austria and Germany, there are no foreign makers. The French have nearly the whole of the trade in marble, gilt, and carriage clocks, while the Americans have beaten the Germans out of the field with their cheap kitchen and bedroom timepieces and alarums. Mr. Glasgow devotes more space to the history of the watch, which has been gradually developed since the invention of the mainspring by Peter Hele, of Nuremberg, circa 1500. Cheap watches are made at Liverpool, Coventry, and Birmingham, and factories have been established at the two latter towns, to compete with the large number of American factory-made watches. These, it must be confessed, are so good in their way that they are serious rivals of the cheaper makes of English watch, and are preferred to those manufactured in Switzerland. The attention of the English watchmakers has been devoted rather to improvement in the quality of their goods, than to cheapness of production, and it is a question whether the introduction of the factory system and the wholesale adoption of machinery would altogether benefit the trade here. As Mr. Glasgow says, "English watches have always commanded their price in the markets of the world, and the good name they have ever borne has led to their imitation by foreign producers, both by the forgery of English makers' names, and of the English hall marks in the cases." It is advisable to keep up the high standard of excellence achieved by our Clerkenwell horologists; and if we are to produce a more marketable article, proceed in the right direction by "organising our system of manufacture, by altering and improving the plan of our movement (not by the elimination of the fusee, but by, amongst other things, the total abolition of the full plate in favour of three-quarter and half-plate movements), and by imparting more intelligence and education among our workmen." There can be no doubt about the advisability of organising the manufacture, and giving the best technical education to apprentices; but we imagine that Mr. Glasgow will not find everybody agreeing with him as to the best plan of movement, and the divergences of opinion will increase as watchmakers become more and more technically educated. The parts of a watch known as the movement, that is the frame, fusee, barrel, wheels, and pinions, have been made at Prescot in Lancashire for many years, whence they are sent to the three places above mentioned, though the bulk of the trade is done with London and Coventry. The choice of Prescot as the seat of this trade came about in this way: When watchmaking for export became an important business in Liverpool, it was soon evident that it would be economy to have the rougher parts made in villages by less skilled workmen, and finish the watch in the town. Accordingly Prescot, being near Liverpool, and having a reputation for making the best files and other tools, was chosen; and there, thanks to the energy of Wycherley, movement-making has been firmly established, for he erected a factory, put down several costly machines, by which ultimately he was able to supply the trade with movements in eight standard sizes, at a very low price. His successor followed the lead, and at Prescot they now turn out movements with the keyless work attached, which are superior in quality to the Swiss, and compare favourably with them in price. This fact, that the movements are made by those who are not watchmakers, accounts for the difficulty experienced in introducing changes; for the Prescot manufacturers, puzzled by the conflicting opinions and requirements of the watchmakers, have failed to make any improvements in the design of the movement, and a bad model for a cheap watch was allowed to keep the field until the trade woke up to the fact that a large portion of their business was leaving them. The factories established at Coventry and Birmingham, of course, make the movement on the premises, and may ultimately work a revolution in the trade. Mr. Glasgow has nothing but condemnation for the "full plate" movement found in the bulk of English watches; for, in the first place, it makes a thick and clumsy-looking watch, in which the hands cannot be set without opening the cover, and as the square of the cannon pinion must project above the minute hand, there must be more room between the dial and the glass than is wanted for the clearance of the hands. There is an arrangement for setting the full-plate watch from the back, but Mr. Glasgow says it is so bad it is not worth describing. If its external defects are so serious, its internal arrangements are positively bad, and yet "it is still considered to be *the* English watch, nearly all the Coventry watches being of that construction." The plates for the movement are stamped out in Birmingham, whence some of the Swiss manufacturers obtain their supplies, and labour-saving machines are used wherever practicable and economical. In the case of screws it would seem that a machine is not wanted, for Mr. Glasgow tells us he saw a man making them in an ordinary hand-throw at Wycherley's factory. So expert was this workman that "he turned down the body of the screw, tapped it, rounded and burnished the end, tapered the head, and cut it off in 15 seconds. These were bar screws—pillar screws took a little longer, he made three of those a minute, repeating this operation several times while I watched him, and he appeared to be in no hurry over his work." Here and there throughout the volume the author loses no opportunity of expressing his opinion about the "full plate," and it would be fitting for some of those who defend it to answer Mr. Glasgow's objections. The succeeding chapters to that on the movement are necessarily of a technical character, but in that on wheels and pinions, the theoretical and practical information is sufficient for the student, while in that on trains, the reasons why the Nos. 18,000, 16,200, and 14,400 are adopted in different makes, are clearly explained. In the chapter on the fusee and mainspring there is matter to interest any mechanic, whether he has a watch or not; and in that on chronometer and watchmaking, there are many points which should be carefully studied by the apprentice or pupil, for Mr. Glasgow does not believe in the old apprenticeship system. Here is a point, for instance, where the author says, "if watch finishers, or even examiners, had thoroughly understood the uses of the adjusting rod, and freely used it, half the faults that have been found with the fusee watch would have been avoided." Amongst those who buy many are attracted by the statement that the watch is jewelled in such or such a number of holes. On that point Mr. Glasgow says: "I have heard men argue that the third and fourth wheel holes of a watch would be better to be of good brass than to be jewelled. I am sure there are thousands of English watches that would have gone longer and cost less to repair, if they had been jewelled in a few more holes. The Swiss, on the other hand, jewel their very worst watches in as many holes as possible, and do it so badly, that brass holes would in many cases be preferable." Mr. Glasgow writes at considerable length on escapements, the balance spring, and the compensation balance, and he also gives some interesting information on keyless watches with the fusee—the stem-winding arrangement, which promises to become fashionable, being much more easily applied to the going-barrel watch. Keyless watches were, it seems, first made by Peter Caron, of Paris, in 1752; but the first invention of the kind which was adopted by the trade to any extent was that of Prest, of Chigwell, who in 1820 took out a patent for winding a watch by the pendant knob. Since then, and more especially in recent years, several forms of keyless work have been devised; but, as Mr. Glasgow says, if many watches are to be made on this principle, it would be better for the trade to adopt one form; and keep to it. The keyless work is, however, nearly all done in Lancashire by the movement makers, thus for the ordinary run of watches securing the best model, great uniformity, and cheapness of production. Pendulums and compensation pendulums for standard clocks and regulators receive a due amount of attention from Mr. Glasgow, who says that the zinc and steel compensation pendulum is probably more suitable than any other for all very large clocks, as it is cheap and sufficiently accurate. That is perhaps faint praise, for, according to Sir G. B. Airy, the zinc and steel pendulum applied to the Greenwich sidereal clock answered quite as well as a mercurial pendulum. Of dead-beat and gravity escapements, Mr. Glasgow says that Graham's device is the one generally applied to all the better clocks with seconds pendulums, for which it is best adapted; but it is not so suitable for smaller clocks with shorter pendulums, or where springs are used for the driving power. The gravity escapement of Sir E. Beckett is the best for all very large clocks where the hands are exposed to the action of wind, as it admits the application of great driving power without sensibly affecting the escapement by increased resistance to unlocking. The performances of the Westminster clock effected a revolution in the turret-clock trade of this country, and produced a revival of an industry which was rapidly declining. There seems no good reason why clocks should not be made as cheaply here as anywhere, remembering that quality is the test of cheapness. Says Mr. Glasgow; "If a factory or factories could be established here with sufficient capital and machinery, there is no doubt we could make clocks cheap enough to compete with all comers. I believe that at present only the movements of the American clocks are imported, the cases and fittings being made more cheaply here; and these movements are poor things." We have, however, reached the limits of our space; and in taking leave of Mr. Glasgow's manual, we must say that it is just what a technological handbook should be, for it explains the principles and the practices side by side, as it were, and gives sufficient details to enable the student to thoroughly comprehend the subject.

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* Watch and Clock Making. By David Glasgow, London, Paris, New York, and Melbourne: Cassell and Co.

## THE ELECTRICAL EXHIBITION AT THE PARIS OBSERVATORY.

THE Société Internationale des Electriciens under the presidency of M. Berger, has held a very interesting exhibition in the galleries of the Paris Observatory, which Contre-Amiral Mouchez kindly left at the disposal of the electricians for their attractive displays. Our readers will not expect to have anything altogether new since 1881, and the Electrical Congress. However, even to the superficial observer, this exhibition, though on a much smaller scale than that of 1881, shows a striking progress in the fixity of the electric light.

The necessary power was supplied by steam engines, making a total of 200 h.p. About 500 incandescent lamps and 50 regulators were distributed in the building.

M. Gerard exhibits three dynamos, absorbing each 3½ h.p. and giving each a current of 100 volts and 20 ampères.

The first of these dynamos lights 32 incandescent lamps of 25 candles each. The second 21 lamps of 50 candles, and the third lights four lustres of 21 lamps of 25 candles each. M. Gerard also exhibits a smaller dynamo of ½ h.p. lighting 6 lamps of 12 candles, or 4 lamps of 25 candles, or 3 of 50. M. Gerard's 12-candle lamps require from 16 to 18 volts and 1½ ampère; the 25-candle lamps require 25 volts and 2 ampères; the 50-candle lamps 30 volts and 2½ amperes.

Among the other incandescent lamps we notice those of Edison, Swan, Maxim, Cruto, Aboilard; among the regulators Breguet's, Cance's, and Siemens'.

The Société d'Electricité exhibits a Gramme machine absorbing 8 h.p., which works an endless saw, a printing press, a ventilator, a motor for turning the great dome of the Observatory and lights a 500 Carcel regulator in the said dome. The Hotel de Ville of Paris, and the Ecole Centrale are furnished with ventilators worked by Gramme machines.

One of Colonel Mangin's projectors sends forth a brilliant cone of light from the terrace of the Observatory, casting long and dark shadows, which puzzle the foot passengers, and cause a stumble now and then. The light from this projector was powerful enough to enable me to photograph the fountains of the Luxembourg with its dark green statues. The distance is about 450 yards from the Observatory.

Experiments and auditions, with the Ochorowicz loud-speaking telephone have been very successfully conducted at this exhibition. Not only cornet playing and singing were transmitted, but also the accordion, and even the violin, were well heard by a whole room of visitors. This telephone is described on page 97 of the English Mechanic. Even without the microphone, Dr. Ochorowicz's telephone gives the loudest transmission of speech that I ever heard. For the auditions at the Observatory, the loud-speaking telephone was used in connection with Dr. Ochorowicz's thermo-microphone.

M. Estienne exhibited a new form of Morse telegraph, in which the dots and dashes are replaced by short and long vertical strokes. This result is obtained by two pens which can be made to press against the strip of paper by means of an electro-magnet and suitable levers. The inversion of the current is obtained by a transmitter like that of the single-needle-telegraph. The telegrams are much more easily read with this system than with the ordinary one. It is easily seen that by pressing longer on each key of the transmitter, we may also obtain thick signals, so that we may have four different signals with M. Estienne's instrument.

M. Carpentier's exhibition is almost wholly devoted to electrical measures. We notice the standard ohm as fixed by the Congress of Electricians. M. Lippmann's new and ingenious ampère-meter is shown by Breguet. In this instrument a tube containing mercury is fixed at right angles to the poles of a magnet. The current to be measured passes through the mercury, which is put in motion according to the laws of electricity; the metal rises or falls in a graduated tube, and thus indicates its intensity.

Two railway companies have sent specimens of their electrical appliances.

Among the various apparatus exhibited by the Chemin de Fer du Nord, let us notice the "crocodile." It consists of a slanting piece of wood covered with brass which is placed in the middle of the two rails. A metallic brush is fixed underneath the locomotive so as to brush over the "crocodile" when the train passes at that spot. Now if we connect one pole of a battery to the crocodile and another to the rail, it is clear that when the train passes, the circuit will be closed, and may be made to ring a bell at a distance and announce the train. M. Sartiaux has improved this contrivance by putting two parallel brass strips to the crocodile instead of one. Two separate circuits can thus be closed by the locomotive, and they are thus utilised. The crocodile is placed about 200 yards before the disc. If the line is open (*i.e.*, not blocked by the disc) the train goes by, brushes the two strips of the crocodile and announces itself at the next signal-box. The signal-man, of course, immediately blocks the line by turning the red disc at right angles to the rails. Now, suppose another train follows and the driver does not see the disc on account of fog, for instance, not only the train will announce itself as the first one did, but moreover, it will be automatically stopped, for when the disc blocks the line, a second battery sends a current in the second brass strip of the crocodile and passes through an electro-magnet in the machine, which puts the air-brake on. All accidents are thus avoided.

In the exhibits of Paris-Lyons Company, the train announces itself by running over a pedal placed on one side of the rail; this overturns an iron cylinder containing mercury which closes a bell circuit. In M. Chaperon's device the trepidation of the train causes a ball carried by a horizontal spring to tremble. This breaks a current which passes continuously when the ball is horizontal (for it then rests against a vertical spring which closes the circuit) and rings a bell by interrupting the current.

This exhibition is certainly a very great success; but, unfortunately no means have been taken to prevent overcrowding by a too-numerous, unscientific public. Nevertheless it has been sufficiently complete to show that electricity means to maintain its noble device—*Quo non ascendam.*

**C. Detaille.**

## SIMPLE EXERCISES IN TECHNICAL ANALYSIS.—VI.

By An Analytical Chemist.

### Green Paints.

Common Green (Mixed).

67. *Composition*:—

| | | | |
|---|---|---|---|
| Chromate of Lead | 2·56 | 4·6 | 24·9 |
| Prussian Blue .... | 4·73 | | |
| Oil .............. | 8·57 | 8·6 | 13·3 |
| Sulphate of Baryta | 80·02 | 72·6 | 55·5 |
| Chalk ............ | 4·12 | 14·2 | 6·3 |
| | 100 | 100 | 100 |

68. *Chromate of Lead.*—Dissolve the residue after ignition in dilute nitric acid, filter from any insoluble (sulphate of baryta, &c.), add ammonia to the filtrate till just alkaline, and hydrochloric acid till just acid, pass $SH_2$ gas to precipitate the lead as sulphide. Treat as described in Art. 11, weighing as sulphate of lead, and multiplying by 1·06766 for the equivalent of chromate of lead.

69. It is necessary that the last calculation should be verified by estimating the chromium present. The chromium, if precipitated as described in Art. 46, would be mixed with the iron from the Prussian blue, and any alumina that might be present. Alumina is not usually found in these paints, and the only substances to be separated are the chromium and the iron. This may be done in either of two ways.

70. *Separation of Iron and Chromium.*

(*a*) Add ammonic chloride and ammonia, as described in Art. 46.

This precipitates as hydrates, both the chromium and the iron. Dry, and ascertain the total weight of the two oxides. Fuse with a mixture of potassic carbonate and nitre to convert the chromic oxide into a soluble salt. Wash thoroughly with hot water, and weigh the insoluble iron as $Fe_2O_3$. Subtract this weight from the total weight found above, and the remainder gives the weight of oxide of chromium ($Cr_2O_3$) dissolved out. The latter may also be reprecipitated from the soluble portion by adding ammonia as before.

(*b*) Or instead of precipitating with ammonia, caustic potash or soda may be used. The chromic hydrate at first precipitated is readily soluble in excess of potash or soda, while the ferric hydrate remains insoluble. Add, therefore, potash or soda in excess, filter the insoluble ferric hydrate, wash thoroughly in hot water till every trace of the alkali is removed, dry and weigh, as in Art. 34. This gives the weight of oxide of iron. To the filtrate add chloride of ammonium in excess. This reprecipitates the chromium as hydrate. Dry and weigh as before.

From the weight of chromic oxide, the amount of chromate of lead in the sample can be calculated, as in Art. 46. The percentage thus found should agree very closely with that found by estimating the lead. Should the latter be in excess, salts of lead other than the chromate are present—probably the carbonate or sulphate. These may be estimated by difference in this way: The weight of chromate of lead is calculated from the chromic oxide; the amount of sulphate of lead corresponding to this chromate of lead is found by multiplying by 0·9366. Subtract the sulphate of lead from that found by estimating the lead as above (Art. 68); the difference is the amount of sulphate of lead present in the sample. If white lead, and not sulphate of lead, is found to be the salt present, multiply this difference by 0·8525 for the amount of white lead.

(71.) *Prussian Blue.*—Multiply the percentage of oxide of iron found in either of the last two processes by 2·1142 for the percentage of Prussian blue, as in Art. 59.

The other constituents are determined as already described.

### Brunswick Green Paints.

(72.) *Composition*:—

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Chromate of lead and Prussian blue | 19·79 | 20·3 | 4·79 | 29·7 |
| White lead ...... | — | 79·7 | — | 62·5 |
| Sulphate of lead.. | — | — | — | |
| Oil .............. | — | — | 9·75 | — |
| Sulphate of baryta | 77·51 | — | 71·24 | — |
| Chalk .......... | 2·00 | — | 14·22 | 4·6 |
| Moisture ........ | ·70 | — | — | 3·2 |
| | 100· | 100· | 100· | 100· |

The method of analysis is similar to that for common green paints.

(73.) *Estimation of Chromate of Lead* (another method).—Boil the dry paint or the residue after ignition in caustic potash or soda to dissolve all the chromate of lead. Filter and wash; make the filtrate just acid and pass $SH_2$ gas to precipitate the lead, which is weighed as sulphate as before. The chromium is precipitated from the filtrate by ammonia, and filtered as in Art. 46; weighed, and the equivalent of chromate of lead calculated. The filtrate left after the chromium has been separated is tested qualitatively for other substances (chalk, &c.), or added to the main solution.

The insoluble in potash is boiled in acids, and anything left insoluble weighed and examined. The acid solution is freed from lead, if any is present, and any other substances in solution are precipitated and weighed as already described.

This method, when properly performed, requires less time than the other.

### Engine Green Paint.

(74.) *Composition*:—

| | | |
|---|---|---|
| Mineral matter ............ | 44 | 45·35 |
| Oil and varnish ............ | 56 | 54·65 |

(75.) This paint, as the name denotes, is used for engine painting. It differs from ordinary paints in having as a constituent varnish, which in good samples is made from copal of best quality. It is usually sold in a state ready for use. The mineral matter corresponds with that found in an ordinary green paint.

The presence of varnish is easily detected by allowing the sample to stand over night, when the varnish floats on the top. Its amount can be roughly approximated by measuring this upper layer. Its quality is ascertained by spreading the varnish with a brush on paper, and allowing it to dry. If the varnish has been prepared from best copal, it will dry very rapidly (in a few hours or less). Experience will soon enable the analyst to distinguish between good and bad varnishes.

The percentage of oil and varnish is usually estimated as for oil.

### Metallic Green Paint.

(76.) *Composition*:—

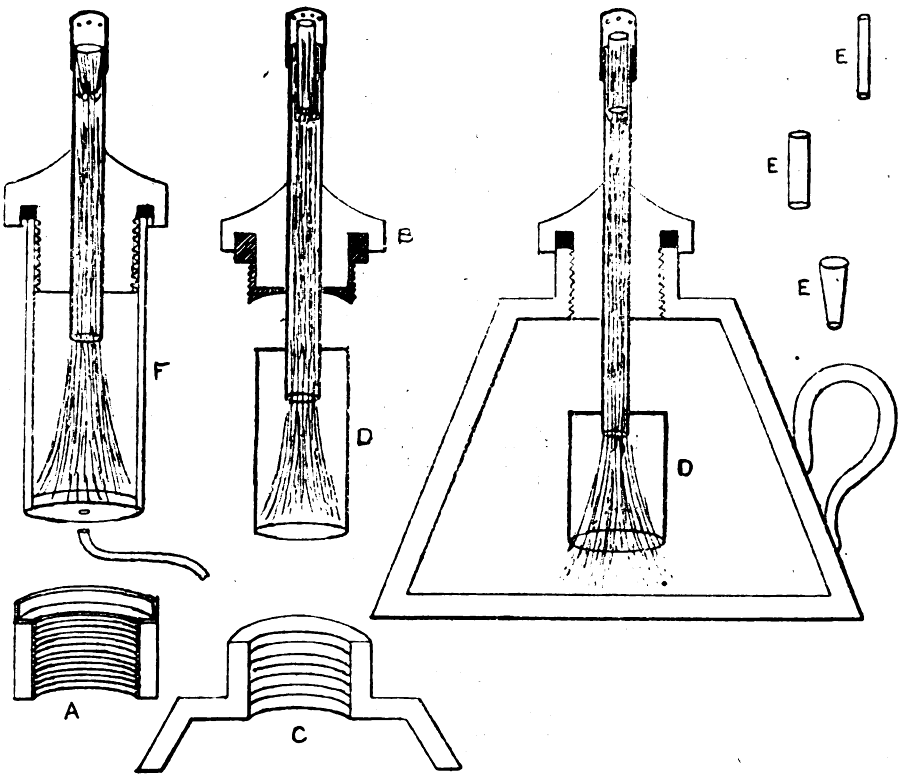
| | | | |
|---|---|---|---|
| Chromate of lead and prussian blue .... | 17·41 | 72·61 | 33·85 |
| Oil ................ | 12·06 | 24·47 | 10·35 |
| Sulphate of baryta .. | 67·35 | 2·34 | 50·92 |
| Chalk .............. | 3·18 | ·58 | 4·88 |
| | 100· | 100· | 100· |

The method of estimating is the same as before.

### Emerald Green Paint.

(77.) *Composition*:—

| | |
|---|---|
| Arsenite of copper ............... | 79·57 |
| Oil.................................... | 16·31 |
| Sulphate of baryta ............... | 4·30 |
| | 100·18 |



(78.) *Oil.*—In this case the oil must be determined by extracting with ether or other solvent, and weighing the residue when dried.

(79.) *Arsenite of Copper.*—A weighed example is ignited and the amount of residue determined. It is then treated with nitric acid and any insoluble (sulphate of baryta) weighed. The arsenite of copper is then estimated in this way: Boil off the filtrate nearly to dryness, add dilute sulphuric acid, and boil again till all the nitric acid is expelled. When cold, dilute largely and boil. When boiling add thiosulphate of soda (hyposulphite) until a black precipitate is no longer produced, and the bulk of the liquid is white from precipitated sulphur, then filter and wash, and dry at 100° C. Transfer the precipitate to a sheet of paper, and from the latter to a tared crucible; remove with sulphur the last traces of copper adhering to the paper, add the sulphur to the precipitate in the crucible, until it is nearly filled; then burn in an ignited jet of hydrogen until all the sulphur disappears. The crucible, when placed in the stream of hydrogen, is gently heated at first, afterwards strongly; and finally, it is allowed to cool, with the hydrogen gas still flowing upon it. In this operation the copper is converted into $Cu_2S$, from which the percentage of arsenite of copper is found by multiplying by 2·389.

This amount may be checked by subtracting the weight of sulphate of baryta found in the above sample from the weight left after ignition. The difference is the weight of CuO from which the arsenite is found by calculation.

### Green Bronze Paint.

(80.) *Composition*:—

| | |
|---|---|
| Insoluble silica and alumina ...... | 22·55 |
| Oxide of iron ........................ | 16·80 |
| Chalk ................................ | 37·10 |
| Chromate of lead ................. | 7·65 |
| Prussian blue ....................... | 4·54 |
| Soluble in water (sulphates and chlorides of soda and magnesia).. | 6·10 |
| Oxide of manganese and loss...... | 5·26 |
| | 100· |

### Sea-Green Paint.

(81.) *Composition*:—

| | |
|---|---|
| Prussian blue ....................... | 0·59 |
| Chromate of potash ............... | 1·83 |
| Sulphate of baryta.................. | 71·88 |
| Chalk ................................ | 12·96 |
| Oil.................................... | 12·74 |
| | 100·00 |

These paints are not of common occurrence, nor is the method of analysis difficult. We must therefore content ourselves with giving the composition, believing that they are not of sufficient importance to justify a special description.

## WOOD'S GAS-MAKER LAMP.

THE following is a description of the Gasmaker Lamp for burning benzoline and similar hydrocarbons patented by Mr. T. Wood, of Blindley Heath, Godstone, which is stated to have the following special parts and improvements forming the claims in the patent:—1st. An airtight neck at the screw of burner, in connection with compressed wick secures a safe lamp. 2nd. Economy of wick, time, and trouble, by use of small tube at burner cap. 3rd. Prevention of flooding wick by use of air chamber. 4th. Small size solid tube for supply. The lamp called the "Wood Gas-maker Lamp" may be made in metal, china, glass, or earthenware. The neck of the reservoir A must be made with a ledge or shoulder at the top of screw inside; a washer of leather, or other elastic substance must be made to fit the shoulder and to run on the screw of the burner tube. Or preferably, the B flange of the burner screw can be made with a channel, so as to allow the neck of reservoir to slide or screw within, and render the neck perfectly airtight at the screw, using the washer before mentioned. An air chamber, D, of convenient size is attached to the burner tube or flange, to prevent the flooding of the wick by the liquid. The air chamber is closed to the burner tube, or to the flange, at the top of chamber. The conducting wick is very tightly compressed in the burner tube, to just below the charring point of the cotton or wick, and from there it is met by a smaller tube and wick to supply the burner proper. E, the smaller tube, may fit the burner tube either loosely or tightly at the junction of the cap; if a loose tube is used, the wick drawn through must be returned back evenly to exclude the air. Or to attain the same end (but not so well), cotton, asbestos, or other conductive material may be used instead of the small tube. These, if used, must fit loosely. With respect to fixed lamps in which the air chamber is optional, they are supplied with liquid by solid-drawn tubing of the smallest convenient size, G, so that the bulk of the liquid may be at any safe distance from the light. The size also of the fixed lamps with supply tube can be greatly reduced. The engravings show the different parts with two kinds of lamps and three sizes of burner tube, E.

## THE REAL VALUE OF LUBRICANTS.

IF steam-users, as a body, were asked the simple question "What is the real value of a lubricant?" very few of them would be able to give a correct answer. In the majority of cases, the reply would have reference to the market prices of the different oils or lubricants, and in very few would the answer dive so far into the matter as to compare the lubricating value with the price per gallon of the oil. But the real value of any lubricant has little to do with its market price, for it depends, not only on the intrinsic qualities of the unguent itself, but also upon the economical conditions under which it is to be used. Prof. R. H. Thurston has recently presented the subject in this aspect to the notice of the American Society of Civil Engineers, and has promised to develop it more completely in the future. His note naturally takes the form of mathematical formulæ to a large extent, and will probably not attract the attention of the average steam-user so much as it might have done. According to Prof. Thurston, the correct method of comparing prices of lubricants from the user's standpoint is not one involving merely a determination of the properties of the material as a reducer of friction, and the true value of the oil is not simply proportional to its endurance and its power of reducing lost work: it includes a study of the method by which it reduces the total expenses of lessening the friction, and the extent to which the total expense for power is lessened by the reduction of work wasted in friction. The usual systems of comparison are entirely wrong, and are justifiable only by the fact that, hitherto, it has been impracticable to obtain the data required for the establishment of a correct method. Every student of the subject knows that between the power lying latent in the coals and that produced at the machine there is an enormous loss, much of which cannot be prevented so long as a steam boiler and engine intervenes. The limits of economy are tolerably well determined nowadays, and so long as they are approached the average steam-user is satisfied; but when we come to the machine itself, and look to the lubricant, we find that unless the latter is adapted to the former, and supplied in proper quantities, there is a large, and in many cases unsuspected, loss. The total cost of the lost work in machines includes, in fact, two items—the cost of lubricant, and the cost of doing the work of overcoming the friction of the lubricated surfaces. Of these items, the latter is by far the greater, and it follows that a slight saving of actual money paid for lubricants is of no practical importance in comparison with a saving of equal proportion in the cost of the power demanded to overcome friction. The cost of power includes fuel, salaries, interest on the capital invested, &c., which can be readily estimated at so much per horse-power per annum when the data are available, as they are to most steam-users. If that is known, and it can be shown that another lubricant will reduce the loss by friction to a certain amount, it then becomes a question whether the saving by the reduction of wasted power more than covers the extra cost of the superior lubricant. In the majority of cases it will be found to do so, but it may also happen in some cases that it will be more economical to use larger quantities of a lower-priced lubricant. The datum required first of all is the cost of friction, and then, when two oils are to be compared, an easily-worked formula will show the total expense per hour, the quantity of oil used being known, as well as the magnitude of the co-efficient of friction, and the cost of the lubricant. Prof. Thurston shows by examples the magnitude of the losses which are going on in consequence of the want of knowledge in purchasing lubricants and in using them. It is obvious that the value of the co-efficient of friction is the principal factor in the question, and the experiments made by Prof. Thurston show that, for instance, in light machinery, such as spinning frames, different oils will give figures varying from ·10 to ·25; under the pressures usual in heavy mill shafting the figures range from ·05 to ·10; with pressures of greater intensity, such as in the steam-engine and railroad axles, the co-efficient of friction varies with different lubricants from ·01 up to ·025, the first value being given by the best oils, the second by heavy greases. The endurance of the lubricant also varies in similar degree, and is twice as great with the best oils for the given purpose as with others of good reputation. Further, the price of the lubricant is no guide at all, for the best oils to use may be either more costly or much lower in price than others less well fitted for the work. Sperm, lard, olive, and other standard grades of oils have probably fair and well settled values, but, as a rule, the price of a lubricant is not a safe guide to selection.

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A LARGE number of signal lamps are being fitted on the Great Western Railway with electric lamps.

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# THE LIFE OF AN OYSTER.[*]

By Prof. Samuel Lockwood, Ph.D.

THE time was when it was enough to say of a living thing that it lived. You remember the Fool's question in "King Lear,—

> Canst tell how an oyster makes his shell?

This was simply a proverb of old. Here was a little creature, a mere clot of animate jelly, capable of building for itself a house of stone. How it did it, who could tell? No one. The Fool's question was a puzzle to the wisest. Indeed, then, and long after, it was hardly safe to seem to know too much. To-day, however, the question may be put, not only how does the oyster make its shell, but also how does the egg make the oyster? Science, now, can describe the building of the house, and can narrate the life-history of the builder and occupant. Two years ago I lectured in this place on the oyster. I desire that my address to-night shall be wholly distinct from that one. Yes, as my lecture-notes are always very brief, it is easy to forget what was said so long ago; hence I shall trust to your charity should I unwittingly at some point repeat myself. I recollect that the longest part of that lecture was devoted to the physiology of the oyster—that the three vegetal systems were discussed at length—namely, the nutritive, or food system; the circulatory, or blood system; and the respiratory, or breathing system. The nerve system was also considered in detail. Now, my desire when coming here was to make no reference to any of these four sets of functions. But I have been requested to dwell a little upon the nutritive, or digestive group of functions; and this I am glad to do, because it will enable me to speak of an organ the use of which was not known at the date of my former lecture.

You will remember that I had some large carefully-drawn diagrams. The fear of repeating myself induced me not to bring them; hence you will please follow my rude illustrations on the blackboard. I will now with the crayon outline an oyster shell. This is the right valve, the one from which the mollusc is eaten when taken on the half-shell. This large spot which I make is the adductor muscle, with which the creature pulls together its shells. It is the part which is cut through with the knife when the caterer opens the bivalve. Well to the left of this I draw four plates, or leaves, so lying on one another as to show their outer edges, which give the appearance of a frill. This series of plates constitutes the gills or breathing apparatus. Now, here we find the inner edges of these four plates to be, so to speak, soldered together, making the base of the gills; and along this base, in rows, is a series of holes. The plates are really composed of an infinite series of microscopic tubes, each tube being like a tiny flute with holes on the side. The water enters between the plates, and as the surface of the tiny tubes is covered with cilia, or fleshy hairs, these keep up a lashing by which the water is driven through the gill-tubes, and the air contained in the water is deprived of its oxygen; after which the disaërated fluid passes out at the holes in the bases of the gills. The coarse cilia, or beard, on the edges of the mantle, or thin film which enwraps the oyster, by their action make an eddy at the opened valves, into which the water rushes, bringing in the food. The outer surface of the gills is covered with the minute cilia, all helping to drive the inflowing current upward. Here at the uppermost end of the oyster, near the hinge, are four little plates, not lying upon one another, as the gill-plates do, but standing together, as it were. These are the labio, or lips of the oyster; for, in fact, the creature's mouth is simply the orifice between these two pairs of lips. When the food-laden water reaches this spot, the lips begin a sorting process, by which that which is fit for food is allowed to enter, and the unfit is rejected. The oral aperture is almost immediately over the stomach, the passage being too short to be properly called a gullet, or œsophagus. Yet the word is convenient. Thus the stomach receives the food immediately. The dark grey mass in which this organ is embedded is the liver. The oyster's stomach is literally inside of its liver. Let us now note the course of the intestinal tract. Beginning at the lower end of the stomach, or where in our own structure would be the pylorus, the intestine runs to a point considerably beyond the middle of the adductor muscle, between that and the gill bases. Here it doubles upon itself. Then, returning, it passes through the liver to a point near the oral cavity, or mouth, which it sweeps nearly over; and, winding round the liver on its other side, and then going beneath that organ, it passes beyond to the other side of the adductor muscle, in front of which the vent rests in an open space which we will call the cloaca. Here it voids its indigesta, which are immediately committed to the sea.

The liver, as you know, is bitter, a quality which the Roman epicures prized highly. But we must dwell here a minute longer, to describe the remarkable services which this large organ renders to the stomach of the oyster.

But, first, a word as to the oyster's food. A part is composed of infusoria, often called animalcules, little creatures invisible to our unaided eyes. These are easily digested. This is probably true also of the sporules of algæ, and even the unicellular algæ themselves. It is not true, however, of a large part of the oyster's food, such as the minute copepods, tiny crustaceans with limy shells; and the swarms of diatoms, very minute plants with silicious shields, which even resist the action of nitric acid. An oyster's stomach is of itself a helpless affair. It has no triturating surface, or secretors of solvent acid. But it draws all it needs from the liver. In the walls of the stomach are openings continuous into small tubes in the renal mass. Here are the bile secretions, and those of the pancreas; also the salivary glands, and the gastric follicles. We see, therefore, why the stomach is placed inside the liver—that organ is really the laboratory of the necessary dissolvents of the oyster's food.

Now it may be that one important ingredient which is contained most richly in gastric juice is supplied but feebly, if at all, from this renal source. You who like tripe hardly need be told that it is not strong food, but is of easy digestion, because of the pepsin it contains, derived from the gastric follicles of the bovine stomach. The action of pepsin is probably that of a ferment, while that of the other substances mentioned may be chemical and mechanical. Lately the microscope has given a hint in this direction, and a hint to the scientist is sometimes a God-send leading to a discovery. Here you see a little organ, like a tiny white thread of vermicilli. It lies almost parallel to the intestines, and one end of it penetrates into the stomach at its lower end. This is called the crystalline style, or rod; and a notable fact is that under the microscope it does not reveal the slightest cell structure, as a tiny morsel taken from the oyster anywhere else certainly would. What I mean is that the substance of this style is homogeneous, as if it were made of simple gelatine. Now for the hint to which I have alluded. The part, or end, which is inside the stomach, like the end of a stick of candy in the baby's mouth, is abraded, or melted away in part. The surprising fact, then, is the almost perfect certainty that this organ supplies pepsin to the oyster's stomach—a conclusion which has only been reached within a few days past, from the study of this organ in other molluscs.

But you observed the extraordinary length of the intestines—nearly three times that of the oyster's body. Now, as the food is lashed along by the numberless cilia inside the intestine through its entire length, and as the nourishing juices are taken through the walls by osmosis, you see that this arrangement subjects the entire food-supply to a thorough absorption. But the length is not all the wisdom in this digestive scheme. The intestine is not a simple cylinder. A cross section shows a convolute inner wall; it is as if a small cylinder were soldered by one side along the inside of the large cylinder along its whole length, thus increasing immensely the absorbing surface.

You may think it wonderful that the oyster should grow so fast upon such minute food. I have lately been compelled to study this matter up. Some months ago a live sea-horse was brought to me. Her scientific name is *Hippocampus heptagonus*, but we named her Hippie. It has been a joy to me to have kept her in good condition so long. But it has required some management. The fisherman who brought it was asked how it should be fed. "Oh," said he, "it isn't a fish, and so don't feed, but lives on suction." He spake wiser than he knew, as this singular fish does live entirely on microscopic life. I will tell you my secret—how I managed the matter. I gave her an aquarium to herself, and kept two large jars for breeding animalcules—that is, infusoria, &c. But these invisible things need nitrogen, and an aquarium should be absolutely clean. The problem seemed to be, how to have it clean and dirty at the same time. Now, if you drop into your aquarium a bit of fresh beef, and let it be until, like the peddler's fish, it has become a little mellow, it will generate nitrogen, and that will quicken the breeding of infusoria. When, by microscopical examination, I find that this food-supply is getting low, I transfer Hippie to one of the large jars; and, if that gives out, I place her in the other jar. By this time the larder at home is resupplied, and the little creature is restored to her proper place.

So far we have got along without much technical discourse. As I must note the leading kinds, or species, of oysters, we must resort to a few scientific names. In the extreme South there is a long narrow oyster called the strap oyster, and by the negroes, coon-heel. In southern New Jersey, in the mouth of the Delaware, on the crowded beds, the oysters, for want of room, will grow standing on their heads; hence they elongate. These are known as stick-ups. But these and some other forms are but variations of our common oyster along the entire eastern coast-line, and are all one species known as *Ostrea Virginiana*. Europe has three species. The one common to England and France, and some other places on the Continent, is *O. edulis*. On reaching Italy we find the little oyster known as *O. plicatula*. You have heard of that greediest Roman of them all, that imperial gourmand Vitellius, who ate a thousand oysters at a sitting, and who, after having the royal fauces tickled with a feather by a slave, would disburden his stomach, then fill it afresh. Perhaps the transaction was possible with the little *Plicatula*. But what about such specimens as the *Virginiana*, which Mr. Thackeray was invited to grapple with in Fulton Market? Three individuals filled his plate. Said an English lady to whom he was relating his experience: "Why, Mr. Thackeray, what were your feelings?" "Well, I felt, in attacking but one of them, that it was like trying to swallow a baby." A thousand "Virginias" would have been trying to the vitals of Vitellius. The fourth oyster to be mentioned is the one whose original home seems to be the Tagus in Portugal. This species is *Ostrea angulata*. It is said to be the one whose shells were used in the ostracism, or vote of banishment, in ancient Greece.

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[*] A lecture delivered before the New York Microscopical Society.

The four species mentioned are all that have any place in commerce. The oyster native to France, Northern Europe, and England, is the *O. edulis*. This species, and the Italian, *O. plicatula*, are hermaphrodite, or bisexual, while the Portuguese, *O. angulata*, and the American, *O. Virginiana*, are unisexual. In these species, as among the fishes, there is a true spawning of eggs by the female, and a fecundating of them in the water which has been fertilised by the presence of the male. But with *O. edulis* and *O. plicatula* there is no spawning of eggs at all. The eggs are retained between the lobes of the animal, and there hatched, and when emitted into the water, are already well advanced, each having a pair of perfectly formed shells.

The English oyster, *O. edulis*, is capable of producing a million and a half of spawn in a season. But it is shown to a demonstration that our American bivalve, *O. Virginiana*, can produce in one season—that is, in the r-less months—from twenty to twenty and a half millions of spawn. But these are simply eggs, and do not get the start of the spawn which is emitted already hatched. However, I do think that there is some relation between our American push and our physical environment. It is a characteristic of the country. An insect ordinarily well-behaved on the other side of the ocean, so multiplies, if it but immigrate here, as to become a pest and a defiance.

How does the oyster make his shell? At a recent meeting of the American Association for the Advancement of Science a paper was read asserting that the extreme age of an oyster is twenty years. Now I had previously, in an article in the *Popular Science Monthly*, demonstrated that an oyster might be in fair edible condition at the age of thirty years. Here are the shells of one of the oysters on the characters of which the statement was based. This double shell is thirty years old, and the inclosed mollusc was large and in fair condition. But of this specimen more anon. In building its shell the oyster starts with the hinge ends, at the spot known to conchologists as the *umbo*. A small plate, or single scale, now represents each valve, and that is the first season's growth. The next season a new growth, or plate, shoots out from underneath the first one, just as shingles do. The oystermen call these laps, or plates, "shoots," and they claim that the number of shoots indicates the years of the oyster. They certainly do contain a record of the seasons, showing the slow-growing and the fast-growing seasons. But there is often great difficulty in clearly differentiating these shoots. The record is often obliterated in places by the growth of parasites, which build their shells or tubes upon the oyster. I have likened these shoots to shingles. Now, at the gable of a house these shingles may be seen edgewise. So on the side of an oyster-shell is a series of lines. This is the edgewise view of the shoots, or season-growths. Another factor is this purple spot, or scar, in the interior of the shell. It is the place of attachment of the adductor muscle. Its first place of attachment was close up to the hinge. Had it stayed there until the shell had become adult, how difficult would be the task of pulling the valves together; the leverage to be overcome would be so great; for we must bear in mind the fact that at the hinge end the valves are held by this black ligament, which is, in life, elastic, swelling when the shell opens, and being compressed when the animal draws the values together. So, with every year's growth, or elongation of the shell, the mollusc moves the place of attachment of the muscle onward, that is, an advance further from the hinge. As it does so, it covers up with white nacre all the scars that are back of the one in actual use as the point of attachment of the muscle. This you can prove by eating off with nitric acid this covering, and thus exposing the whole life-series of scars, or attachments.

I have likened the oyster's shoots, or season-growths, to the shingles on a roof. To make the similitude complete, it would be necessary for the bottom shingle on the roof to underlie the whole series, and reach even to the roof-tree, or ridge-pole. Then the second shingle from the gutter must in like manner underlie all the rest of the series; so of the third; and so on with the rest. In this way lie the shoots, or laps, of the oyster's shell. The last one deposited underlies them all, and every one terminates at the channel in the bill—so that this groove in the bill contains a series of transverse lines, each one marking a season, or year. Thus we get really four factors for the solution of the question, "How old is the oyster?" all of which are the outcome of the method or way of making the shell.

Now for the story of the shell in my hand. This, with another, was given me by an intelligent oyster-raiser at Keyport, N.J., with the question, "How old are they?" My answer was: "About thirty years." Said he: "You have hit it. In 1855 I planted a bed of oysters on a clean sandy bottom. But they did not do well. Oysters want, at least, a little mud. The next year we took them up for the market; but they were poor. So we dredged the bed, and did not plant there again. This year I thought we would examine that bottom, and, to my surprise, we took up these two oysters, which evidently were left of that planting thirty years ago. I opened them, and they proved to be of fair quality." Does not this agreement between the naturalist and the oysterman deserve to be called a demonstration?

How does the oyster begin life? I shall now speak only of the American oyster, whose earliest babyhood is so different from that of the English mollusc—since theirs is emitted in an advanced stage of development, while ours is emitted simply as an egg. In the r-less months our oyster-beds are, many of them, marked by the appearance of little clouds of a milky hue. These proceed from the female oyster, which snaps its shell, and thus emits its spawn into the water. The male, in like way, emits the fecundating milt; but, to the eye, this is invisible. The eggs, sinking to the bottom. fall in with some of the milt in the water, and the spermatoza at once attach themselves to them. As seen under the microscope, the tiny egg becomes like a bur—that is, as if it were beset on the surface with cilia. In a word, it is fecundated, and with this addition of life it mounts up from its bed and floats away. In two or three hours the egg is hatched, and the development of the little creature begins. At first, it is a little triangular thing. It now begins to swim actively. But how does it do it? From what we might call the base of the angle which outlines the little thing, you see a pad projecting. Really it is a brush of cilia, every individual of which is lashing its way with the force of a projectile. In a very few hours a spot appears on each side of the apex of the triangle. Each spot is the beginning of a shell, or valve; and the fact of its beginning where it does, at what we have already called the umbo, has caused Dr. John Ryder to name this the umbo stage of the oyster's life. Nature in her work with an egg seems to delight in developing toward a side. In this way she starts a fish, a reptile, a bird, and a mammal. But our "midget" oyster is perfectly symmetrical—each valve, or side, is the exact counterpart of the other.

This roving life of the embryo oyster exposes it to infinite perils. It is certain that of the twenty or thirty millions of eggs emitted, not more than an average of two or three individuals will attain a size fit for the market. If all were to survive, such would be the growth of oyster-beds that coastwise navigation must cease. But the waste is simply enormous—so many are the enemies and so various the perils of the infant mollusc. To devise wise methods of artificial culture is now the great problem on which the scientific men of the U. S. Fish Commission are at work. That done, we may hope for some arrest of this stupendous waste.

I suppose our young oyster to have stopped his roving life. He has made an attachment, wise or unwise. And strange attachments he does sometimes form. I have in my collection quite a display of eccentric, if not discreditable, ostrean alliances. I have one oyster which is hugging desperately a ring-bolt, another devotedly attached to a decanter, and, again, no less than half a dozen ardently attached to a whisky bottle. Whatever may be the object chosen—and anything will do that serves as an anchorage—the mollusc, if not disturbed, stays there for the rest of its natural life.

Let us suppose our little oyster now attached to its object. It is yet the merest atomy of life—a microscopic object—and, it is likely, not much over a day old. But in that atom, and during that time, how rapidly the life forces have worked! The little thing now puts all its powers at house building. First, it lays the foundation by placing itself on its left side, in order that the hollow, or dish-shaped valve, may be cemented to its anchorage. There is now a secreting and exuding of a horny substance, of a mucilaginous consistency, which is called concholine. This is laid down on the rock, or other support, in a meshy form, just like a tiny wad of the finest conceivable lace. Into these meshes percolates the carbonate of lime held in solution by the sea water. In this way is the foundation laid. Next, there is a spreading out of the shells on asymmetrical lines—for the valves are becoming inequal and dissimilar. But during this foundation work, what about food-getting? Perhaps we shall see.

One of the first serious studies of my young days, in zoology, was the question, What becomes of the tadpole's tail? I carried a tadpole into froghood. He had ceased to be a gill-breather, and, having lungs, must emerge from the water, and come to the air. Nor could he any longer live on carrion and putrid plants. He must now hunt the living insects. Such a change is hardly less than a shock. I observed that my frog kept still, but bearing his tail behind him, which, of course, was the proper place, if he must carry it at all. Now it was just this "at all" which perplexed me. The books said that the tadpole's tail is lost by atrophy—that is, that it dries off. Nonsense! Nature does not entail such a waste of the raw material. I watched the frog day by day, and discovered that the caudal annex was being absorbed. It was getting shorter, but the shortening was going on at the thick, or proximal, end. Now, so it was—every particle of that appendage was taken in. This done, the animal had to forage for subsistence. And similarly is it with our baby oyster while laying the foundation, and shaping its house. That prominent organ, the swimming pad, is getting absorbed—for it is now its food-supply. It is now developing internally, for as yet there is but little more than the beginning of things. The intestine is simply a short, straight organ, and is not yet convolute. But the liver is very large: in fact, it quite preponderates.

And what of Ostrea's life? Who are her friends? There is a pretty red branching sponge, which often grows upon the oyster, *Microciona prolifera*. Formerly it was very common. It is less so now. This sponge often serves the oyster well, in buoying the bivalve up when sinking in the mud. It is also, in its way, a grove in which the infusoria breed, and so supply food to the mollusc. The oyster, too, has a gay "commensal." I like this pretty old word of Chaucer, meaning one who dines at our table, and is welcome there. Of course, all this precludes the idea of a parasite. This gay little commensal is a red and white crab hardly larger than a pea. It lives literally in the oyster ensconced between the folds of the mantle, but it does not live upon its host. Between them both there seems to be a good understanding. It is the female *Pinnotheres ostreum*. Experienced oystermen have told me that it is rarely found except with oysters in good condition. The curious fact is that it is only the female *Pinnotheres* that live in the oyster. The male is often seen floating on the surface of the water, with a pretty white anchor on his jacket, the gay little sailor that he is. His general hue is brown. He has a harder shell than the female, whose shell is thin and transparent. The truth is that, though twice as large as the male, she is very tender, and her coddling life as a commensal is a necessity. The red sponge I have mentioned is called by the oystermen "red-beard." There is another object that delights to grow upon the oyster, which they call "grey-beard," and sometimes "grey-moss." It is one of the Bryozoa. The one that I have often found is *Sertularia argentea*, an exquisite creature; for, though looking like a delicate silvery alga, it is not a plant at all, but a finely branching zoophyte, or community of exquisite living animal florets. This serves the oyster well in much the same way as does the red sponge.

But our oyster has many enemies. The boring yellow sponge, *Cliona sulphurea*, eats very minute holes into the shell, so numerous, and so winding, as in some instances to cause the shell to fall in pieces. These minute holes, under the microscope, show gouges at their edges, as if they had been cut with chisels, like post holes. But the process is as yet a mystery. The great winkles, *Sycotypus canaliculatus* and *Fulgur carica*, with their file-tongues, will rasp off the nib end of the oyster shell, then introduce the sucking siphon, and so consume the mollusc at their leisure. The little drill, *Urosalpinx cinerea*, is a severe pest. This shell and the two just mentioned are spiral univalves. The drill is a small shell rarely measuring ¾in. in length, and its lingual ribbon or file-tongue with its armature of several rows of sharp teeth, is microscopic. I have watched it at work, and I think that the little burglar bores a hole through the oyster's house by crooking its tongue, as I do my finger, letting the knuckle represent the bend, or crook of the file tongue, in which case the teeth would stand out like a brush; which brush twisted around and back again, in a three-quarter or perhaps entire circle, would represent the action of a drill. The hole is always perfectly symmetrical, and generally is countersunk at the place of starting. The hole completed, the tiny siphon tube of the mollusc is introduced, and the soft parts of the oyster are taken up. Sometimes the drum, *Pogonias chromis*, inflicts severe damage on an oyster bed. This singular fish has in the upper part of its throat very large, and solid, pharyngeal bones, which are covered with closely-set, hard, round, pavement teeth, not unlike the cobble stones of old. With its front teeth it picks up an oyster, and it crushes it with the pharyngeal teeth, and then swallows it. This fearful creature gets its name from a booming noise which it is able to make. One year a school of drums entered Raritan Bay, and destroyed many thousands of dollars' worth of oysters in a single night. Excepting man himself, the worst enemy of the oyster is the five-finger, or sea-star, *Asterias arenicola*. A sea-star is an object with five rays, and is of the consistence of soft leather. If we turn it over, we observe a canal along each ray, or finger, through its entire length. On each side of this canal is a row of ambulacra, or little feet, each with a sucking disc at its extremity. At the centre, or base, of the rays is the oral cavity, in which is the stomach sack, which is capable of being everted and protruded. It is a blind sack, but its walls will, by osmosis, take up food. With these five rays, and their thousands of little suckers, it will grasp an oyster, and, waiting until the mollusc opens, be it never so little, it will thrust in its everted stomach, and suck out the oyster's life. I have not demonstrated the point, but my belief is that the sea-star has some urticating power, and even paralyses its victim. To the oyster raiser, the star is often a calamity. Many thousands of bushels are sometimes taken by it in a season from the beds. Other enemies there are, but time is wanted to speak of them.

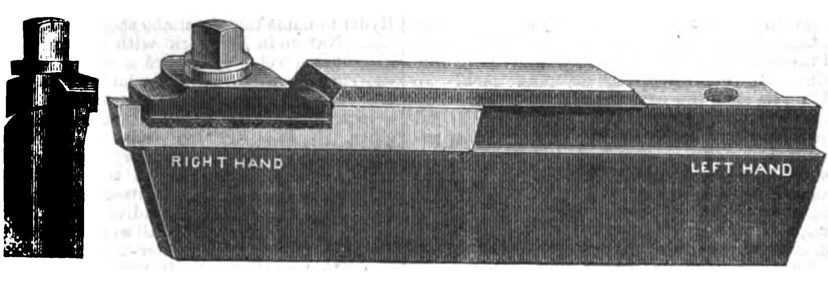
I must say a word on the pearl. Though not the pearl oyster, our mollusc is a pearl maker. Nacre, or mother of pearl, constitutes, to a greater or less extent, the shells of all oysters. But the isolated individual pearl, that which is accounted a gem, and the worthy decoration of a bride, is always an enforced product. It is made upon occasion of inconvenience, suffering, or disease. It was a pretty coincidence this morning, that, having just finished thinking out the brief for this address, I looked into Shakespeare, and alighted on that expression of Touchstone: "Rich honesty dwells like a miser in a poor house, as your pearl in your foul oyster." It is surely interesting that this wisdom of the poet, drawn from the proverbial lore of the people, finds its verification in science. The pearl is the outcome of suffering. It is elaborated in distress. So delicate, so mild, so exquisite. It is already perfect—the one only gem that does not ask the lapidary's skill. And how many a precious thought, having passed through the alembic of suffering, has crystallised into a living form, a thought-pearl of purity, ethereal and immaculate! And now, my friends, if our discourse has enabled us to know better one of God's lowly little creatures, we have done well, since it will help us to love the Creator more.

## THE RETRIEVING HARPOON.

THERE was found in universal use at Point Barrow, Arctic Alaska, a peculiar form of harpoon, exclusively used, as the name I have suggested for it implies, for retrieving seals that have been shot in open holes or "leads" of water, within darting distance from the edge of the ice. The Eskimos call call it "*naú-li-gû*." It consists of a long light shaft (*i-pù-ä*) of wood, about one inch in diameter, and generally about five feet long, though the length varies with the height of the man who uses it. The butt of this is armed with a slender bayonet-shaped ice-pick (*tú-u*) of walrus ivory, about fourteen inches long, and to the other end is securely fastened a heavy pear-shaped foreshaft (*u-ku-mai-lu-ta*, "weight") of walrus ivory or compact bone, which serves to give weight to the head of the harpoon and make it fly straight. It is about five inches long and an inch and a half in diameter at the forward end. In the centre of the end of the foreshaft is a deep round socket, into which fits the butt of a slender rod of ivory about two inches long, the "loose-shaft" (*i-gi-mû*). This is secured to the foreshaft by a thong passing through a hole drilled in it, so that it can be easily removed from the socket, while the thong prevents it from being dropped and lost. On the tip of the loose-shaft fits a detachable toggle-head (*naú-lû*) of the ordinary type common to the whole Eskimo race, provided with a long line of seal thong upwards of ninety feet in length. When ready for use the line is drawn taut from the head to about the middle of the shaft, made fast by a couple of half-hitches, and kept from slipping by a little ivory peg (*ki-ler-bwin*) inserted into the shaft. Just back of this there is also a little curved ivory knob (*ti-ka*) secured to the shaft as a rest for the forefinger in aiming the weapon. The hunter on starting out carries his rifle slung in a sort of holster across his back, and secured to this the *naú-lû* and line folded in long hanks. The rest of the harpoon is carried in the hand and serves as a staff in walking and climbing among the ice-hummocks, where the sharp pick is useful to prevent slipping and to try doubtful ice, and also enables the hunter to break away thin ice at the edge of a hole so as to draw his game to the solid floe. It can also serve as a bayonet for defence in case of necessity. When a seal has been shot and floats, the *naú-lû* and lines are fitted on and the weapon darted with the right hand, while the left holds the end of the line. The *naú-lû* enters the animal entirely, and a pull on the line causes it to slip off the top of the loose-shaft (which is facilitated by the play of the latter) and to toggle securely under the skin. The whole is then drawn in by the line. The use of this weapon appears to be confined to Northwestern Alaska, and it is very rarely found south of Behring's strait. In the large collection made by Mr. E. W. Nelson, in the neighbourhood of Norton sound, there is only one rather clumsily-made *naú-li-gû*, with a fragment of the line, which is labelled a "beluga spear." It is manifestly unfitted for such use, but this statement goes to show that it was an unfamiliar weapon among the people by whom he was surrounded. The natives of that region, as well as the Greenlanders and Eastern Eskimos, retrieve seals with the kaiak, accasionally using the stabbing harpoon, common to the whole Eskimo race, to secure a seal, but they are unprovided with any special weapon for retrieving. We were unable, during our stay at Point Barrow, to ascertain whether this weapon was in use before the introduction of firearms, which were now universally employed, but I am strongly led to conjecture that it is a modern invention. I am of the opinion that the people of this limited area, enabled by the introduction of firearms to kill seals in the open holes of water, where they had previously been safe from the ordinary spear, and prevented from using the kaiak from the extreme roughness of the ice, invented this weapon by reducing the great walrus-harpoon to a convenient size for carrying on the ice. It is a perfect miniature of the walrus-harpoon, with the addition of the ice-pick, an essential part of the ordinary stabbing harpoon. I am strengthened in this opinion by the fact that Dr. Simpson, who spent the winters of 1852-3 and 1853-4 at Point Barrow, before the general introduction of firearms, makes no mention of the use of this weapon in his excellent paper on the Western Eskimos. He would undoubtedly have done so had he seen it, so different is it from the ordinary Eskimo methods of seal hunting.—John Murdoch, in the *American Naturalist*.

## THREADING TOOL FOR SQUARE THREADS.

THE Hartford Tool Company, Hartford, Conn., have recently brought out a tool-holder and tools for cutting square threads, which must, says the *American Machinist*, prove a convenience to those having much of this kind of work to do, as well as much cheaper than the ordinary practice in this respect. Square threads would undoubtedly be used more than they are but for the trouble and expense of cutting them. The engraving needs but little in the way of explanation. Right-hand threads are cut with one end of holder forward, and by simply reversing holder and cutter left-hand threads may be cut. The strap which clamps the cutter has an elongated hole, and adjusts itself to different widths of cutter, pressing the cutter against straight side of holder, and holding it rigidly in place. The cutters are concaved on the sides requiring clearance. When nice work is required, a cutter one size smaller than that required for finishing can be used for roughing out. Should a cutter require sharpening before the thread is finished, it can be taken out and ground without disturbing the holder; then, when replaced, it will be exactly right to resume its cut. The holder is of a size to fit the ordinary tool-post.



## THE DURABILITY OF LEATHER BINDINGS AND GELATINE NEGATIVES.

IN a note on this subject contributed to the *British Journal of Photography*, Mr. W. H. Harrison says:—Recently I drew attention to the circumstance that gelatine negatives not treated with alum, or other strong hardening or tanning matters, probably have not within them the elements of permanency in as strong a degree as those which have been so soaked, and the authority of the late Dr. Van Monckhoven was quoted to the effect that alum-treated plates are more imperishable than others. The fact was also mentioned that Hungarian, or other leathers, tanned or hardened with alum, are more harsh and less waterproof than leathers tanned in the ordinary way, which now raises the additional question, whether it is possible to well tan negatives in a proper way, without imparting to them an injurious stain. For the benefit of those who may wish to work out this problem practically, it may be well to state that vegetable astringents differ in the hardness and durability of the leathers they produce. Oak-bark infusion is slow in action, but produces a first-class leather. Infusion of valonia, prepared from the acorn-cups of an oak of the south of Europe, gives a hard and heavy leather. Red catechu, or cutch, is very cheap, and tans quickly; so also does the pale catechu, known as gambier, but the leathers produced by the catechus are soft and spongy, unless some other tanning materials be added to the infusion. Good leather is scarce in the shops nowadays, and high in price, because of the great length of time it takes to tan. It has a strong "leathery" smell, the well-known smell being due to the oak-bark, and not to the original hides. When this particular smell is present in the leather in strength, it is a good sign, though not all that is requisite to afford materials for sound judgment whether the leather was entirely tanned by oak-bark infusion, and for a long time. As to the durability of leather, I recently published some information obtained from the Egyptian department of the British Museum, and since then, to glean facts of use for the purposes of this article, have seen Mr. W. Y. Fletcher, who has extensive experience as to the durability of various leathers used in the printed-book department of the national library. In that department the dates of the bindings of books go back to about the year 1450 or 1455, and some of them are in very good condition. There has been a falling off in the quality of English leather during the last hundred years, probably in consequence of the demand for cheapness, therefore for rapid tanning. The chief point of interest he gave me having a bearing upon photography, is that morocco leather is decidedly the most durable leather for the bindings of books. This is made from different skins—namely, those of the goat, seal, and sheep, but the tanning material is one—namely, sumach. It takes but twenty-four hours to tan a sheepskin with this substance, so probably twelve hours or less in it would be sufficient for a gelatine plate. Another point which may be in favour of sumach is, that the Sicilian variety, which is the best, is used to tan leather white. Whether it would gelatine an opaque whiteness, or leave the film transparent, is a matter for experiment. The material is cheap enough, the prices in the London market varying from about 15s. to 16s. 6d. a cwt., and it may be obtained in the pulverised form. Sumach is a small plant which grows wild in southern Europe and southern America, but is also extensively cultivated for commercial purposes; this cultivation is carried on to a considerable extent in Italy. The leaves are the portion of the plant used in tanning. Next in durability to morocco leather, says Mr. Fletcher, comes roan, which is prepared from sheepskin; calf is worse, and Russian leather worse still. Among the curiosities of binding we examined, was that of a book bound in deerskin and wooden boards, published in 1485, and still in good condition. There are, of course, many books bound in vellum; modern vellum cracks very much with time. Plenty of morocco-bound books of about the end of the 15th century are still in excellent condition. There is an ugly rumour afloat, that the best "Turkey" morocco comes from Switzerland, and the best "Levant" morocco from Austria. Some of the books in the Museum, bound in tanned pigskin, have lasted well. One book there is bound in the skin of the kangaroo; this is in the King's Library, and was presented, at Botany Bay, to Sir Joseph Banks, in 1789. The artificial colouring matters of leather do not seem to injure their durability. This general information is penned in the hope that those who wish to develop a process for rendering particular negatives exceptionally durable, will try the effect of tanning the films with suitable vegetable astringents. Most of these astringents are absorbents of oxygen, consequently likely to be developing agents. In solution with an alkali, if any such mixture should bring out a picture well, there would be the satisfaction of knowing at the time that the negative was rendered more durable; the slower such development, the greater would be the permanency of the result. Gallic acid, so often used in the past for paper and other negatives, is not a tanning agent; pyrogallol probably has a feeble influence, however, in that direction.

# SCIENTIFIC SOCIETIES.

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## ROYAL ASTRONOMICAL SOCIETY.

THE April meeting of this society was held on the 10th inst. at Burlington House, Mr. Ed. Dunkin, F.R.S., President, in the chair.

Lieut. S. G. Burrard, R.E., Dehra Dun, India; Mr. J. H. Honeyburne, M.A., 97, Mulgrave-street, Liverpool; Mr. Jas. McKerrow, Surveyor-General of New Zealand, Wellington, N.Z.; Mr. John A. Westwood Oliver, 13, Bruton-street, Berkeley-square, W.; and Major Harry T. Watson, Langley House, Slough, Bucks, were balloted for, and duly elected Fellows of the Society.

Captain Noble asked whether the *Monthly Notices* could not be issued earlier, so as to give Fellows an opportunity of examining them before the meeting.

Mr. Knobel said that he was glad the subject had been mentioned, as he should like to take the opinion of the society as to whether it was desirable to hurry the printing of the numbers when they contained, as in the present instance, diagrams and woodcuts, which took a long time to prepare.

Mr. Chambers said that the explanation of the delay which had been given was the periodical explanation, which at tolerably regular intervals had been given for the last 20 years. Great care should of course be exercised in correcting for the press; but he thought that it would be more satisfactory to the Fellows if the longer and illustrated papers were kept back for another month rather than that the issue of the number should be delayed for them.

Captain Noble said that when Mr. Proctor edited the *Notices* they were always published about a week before the meeting.

Colonel Tupman said that he should like to hear from Captain Noble what difference it would make to Fellows if they did not receive the *Monthly Notices* before the next meeting.

Captain Noble said that subjects were often discussed having reference to papers read at the preceding meeting, and unless Fellows had had an opportunity of reading the papers they could not follow the discussions.

Professor Adams hoped that the editors would never hurry the publication of the *Notices* for the purpose of getting them out before the next meeting; accuracy should never be sacrificed for the sake of expedition.

Mr. Green exhibited a drawing of Saturn, which showed the belt upon the body of the planet, to which attention was drawn at the last opposition by Mr. Ranyard. Mr. Green had not been able to observe Encke's division in the outer ring, although he had had several very favourable opportunities for observation during the recent, as well as during the preceding, opposition. He was disposed to think that the appearance which had been described was due to inequalities of tint in different parts of the outer ring, which when seen with a smaller aperture might give the appearance of a division. Many drawings also showed a sharp line of demarcation between the inner ring and the crape ring; but to him it had always appeared that the crape ring merged gradually into the brighter ring outside it. In former years he had considered that Saturn was a more favourable object for definition than Jupiter; but during the past opposition the general sharpness of the details seen upon the body of the planet seemed to be decidedly inferior to those upon Jupiter. He had at no time seen a bright spot near to the southern pole of the planet, such as was shown in some drawings; but there was a great deal of detail visible in the polar cap, which extended down to within a short distance of the dark belt before referred to.

Mr. Ranyard said he concurred with Mr. Green as to the gradual merging of the crape ring into the brighter ring outside it. The dark belt shown in Mr. Green's drawing was somewhat broader and lower down towards the equatorial regions than it appeared to him, and he thought that the polar cloud cap was more uniform in tint than it appeared in Mr. Green's drawing.

Mr. Knobel said that there had evidently been a great change in the appearance of the markings on the planet during the last two oppositions.

Captain Noble said it might be interesting to possessors of moderate optical means to know that he had seen the dark belt on the body of the planet quite distinctly with an aperture of $4\frac{2}{10}$in.

The President, after returning thanks to Mr. Green for his drawing and explanations, said that the meeting would be pleased to hear that Prof. Langley, the Director of the Allegheny Observatory, was present, and they would be glad to hear some account of the work upon which he was engaged.

Prof. Langley said that he was quite unprepared to make any formal report to the meeting, as he was not aware that he would have been called upon. For the last four or five years he had been engaged in a study of the energy which comes to us from the sun, regarded not merely as light, but also as heat. He had also been studying the obstacle which our atmosphere offers to the transmission of radiations in different parts of the spectrum. For this purpose he had made use of an instrument more delicate than the thermopile, to which he had given the name of "Bolometer." It consists of an extremely fine wire, through which an electric current passes, and on which heat falling causes change in conductivity, which is indicated by a deflection of the needle of a delicate galvanometer. By means of this instrument he had mapped the spectrum at the infra-red end, and had traced lines in a region far beyond that which had been photographed by Captain Abney. The wire of the bolometer was placed at right angles to the length of the spectrum, and as it was passed up and down the spectrum it indicated the presence of dark lines as cold regions. The instrument was so sensitive that although the grating spectrum has only in certain parts of the spectrum about $\frac{1}{400}$th of the intensity of the prismatic spectrum, yet he had been able to explore the infra red region to a distance three or four times further below the lowest visible portion than it had been explored by means of photography. In the case of the lunar spectrum, this infra-red region had been explored with a train of rock-salt prisms, and his experiments showed that the infra-red region was relatively much richer in the lunar than in the solar spectrum, indicating that there was dark heat emitted by the moon. In the course of these experiments he had made an expedition to Mount Whitney, and had encamped at a height of 15,000ft. in the Sierra Nevada. He was greatly struck with the immense advantages afforded by great altitudes for observers in physical astronomy, and especially with the good definition as well as the admirable transparency of the atmosphere, which afforded opportunities of photographing nebulæ and observing double stars and faint objects which could not be obtained at lower altitudes.

Mr. Stone said that some years ago he had attempted to make observations with a thermopile, which was probably not nearly so delicate an instrument as that used by Prof. Langley, and had found very serious difficulties arising from constant changes in the absorption of the atmosphere. As long as he made use of only one thermopile, he found that he was simply registering variations in the absorption of the atmosphere; but he succeeded in getting over this difficulty, and obtaining quantitative results more or less satisfactory by using two thermopiles, one of which registered the heat from the star or other object of which observations were being made, and the other the heat derived from an adjacent portion of the atmosphere.

Mr. Common inquired how the wire of the bolometer was made?

Prof. Langley said that he had, in the first instance, made use of a thin strip of iron 1-15,000th of an inch in thickness; but the iron was liable to rust and change, and he had more recently used a platinum strip 1-25,000th of an inch in thickness, and with a breadth of 1-120th to 1-250th of an inch, like an extremely minute piece of tape, which was mounted in a frame like the frame of a micrometer, and could be pushed on to different parts of the spectrum by a micrometer screw. He had experienced the differences of absorption referred to by Mr. Stone, but he had not found that they caused an insuperable difficulty in making measurements, as in a clear sky they only corresponded to differences of about 8 or 10 per cent., which could be eliminated by a series of measurements. These variations were reduced to a minimum by inclosing the bolometer in a long tube with diaphragms, which excluded lateral radiations.

The thanks of the Society were returned to Prof. Langley for his very interesting address.

Mr. Common exhibited a series of enlargements of photographs of the nebula of Orion taken with different exposures, varying from a few minutes up to sixty minutes. With the longer exposures the outer and fainter portions of the nebula were shown; but the inner and brighter portions were obscured by over-exposure. It was only by a combination of such pictures that the whole of the details visible in the nebula could be studied. With the longer exposures regions of the nebula invisible to the eye with the telescope registered themselves on the photographic plate. With sixty minutes he had obtained traces of many stars invisible to the eye. He had not at present tested what could be obtained by still longer exposures.

The following papers were presented or taken as read:—"Occultations of Stars by the Moon in the Years 1876-80, and Resulting Final Equations between the Errors of the Tables and the Errors of Observation," by Lieut.-Col. G. L. Tupman; "Occultations Observed at Forest Lodge, Maresfield," by Captain W. Noble; "Occultations of Aldebaran, 1885, Feb. 22, Observed at Dun Echt, Aberdeen, and Observation of Jupiter, 1885, Feb. 18, made at Dun Echt, Aberdeen," by Dr. R. Copeland.

## ROYAL MICROSCOPICAL SOCIETY.

THE seventh meeting of the session was held on the 8th inst., at King's College, Strand, W.C., the president, the Rev. Dr. Dallinger, F.R.S., in the chair.

Mr. Crisp, remarking that it had been said "there was nothing new under the sun," referred to Schieck's Revolver Microscope exhibited in December, 1883, in which a drum revolved beneath the objective with the objects arranged on the periphery, so that by turning the drum they were brought successively into view. The novelty of the microscope was challenged, and one on a similar principle was produced, made nearly 60 years earlier by T. Winter, which was considered to be the earliest of all such forms. It now appeared, however, that Winter had been anticipated by one made two centuries ago. This was proved by a description and illustration of such an instrument which appeared in an old Italian book, without title page, which, together with a model of the instrument, was handed round for inspection. The first page commenced: "Nuove Inventioni di tubi ottici dimostrate nell' Accademia Fisico-matematica Romana, l'Anno 1686."

Mr. Beck said that the interesting portion of the instrument was the spring which was used for adjusting the focus of the lens, because that was the subject of a patent which had been taken out about 15 years ago.

Mr. H. G. Madan said the form of polarising prism recently suggested by M. Bertrand in the Comptes Rendus,* and also described in the Society's *Journal*,† he thought would interest the Fellows, as it was almost the only one which had yet been seen in this country, added to which it was always more interesting to see a thing in the flesh than merely to read a description of it. By the aid of diagrams on the board he explained that the prism consisted of a four-sided parallelopiped of dense glass about three times as long as broad, and having a refractive index of 1·658, the same as that of calc-spar. This was cut through obliquely in the same way as in an ordinary Nicol prism, making an angle of 76° 43′ with the terminal end. A thin cleavage plate of calc-spar, not more than 1mm. in thickness, was placed between the two pieces of glass, and the whole were cemented together with a cement having a refractive index not less than that of the glass. It worked in the same way as the Nicol prism, except that it was the ordinary ray which emerged instead of the extraordinary ray, the index of the former being 1·658, and that of the latter 1·48. It would be seen that when a ray of light entered the prism and passed through the glass and the cement, it would meet the calc-spar, and be thereby separated into two rays, and then, passing on, the ordinary ray would meet a medium having the same refractive index and would pass straight on, whilst the extraordinary ray meeting with a substance of different refractive index from its own became totally reflected. In this way the extraordinary ray was got rid of, but the ordinary ray passed through as if the prism had been solid. The principle of the construction of this prism was known to Jamin in 1869, and it had been more lately (1884) described by Feussner; but the credit to which Bertrand was entitled was in the use of a cement which had the high refractive index of 1·66. The great advantage which this prism possessed over the Nicol prism, apart from its cost, was in the larger field which it was possible to obtain. One defect in the prism arose from the great density of the glass, which, being due to the large percentage of lead which it contained, made it very apt to get tarnished. He suggested, as an effectual preventive of this evil, that a piece of thin microscopic glass should be cemented upon each end, which, by keeping off the air, would entirely preserve the surface without impairing the efficiency of the prism in any way. Mr. Madan also exhibited another form of polarising prism, which was a modification of Ahrens's double-image prism, in which a very great divergence of the beams was obtained by the combination of three prisms of calc-spar and one of dense flint glass, the glass merely being used as a correcting prism. This form was very effective as a double-image prism; but he found it was possible to get rid of the other ray entirely instead of merely turning it aside. This was done by including a thin film of air, and by means of this, if the surface did not exceed 14°, the ordinary ray was totally reflected and passed off. There was, however, in this arrangement a great over-correction for colour, so that the blue rays were much more deviated than the red, in the proportions of 12° 20′ and 12° 35′; this had to be corrected first by putting on a crown glass prism beyond the film of air, and then the colour correction was effected by the addition of another prism of dense flint glass, after passing which the extraordinary ray left the arrangement corrected for deviation and almost corrected for colour. The incident light must be limited to 28°, and they then obtained on one side a field of 30°, and on the other of 14°. He did not think it was much better than Ahrens's prism, from a practical point of view.

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* Comptes Rendus 99 (1884), pp. 538-40.

† Vol. IV. pp. 965.

The President said the society was much indebted to Mr. Madan for these details, which showed a great amount of ingenuity.

Mr. Cheshire said it was of course of great value to be able to get such a large field; but it occurred to him that in Mr. Madan's modification of Ahrens's prism there must be a considerable loss of light in the case of the ordinary ray in passing from the first prism into the air space.

Mr. Madan said no doubt there was a loss of light in this case; but this was a disadvantage which the prism suffered in common with Foucault's and other prisms. Something must necessarily be sacrificed to obtain greater advantages in other directions. He thought that as regarded light Bertrand's was certainly more effective.

Mr. Dowdeswell exhibited some septic microbes from high altitudes, and detailed experiments as to Bacterial germs found at various heights, notably upon the Niesen, at an elevation of about 7,500ft.

The President regarded every addition to their knowledge in this direction as being of the utmost value, and remarked that everything pointed to the necessity of a thorough working out of the correlation of the whole of the specific forms. When that was done they would have gone a long way nearer towards the solution of the problem of their connection with epidemic disease.

Dr. Maddox said he had been in correspondence with M. Freudenreich on this subject, and had obtained a specimen of the organism to which he had referred, and he could say from examination that it was only a septic organism and not a pathogenic form. Great pains had been taken in carrying out these observations, as would be seen from the fact that all the apparatus had to be carried up high mountains. It was found that the tubes originally provided could not be used conveniently, and he had therefore devised a form of bottle for the purpose, which would fulfil the required conditions, and be also portable. This bottle had a cap fitting hermetically over the neck, in which cotton wool was placed, and two tubes were provided for the purpose of aspiration and for removing the contents for cultivation. The time required for aspirating with a large quantity of air was also found to be inconveniently great, so that an apparatus of greater capacity was made on the principle of a steam injector, which was capable of throwing nearly 2,000 litres of air in an hour. By means of a diagram the method of charging the cultivation tubes with the contents of the bottle was explained, and the use of a small captive balloon was suggested as likely to be of great use in insuring the purity of the samples of air obtained from given localities.

Mr. J. Mayall, jun., reverting to the model of the old microscope exhibited by Mr. Crisp at an earlier period of the meeting, asked if there was any means of fixing the date when it was made, as he thought it would be very interesting if they could do so with certainty.

Mr. Crisp said there was no difficulty in fixing the exact date. Agreeing in the suggestion of Mr. Madan that it was much better to see a thing in the flesh than in a drawing, he had last month ordered one to be made, and it was delivered that night. The workman deserved all credit for the skilful manner in which he had manufactured so deceptive a piece of antiquity, even the paper on the drum was 200 years old.

Mr. A. D. Michael gave a summary of his paper on "New British *Oribatidæ.*" He first called attention to the nymph of *Cepheus bifidatus*, which he has just discovered; the species is very rare, and the immature stages were not known. Last September, at Keswick, Mr. Michael found two or three specimens, and instead of preserving them as examples determined to try and breed from them. He isolated them, and after some weeks obtained a few eggs, from which he reared four larvæ; these he has carefully watched for six months, until they had changed to nymphs and become full-grown; he then killed and preserved two specimens of the hitherto unknown nymph, reserving the two others to rear to the imaginal condition. One was lost by an accident just before the final change, the other lived. The nymph, which was exhibited, was a very remarkable and beautiful creature, surrounded with concentric rows of curved serrated spines longer than the body. Mr. Michael then called attention to a new species of *Hypocthonius*, proposed to be called *H. lanatus*. The ordinary definition of an *Acarus* is an eight-legged arthropod without segmentation, and with head, thorax, and abdomen fused into one mass. Really in the *Oribatidæ*, and several other families of *Acarina*, the abdomen is distinctly divided from the cephalothorax, and in this genus, which has been erroneously supposed to consist of immature creatures, the abdomen is segmented, and in the present species the segments are to a certain extent retractile, as in many insects; this enables the creature to erect, or lower, the long spines attached to the edges of the segments at will. An interesting new species to be called *Notaspis serratus*, abundantly provided with long serrated hairs, and a curious nymph of a Damæus, to be called *D. tenuipes*, which carries its cast dorsal skins in a pyramid on its back, like a pile of dish-covers, and has a central projection on each skin, forming a column to support the whole, were also shown and described, besides other new species.

Mr. Crisp called attention to some very interesting experiments by Dr. Nussbaum and Dr. Gruber on the artificial division of infusoria. Dr. Nussbaum divided an *Oxytricha* into two halves, either longitudinally or transversely, and found the edges at the point of division were soon surrounded with new cilia. Notwithstanding that sometimes some of the body substance, or even a nucleus, was lost during the operation, the two halves became normal animals, with four nuclei and the characteristic ciliary apparatus. The head portion formed a new hinder part, and the right half a new leg. The complete organisms thus formed again developed by spontaneous division. Simultaneously with Herr Nussbaum's experiments Dr. A. Gruber artificially divided *Stentor cæruleus* with the same results. If the divided parts of a *Stentor* were not completely separated they almost tore themselves apart, sometimes by rotating in opposite directions. If the cut was not very deep monstrous forms might be produced, as, for instance, with two complete anterior or two posterior portions.

Mr. C. H. Kain's letter was read as follows: "In the report of the last meeting of the Society, given in the ENGLISH MECHANIC of Jan. 23rd, I notice that a note from Dr. Gray was read, warning members against the use of tolu as a mounting medium on account of its tendency to form crystals. I believe I was the first to call attention to tolu, and therefore it may not be inappropriate for me to say a word. At first I had the same difficulty as Dr. Gray. Indeed, styrax is also likely to produce crystals. There is, however, an easy way of obviating the difficulty in the case of tolu—viz., by dissolving out the cinnamic acid. Tolu is not soluble in benzole; but cinnamic acid is. I have found that by digesting the coarsely powdered gum in benzole for a few days the cinnamic acid is removed. After pouring off all the liquid possible, fresh benzole should be added and allowed to remain a day or two. After pouring off this, the rest of the benzole should be evaporated, and the tolu then dissolved in chloroform and filtered; it is then ready for use. It is best to use heat in mounting, so that, when finished, the medium is nearly, or quite, hard. The greatest objection to the use of tolu is its colour. By this mail I send you three slides of *Navicula rhomboides* (and *Tabellaria fenestrata*) mounted respectively in Canada balsam, styrax, and tolu. That in tolu was mounted October 11th, 1884, and fails to show any signs of crystallisation as yet—indeed, I have had no difficulty with crystals since using the process I have mentioned.

Mr. Crisp referred to some of the differences of opinion having arisen from the different meanings which were attached to the term, benzole. What was here understood by that name appeared to be different from the substance so called in America.

Mr. Michael said he had been trying experiments with some of these substances lately, and perhaps could throw a little more light on the matter. He found that there was a great deal of difference in the gums, and that different samples, obtained from perfectly reliable sources, acted very differently under similar conditions. One sample of styrax, for example, would dissolve perfectly in benzole, whilst another would not do so. He thought this might also be the case with some others; but if the tolu was prepared carefully by boiling in distilled water, to get rid of whatever acid it might contain, he believed it might be reduced to a state in which it would give very little trouble afterwards by crystallisation.

Mr. Crisp called attention to the alteration of the contents of the Journal, which now contained the names of all the authors. The credit of this was due to Mr. Walter Heape, of Cambridge, and he thought the alteration would be found an obvious improvement in facilitating reference to any paper. He had also taken the opportunity of adding the headings of the classification, and had also included all the papers of the bibliography of which any abstract was given, as he found these were often passed over unnoticed.

Mr. H. Mills's note was read as follows:—

I send six slides of *Stephanodiscus Niagaræ*, showing filamentous projections on the margin of the diatom. During the last ten or twelve years I have given attention to the examination of these organisms, but am still at a loss to determine what they are, or the purpose they serve (if any) in the economy of the diatom. If found attached in the same manner to any of the diatoms that have motion, we might conclude at once that they were for the performance of that function, but occurring as they do on these discoids, which have no motion, it is difficult to suggest anything that is probable. We find many of the diatomaceæ in our water supply, none, however, having these attachments; but *S. Niagaræ*, and perhaps a few *cyclotellæ*, or other small discoids. The *S. Niagaræ* are found in great abundance during the winter months, and for several years past I have found the filaments most abundant in January, at which time the diatoms can be taken almost free from foreign matter. The past January has been unusually stormy, and the water consequently roily, while the filaments are not as well developed as in some former years. Five of the slides are mounted dry, as the filaments, with rare exceptions, cannot be seen in water. Slide No. 6 contains a drop of water with the diatoms, as caught from a small stream from the faucet in a muslin bag. The extreme tenuity and hyaline character of the filaments are the greatest hindrance to a more perfect examination of them. They are seen to best advantage with a strong light and dark background illumination; sunlight adding much to the effectiveness of the observation. In slide No. 1, using ¼in. or ⅙in. objective, may be seen how regularly the filaments arrange themselves on the slide; frequently those of one diatom crossing those of another, all maintaining a radial position with some degree of preciseness. This fact alone would indicate a substance very different in character from the mycelium threads of an ordinary fungus. When the diatom is examined edgewise—that is, in front view—the filaments can be seen to proceed from near the line of suture, but whether from the internal contents of the frustule or from the ring of the diatom I am unable to determine. If from the ring I have thought they might be silicious, although recent experiments show that they are consumed by the heat of an alcohol lamp. A drop of water containing a few of these diatoms placed on a slide and allowed to evaporate under the microscope is interesting, and displays a phenomenon not shown by other diatoms that I am aware of. As the line of evaporation proceeds on the slide, the diatoms frequently disappear instantly; in some cases leaving the filaments attached to the glass, while in other cases, where there is but little foreign matter to interfere, they may be found beyond the extent of the drop, with the filaments spread out as radially as if placed so artificially. If the diatoms stand long enough for the water to become sour, the filaments fall off, and may be seen scattered about the slide, as in No. 2. In some of the slides may be seen a few small discoids without spines, which, when alive in the water, seem to possess power to repel every light body from contact with them, so that a distinct transparent annulus as wide as the diameter of the diatom is presented. A little blueing placed in the water under the cover glass makes this more noticeable (see *American Monthly Microscopical Journal*, Vol. II., page 8, 1882.) *This year* I have noticed for the first time that these small diatoms when dry have several short projections which, if in motion, would seem to be sufficient to form the annulus. In some cases the long filaments of *S. Niagaræ* have the appearance of being branched. My opinion is that it is merely an overlapping.

Mr. Badcock said Mr. Mills's specimens were different from those which he had exhibited on a former occasion as occurring upon *Surirella bifrons* at Keston. These appeared to him to have a distinctly pseudopodal character, having movements very much like an amœboid elongation and contraction, whereas these now shown very much resembled the setæ of *Actinophrys*. The question in both cases was whether they represented animal life as being prolongations from the inner protoplasm. So far as their appearance on the slides was concerned they might possibly be foreign bodies.

Mr. Hardy said that he had some of the specimens of *Surirella* taken at Keston, and had observed them quite independently. He was not able to see that they had any motions, and could say that they were certainly not sarcodic forms.

Dr. Wallich said there was a complete analogy between the specimens now shown and some which he exhibited about 20 years ago, to which he gave the name of *Coscinodiscus Sol*. He found his specimens in the Indian Ocean, and they were described and figured at the time in the Society's Journal.* In the case of the Keston diatoms he took them to be Epizoa, and thought that Mr. Hudson, writing from Australia, referred to precisely the same forms; but they were also distinctly epizootic. In the case before them, there was no question in his mind about their being a portion of the animal itself, there being distinct apertures round the valves from which they were given off. He was now engaged in going over the slides which he presented to the Society, and found that all these specimens were amongst them still.

Mr. G. C. Karop remarked on an examination he had recently made of the saliva in a case of hydrophobia. The patient, a boy 12 years old, had been bitten two months before any symptoms appeared. He was then brought to the Middlesex Hospital, where he died the day after admission with all the usual symptoms and agonising tortures of this horrible disease. An attempt to administer chloroform was made during one of the violent paroxysms towards the end of the case, and about two drachms of saliva collected in a clean tube as it dribbled from the mouth. Some covers were prepared in the usual manner, stained with gentian violet, and mounted in xylol-balsam. The specimens presented the following characters:—Epithelium in large quantities, most of the cells crowded with micrococci; bacilli of various lengths, and very variable in diameter, some being thick and others extremely slender. A few showed evidence of spore formation, and were surrounded by a capsule. Micrococci abundant, in masses, diplococci, and short chaplets. Mr. Karop also exhibited a drawing of the Bacilli.

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* *Transactions* of the Society, 1860, plate 2.

Mr. J. Mayall, jun., exhibited the diamonds belonging to the ruling machine of the late F. A. Nobert, a typical one being shown under the microscope by Mr. Powell. He said that in engaging to report to the society the results of his examination of the ruling diamonds, he had expected the task would involve at the most a few hours' work with the microscope, using powers from 20 to 150 diameters. In this expectation he had been mistaken; he had not found it possible to explain the nature of the diamond surfaces by mere inspection with the microscope. On calling in the testimony of "experts" in diamond cleaving, polishing, &c., the results arrived at had become still more complicated—one party affirming that certain surfaces were polished, whilst the other insisted that they were cleavage faces and *not* polished—so that he (Mr. Mayall) had almost despaired of the possibility of bringing before the Society a report to which he could pledge himself. There were ten diamonds with the machine. Two of them were technically termed "points," pyramidal fragments of diamond terminating in points, and all who had examined them agreed that one was a piece of natural crystal, whilst the other had two cleavage faces and one crystalline (natural) face, all three faces untouched by the mill. Regarding these "points," there had been no difficulty in deciding that *none* of the surfaces had been polished. The other eight diamonds each presented the general form of two faces meeting in an "edge"; the difficulty had been to decide whether the faces were in some cases (1) both polished, (2) both cleaved ("cleavage faces" unpolished), or (3) one polished and one cleared. The opinions of the diamond experts could not be reconciled, for in two instances they were in absolute contradiction; one party affirming that both surfaces were polished, whilst the other party were equally positive that both surfaces were due to cleavage, and were *not* polished. Under these circumstances it had appeared to him essential to submit the surfaces to the test of the goniometer, with a view to determining whether the angles of the natural cleavage planes had been altered, any such alteration being necessarily due to artificial polishing of one or both surfaces. He had thought it would be most satisfactory to ask the assistance of a professional mineralogist, and had therefore applied to Mr. Lazarus Fletcher, of the Mineralogical Department in the British Museum, who had very kindly undertaken to examine the diamonds, and measure the angles with Fuess's goniometer. In Mr. Fletcher's opinion the two "points" were untouched by the mill; diamond No. 4 consisted of two cleavage faces meeting in the edge, and was untouched by the mill; in all the other cases *one* of the faces meeting in the edge was an untouched cleavage face and the other had been polished, and in some cases an additional facet or two developed on that side: the alteration of the cleavage-angle he regarded merely as an incident of the polishing. *En résumé*, there were seven diamonds, each having two principal faces meeting in an edge, one face in every case being an untouched (unpolished) cleavage face, whilst the other was polished; one diamond had two cleavage faces meeting in an edge, and both faces were untouched (unpolished); the remaining two were "points," not touched by the mill. The goniometer showed that in the polishing the angles had been altered from the natural cleavage planes by quantities varying from a few minutes up to about six degrees, and as no two were exactly alike it might be assumed that, as Mr. Fletcher suggested, "the alteration of the angle is merely an incident of the polishing," and not a condition distinctly aimed at by Herr Nobert. Mr. Mayall said that, in the face of Mr. Fletcher's opinion, he must withdraw the statement he had made at the previous meeting that some of the diamonds appeared to have two polished surfaces meeting in one edge. On closer examination in Mr. Fletcher's presence, he found that certain striations on the surfaces which he had regarded as imperfectly polished were more probably untouched, and therefore he now gave his adhesion unreservedly to Mr. Fletcher's judgment. Regarding the mode of preparing the ruling diamonds adopted by Herr Nobert, Mr. Mayall said he had no record save the diamonds themselves. The matter could only be decided by conjecture. After various consultations with diamond experts, he had come to the conclusion that diamonds, exhibiting under the microscope precisely the character of the seven "edges" to which he had referred, could be prepared from the fragments of gem diamonds met with at any diamond cleavers. The cleaver would select a fragment which would admit of two faces being cleaved to an edge of about $\frac{1}{18}$in. or $\frac{1}{20}$in. in length; one of these faces should be perfectly polished on the mill as near as might be parallel with the cleavage face; the other face should then be cleaved again parallel to its former cleavage, so as to remove the edge, which would probably have been somewhat rounded by the mill, thus furnishing a new and probably sharper edge—a clean fractured surface meeting the flat polished surface; the diamond should then be mounted in soft metal in a notch at the end of a piece of brass wire by means of a blowpipe. Such fragments of diamonds had but little commercial value. A diamond cleaver in Antwerp had estimated the cost of supplying them complete at less than ten shillings each. After referring to the various notes on the diamonds contained in Herr Nobert's memorandum-book, Mr. Mayall said he had no doubt the publication of the data obtained from the examinations of the diamonds would further the interests of micrometry. Several ruling machines existed both in Europe and America capable of dividing space as minutely and exactly as Herr Nobert's machine; but most, if not all, of them refused to rule lines at all comparable to Nobert's when the closeness exceeded about 50,000 to the inch, and this was, he believed, mainly, if not wholly, due to imperfection in the diamond, or in the method of regulating its pressure upon the surface to be ruled.

Mr. Hardy exhibited a colony of *Vorticelli* having the stalks agglutinated in a bundle, and covered with transparent gelatinous matter. It was found erect on leaves in colonies of 50 to 100, some more erect than others, and coming off the leaf freely. When loose, they appear very like large *Conochilus*, but sink by the weight of stalk. The body was campanulate and very slightly retractile. Hight, 2mm. to 4mm.

Mr. Cheshire exhibited a remarkable slide showing conductive nerve threads escaped from the sheath of the ganglionic chain running through the first three segments of the abdomen of *Vespa vulgaris*.

## LIVERPOOL MICROSCOPICAL SOCIETY.

The ordinary monthly meeting was held on Friday, at the Royal Institution, the President, Mr. Chas. Botterill, F.R.M.S., in the chair. There was a large attendance.

The minutes of the previous meeting were read. Messrs. T. J. Lloyd, L.D.S., and A. Codd were elected members of the Society.

Mr. J. C. Thompson referred to the loss sustained to microscopical science through the death of Mr. Charles Vance Smith (son of the Rev. Vance Smith, of Carmarthen), who, though paralysed for many years, had attained a high position among microscopists, through his delineation of the microscopical structure of plants.

The Rev. H. H. Higgins, M.A., called the attention of members to the importance of observing and recording any variation of species, together with the conditions under which such variations occur, with the view of further advancing microscopical and biological science.

Mr. A. Norman Tate, F.I.C., then read the paper of the evening, on "The Microscopical Examination of Potable Water." After alluding to the impossibility of always determining by chemical means alone whether a water is, or is not, fit for dietetic purposes, he proceeded to speak of the importance of microscopical investigation in relation to water supply, pointing out that it afforded better opportunity of determining the character of organic impurities, and that it might frequently assist in ascertaining the character of the mineral constituents. He considered the arbitrary standards of purity as regards organic constituents, set up by some water analysts as being unsafe to use, without knowing the exact nature of such matters And in deciding this the microscope could help. He then proceeded to speak of investigations concerning the minute animals and plants in waters contaminated with sewage, &c., and then described different modes of collecting and examining waters microscopically, and urged the importance of further investigation, so as to ascertain how far the organised matters present in water are capable of developing disease, and how such organisms may be destroyed by various means, describing several modes which might be adopted in carrying out such inquiries. In conclusion, he mentioned impurities found in natural ice, and also two methods of examination of rain and air.

A discussion followed, in which the Rev. H. H. Higgins, Mr. Davies, and the president took part, and a cordial vote of thanks was passed to the lecturer.

# SCIENTIFIC NEWS.

The death is announced of Prof. Carl von Siebold, the eminent physiologist of Munich, where he had long been Professor of Zoology. He was in his eighty-first year.

Mr. Frederick Field, F.R.S., the senior partner in the firm of J. C. and J. Field, and one of the original members of the Chemical Society, is also dead. He was at one time Professor of Chemistry at St. Mary's Hospital, and filled a similar post at the London Institution. Mr. Field contributed numerous papers to chemistry, and penned many valuable notes on the mineralogy and metallurgy of South America, the facts of which he gathered during the time he held the office of Vice-Consul at Caldera, in Chili.

We have received the report of Commodore Franklin, Superintendent of the United States Naval Observatory, giving the usual account of the work done at the Observatory, Washington, by the different officers, and with the various instruments. The superintendent reiterates the suggestion of his predecessor, that there should be appointed annually a Board of Visitors, to consist of a small number of scientific men, whose duty it should be to examine into the conduct of the Observatory, and make such suggestions as might add to its general usefulness. From the programme of work to be pursued this year, we find that amongst other tasks allotted to the 26in. equatorial will be observations of the conjunctions of the inner satellites of Saturn during the opposition of the planet, and a complete micrometrical measurement of the dimensions of Saturn's ring. Three drawings of the planet will also be made—one before opposition, one at, or near, opposition, and one after opposition. Observations of a selected list of stars are to be made with the prime vertical transit instrument in conjunction with the Royal Observatory, Lisbon, for the determination of the variability of latitude.

The Académie des Sciences of Paris offers for the present, and three following years, a medal of the value of £120 for some important improvement in the theory of the electric transmission of work. The Bordin prize of £120 is also to be given for the best memoir "On the Origin of Atmospheric Electricity and the Causes of the Great Development of Electrical Phenomena in Storm Clouds." The memoirs must be sent to the secretary of the Academy before June 1, in the year in which they compete.

The grounds of the New Natural History Museum, at South Kensington, will shortly be opened to the public, who will be admitted from the subway now being constructed along the Exhibition-road. The collection of fishes, insects, and British zoology will probably be ready for inspection by the next Bank Holiday; those collections in the new buildings already open were visited on Easter Monday by numbers far beyond expectation.

In a paper contributed to *La Houille* on explosions of firedamp and barometric falls, M. de J. Lebrun throws a doubt on their connection. He says that several English engineers and men of science have sought to establish a coincidence between great barometrical depressions and explosions of firedamp; but an inspection of the tables published by the French Commission on Firedamp does not appear to prove this. There are as many explosions at moments when the barometer does not vary and when it rises as there are when it falls.

An electrical railway is in course of construction at the Alexandra Palace, leading from one of the gates to the building itself, so that visitors will be able to avoid the up-hill walk from the entrance.

The annual meeting of the Iron and Steel Institute will be held in London on May 6 and two following days. Dr. Percy is the president-elect, and will deliver an inaugural address on the first day, which will be followed by the reading and discussion of eleven papers, some of which will certainly be taken as read. Two of them deal especially with the coke-making process known as Simon-Carvès, which is now adopted to a considerable extent in the North of England; and a third paper, by Mr. I. Lowthian Bell, will inform the public of the value of such coke for iron-making purposes, as ascertained at the extensive works in the Cleveland district, of which that gentleman is the head. Three papers will deal with the subject of steel in relation to its manufacture and its properties. The first of these, by Sir Henry Bessemer, is likely to cover the ground of the manufacture of steel generally, and will probably show the fitness of Bessemer steel for many purposes. Another paper, by Dr. Sorby, F.R.S., of Sheffield, will illustrate the microscopic structure of steel; and a third paper, by Dr. H. Wedding, of Berlin, will afford information as to the mechanical properties of steel, based upon investigations made by that gentleman in Germany. Mr. Andrew Carnegie sends a paper on "Natural Gas, and its Utilisation for Manufacturing Purposes in the United States"; and steel makers and shipbuilders will be interested in a paper promised by Mr. Parker, of Lloyd's, on "The Causes of Failures in Steel-plates." The Bessemer gold medal for 1885 will be presented to Professor Richard Akerman, of Stockholm.

A locomotive has been recently completed for one of the Brazilian lines by the Baldwin Locomotive Works, Philadelphia, which is the second largest ever built. It is to run on a gauge of 5ft. 3in., and has cylinders of 22in. diameter by 26in. stroke. The driving wheels are 3ft. 9in. in diameter, and are coupled to four other pairs—hence the type is called "Decapod." A pony swing truck leads. The total wheel base is 24ft. 6½in., of which 16ft. 11½in. is covered by the drivers; but the rigid base is only 12ft. 7½in., the second and third pairs of wheels being without flanges. The boiler is straight, 5ft. 4in. in diameter, with copper firebox, and 268 2in. steel tubes. The firebox is 10ft. 1in. long by 39½in. wide, and the total heating surface is 1,940 square feet. The tractive force is 279 pounds for every pound of effective pressure on the pistons.

According to the *Railroad Gazette*, the longest train ever seen on the Lehigh Valley road consisted of 123 eight-wheeled coal cars, all loaded, and it was drawn by a single engine. An extraordinary engine, or perhaps some mistake in the number of loaded coal waggons.

According to Dr. Korab, writing in a Spanish pharmaceutical journal, Helenina, the principle of Inula Helenium, has powerful antiseptic properties. It is sufficient to use it in the proportion of 1 to 10,000 parts to preserve very putrescible fluids. An egg, beaten up with about 10oz. of water, and treated with five grains of helenina dissolved in about 30 grains of alcohol, remained perfectly sweet for six days at a temperature of 82° Fahr. Dr. Korab has made many experiments, and has found that helenina destroys organisms in infusions, and the aroma of the drug keeps away mosquitoes. It is valuable in surgery, and has been used in medicine with advantage. Whether the common elecampane of this country will yield a drug as potent as the Spanish remains to be seen.

## USEFUL AND SCIENTIFIC NOTES.

**Preparation of Absolute Alcohol.**—Dr. Sharp states that absolute alcohol is prepared in Ranvier's laboratory by adding anhydrous cupric sulphate to 95 per cent. alcohol. Pulverised cupric sulphate is heated to red heat in order to drive off the water of crystallisation; when cool the white powder is placed in a wide-mouthed bottle, holding about a litre, and three-fourths full of alcohol. The bottle is quickly closed and the whole shaken. After standing a day or more—with occasional shakings—it is decanted and the operation repeated, especially if the cupric sulphate shows much of the blue colour due to the reassumption of water. As a test, a drop of the alcohol thus dehydrated may be mixed with a drop of turpentine on a glass slide, and examined under the microscope; if no particles of water are to be seen, the alcohol is absolute enough for all practical purposes.

**Mercury as Ballast.**—Some members of the New York Yacht Club propose to use as ballast, during the coming season, flasks of mercury. The idea that liquid ballast will aid a vessel's progress by the impact of its swaying is very widespread, and was certainly in vogue many years ago, as Lord Nelson is said to have used it in naval operations by fastening casks of water from the mainstay for the purpose of increasing the speed of the vessel. Mercury would form a superior ballast, as its heaviness would reduce the centre of gravity of a yacht lower than an equal weight of lead or iron, but it seems strange that its liquid state should credit it with some latent means for augmenting the speed of a craft.—*Engineering.*

# LETTERS TO THE EDITOR.

*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

*All Cheques and Post-office Orders to be made payable to* J. PASSMORE EDWARDS.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

### HYPERION AND DOUBLE STARS.

[24100.]—I AM much obliged to Mr. Sadler for his elaborate reply *re* $\theta$ Aurigæ and Hyperion. I must accept his decision that I did not see Hyperion, but a faint star in its exact position. I am glad he has given such full particulars of apertures with which only it has been seen. But is there any suspicion existing as to its variation? The satellites of Saturn, which are easily visible to me, are, in my opinion, all variable in lustre.

I see in his data of $\theta$ Aurigæ the mag. of the close *comes*, as established by $\beta$. in 1878, is much smaller than by O.$\Sigma$. in 1870. $\beta$. is certainly right, for this very fact of its smallness threw me out in looking for it. I was looking for a much brighter *comes*, and was astonished when I found it so minute. I think Mr. S. will find the notices of this star he refers to in 1883 do not refer to the *comes* at all.

As to O $\Sigma$. 175, I saw it well divided, March 30, with 400 $\pm$; and $\omega$ Leonis also, with same power.

In Horne and Thornthwaite's "Hints," $\alpha^2$ Cancri is given as a test object. Webb does not mention it, and Proctor's maps only show $\alpha$ and not $\alpha^2$. What does the small 2 mean? The R.A. and D. is correct for $\alpha$ Cancri. I should like to propound a query as to under-corrected mirrors. I believe most mirrors are left slightly under-corrected —that is, the central focus is longer than the marginal. Now, the focus of a convex lens, uncorrected for spherical aberration, is just the same, and of course the focus of a concave lens uncorrected will be shorter for central rays—that is, the aberration is in opposite direction. If, then, a Barlow lens be made achromatic, but with a small residuum of spherical aberration, it will correct the under-correction of mirror, and will allow of an exact balance being obtained by moving it to and from the speculum. Its compensating power would be greatest when most within the focus, diminishing to nothing at the focal point. I think the performance of many slightly under-corrected mirrors might be made practically perfect by this means.

**Edwin Holmes.**

### VISIBILITY OF THE 5th AND 6th STARS IN THE TRAPEZIUM OF $\theta^1$ ORIONIS, &c.

[24101.]—MR. SADLER, p. 298, Vol. XL., asks me for dates on which I have seen the 5th and 6th stars in the Trapezium with a 3⅜in. refractor. The occasion to which I referred at Port Macquarie was on the evening of 25th November, 1882, $\theta^1$ being at an elevation of about 60°. On subsequent occasions I have kept no record of dates.

The telescope has really a trifle less aperture than I have named, the setting of the o.g. reducing it to 3.65in., clear focal length 57in., altazimuth stand. The o.g. is of excellent quality, giving a perfect picture of a star disc under the highest power.

Mr. Sadler is quite right in his supposition of the misprint referred to in the concluding portion of his letter.

Sydney, N. S. Wales. **G. D. Hirst.**

### SATURN.

[24102.]—I HAVE lately mounted for myself a splendid 6¼in. Calver mirror. The definition and ease in observing has surpassed my expectation; and I would like to ask those in possession of larger instruments if Encke's division has been seen on Feb. 7 and 18 and March 1 and 14 of present year? On Feb. 17, at 9.45 p.m., the definition of Saturn was very bad with a high power, so I used a low-power eyepiece, and had not been observing long when a beautiful meteor passed through field of view. I reckoned the curve was from 147° to 302° in eyepiece. I could not see any "tail," neither was it visible to the naked eye, as I looked for it directly. I write this merely as a curious incident. Can any of "Ours" give a few tests for the above? I find, in looking at $\xi$ Majoris, given as a test for 4in. o.g., I divorce this double with 200, very wide. I would like naked-eye tests.

**Aleph.**

### $\theta$ AURIGÆ.

[24103.]—IN consequence of the interesting letter (21065) dated February 10, 1883, of your correspondent, Mr. Sadler, I carefully looked at $\theta$ Aurigæ with my 8in. equatoreal. I find in my note book, under date April 2, 1883, the following:—"Could not make out Sadler's companion at about 170° and 50″; distinctly at times, saw his other at about 340° and 50″; also saw the other distant one at about 270° and 150″." I tried Mr. Sadler's faint star at about 170° 50″, with all powers, but utterly failed to see it. With this exception, I had no difficulty in seeing all the others mentioned by Mr. Sadler in his letter (24064) in your last week's number. I am strongly of opinion that, at least, to my eye and instrument, the close companion (B) is much more difficult than it was in 1881, when I could see it well with powers from 350 to 500. I hope to examine this group again, and if successful with Mr. Sadler's companion, which I missed in 1883, to report in your pages.

**George Hunt.**

Hopefield, Alleyn Park, West Dulwich, April 13.

### PRESERVATION OF THE MIRRORS OF REFLECTORS—FRESH WATER AND SALT — SMOKE — SUNSPOTS AND THEIR PERIODICITY—NORWEGIAN LOBSTERS.

[24104.]—WITH reference to Dr. Royston Pigott's footnote on page 118, Vol. XLI., I am quite unaware of any method of preserving the silver films of reflectors, and should be very glad to hear how it is done, if any reader could spare time to inform me? I had the ill luck to miss nearly a year's ENGLISH MECHANICS, so perhaps it has already been referred to. If the process really preserves the film, it would go a long way towards making reflectors suitable for day use; but I am still rather doubtful of the adjustments in uneducated hands.

Can anyone say by what laws fresh and seawater mix? Here, at the mouth of the Tyne, I often observe on fine days that the turbid current of the river, on leaving the piers that confine it, turns away to the north nearly at a right angle, according as the tide is running, and then forms a very distinct brown ribbon, which keeps its original breadth, or at least spreads out very little, and gradually grows fainter and fainter (I suppose as the mud held in suspension is deposited), till it disappears some miles away at sea. Now, no doubt, fresh water is lighter than salt, and should therefore float on its surface; but, if it really does so, I cannot see what prevents it from spreading laterally, as, to float on the sea at all, implies to be on a higher level than the sustaining fluid. Does cohesion come in, or what is the force that retains this brown ribbon of water within fixed limits? It is a most remarkable sight on a fine day, when the sea is calm and the wind in the east. With a wind from the south-west there is a much more explainable and unpleasant phenomenon—namely, the coming down of a vast cloud of smoke from the river and Newcastle, which fills the air with smuts, and blots out the sea and the sun. If I were a member of the Statistical Society, I might amuse myself in calculating how many millions of foot-pounds of energy were daily disappearing in the form of smoke; but as such a computation would have no very practical effect, I forbear. With coals at 12s. a ton, human nature will not consider the future.

There have been splendid groups of spots on the face of the sun during the present year. I confess myself wholly unable to trace the 11-years period, though I am ready to believe in it on authority. But the activity of the sun's envelope should be very visibly decreasing now, and yet I have only once this year seen its face pure of spots. And I generally look out every fine morning.

Is the small Norwegian lobster known at all in the South of England? It is a cheap and pleasant article of food here and in Dublin. In both places the inhabitants call them "prawns."

Tynemouth. **Garrison Gunner.**

### THE ROYAL ASTRONOMICAL SOCIETY'S "MONTHLY NOTICES" FOR DECEMBER, 1884, AND MARCH, 1885.

[24105.]—MAY I be allowed to call the attention of your readers to the very interesting character of the information contained in the above-mentioned periodicals of the dates referred to? If your many amateur readers fail to possess themselves of a valuable amount of knowledge by their perusal, it must be their own fault. They will find, in the latter number, a mass of figures extending from pages 348 to 373 inclusive (i.e., 27 pages), which would take them twelve months' hard toil to decipher, and more than that period properly to appreciate. But if not satisfied with that, they may turn their attention to a chronicle of figures embodying "spectroscopic results for motions of stars in the line of sight obtained at Greenwich," which must be equally fascinating to anyone who can revel in 13 pages more of closely-printed figures. Add to this, there is a well-assorted list of "Notes and corrections to Sir W. Herschel's Memoirs," most instructive and agreeable to all who delight in Sir John Herschel's valuable synopsis. But some more excellent reading is obtained on reference to the 17 pages (pp. 298-316) touching the star-places in the *Nautical Almanac*. The portions of the December number which are so valuable to those who have leisure to visit the Cape Observatory will be found in the 22 pages wherein are discussed the "Systematic Errors of the Cape Transit Circle," for possibly they may learn by this means how to regulate their own instruments at home, if only they have funds at their disposal for the purpose. **Amateur Astronomer.**

Preston, April 11.

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## THE SOLAR DIFFRACTION SPECTROSCOPE AND STAR-SPECTROSCOPE.

[24106.]—I RETURN my sincere thanks to Mr. W. H. Haren for his full and lucid communication regarding the construction of the solar diffraction spectroscope. Through information which comes to me from various sources, I am satisfied that his letters on this subject have aroused the interest of many amateur workers, several of whom will assuredly construct instruments upon the principle he has described. Shortly after Mr. Haren had first drawn the attention of our readers to this interesting subject, I procured a grating similar to the one he is using, and, aided by some hints from our kind and ever-obliging friend, Mr. Brashear, mounted it for experiment in a simple way at first, deferring the construction of a more perfect instrument till I could have the benefit of the fuller instructions which Mr. Haren has since so obligingly furnished. Even with the rough and imperfect model above mentioned, my experiments were most satisfactory; the results quite surprising me. I hope before very long to have completed a properly made spectroscope for this admirable grating, which, indeed, deserves the best and most careful mounting.

In reply to Mr. Edwin Holmes (letter 23848, p. 539), I beg to say that in reciting some of the "other" applications of a small star spectroscope, I fear I shall only be enumerating uses with which he and others are already quite familiar. However, as he puts the question, I may mention that an instrument such as he has constructed will show not only the spectra of stars and nebulæ, but those of the planets also. Doubtless before this, Mr. Holmes has tried his spectroscope on Jupiter and Saturn. In the brilliant spectrum of the former, the dark lines are beautifully shown without a slit, while in the fainter light of Saturn many lines are still visible. No doubt comets would give interesting spectra, though here I do not speak from experience. In connection with all these objects, the hints relative to comparison of spectra given in Browning's "How to Work with the Spectroscope" might be turned to useful account, and would probably be fruitful of interesting results.

Then removing our cylindrical lens and substituting a slit and collimator—adding, too, if possible, a small observing telescope, we are ready to examine and study the lunar spectrum, and, to a certain extent, that of the sun. In this latter the bright lines of the prominences may be readily seen by a little management.

It seems needless for me to speak of the suitability of our modified instrument for exhibiting the simpler chemical and absorption spectra; but I may say that a small equilateral prism fixed over half the slit is an addition readily made, and one which renders possible with very simple means some interesting comparisons of dark solar lines with those of terrestrial elements. Nor should the auroral spectrum be forgotten; nor the study of those atmospheric lines which give to the spectroscope its value in meteorology. In fact, the possessor of a small instrument, such as Mr. Holmes's, may constantly turn it to use in one way or another with results which, though trivial to the possessors of powerful batteries of prisms, are most interesting and instructive to the amateur worker who is contented, or even delighted, if his experiments be moderately successful. The student unprovided with instruments may peruse half a dozen volumes treating of dark lines, bright lines, and so forth with but a partial understanding of the significance of what he reads; but let him *see* these things once, and I doubt not he will find he has thus acquired a far deeper and truer insight into his subject than he could ever have gained by reading only.

I regret my inability to aid Mr. Holmes with advice as to the best form and position of the cylindrical lens. Doubtless, some of our optical correspondents can assist him. So far as my very limited experience reaches, I believe that convex cylindrical lenses are used conjointly with slits, being placed at some distance in front thereof. Lockyer and Schellen, however, found advantage to result from placing the lens in the path of the rays just before the eye receives them. In the McClean star-spectroscope the lens is, for obvious reasons, concave and situated close in front of the compound prism. Neither do I know of any means for separating the spectra of double stars other than by the use of a powerful telescope of long focus, and, of course, a slit-spectroscope. Mr. Holmes' idea in this direction was ingenious, but he could hardly expect it to succeed, except possibly in the case of two stars much more widely separated than the components of γ Andromedæ, and it would also imply great care in the focussing and other adjustments.

On p. 378, Vol. VIII. of the "E. M.," appears a device for showing star-spectra; but its action is not at all clear to me, since it is stated to consist only of a prism and a Huyghenian e.p. of high power. Still, as the arrangement purports to emanate from no less an authority than Dr. Huggins, it might be worth while to try it.

**A. F. Miller.**

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## A 30-LIGHTER SERIES-WOUND DYNAMO.

[24107.]—THE following brief sketch of a dynamo put up by a friend of mine, which is doing excellent work, may be of interest to "Anglo-Dane," W. H. Eaves, and others who are thinking of erecting dynamos for private use.

While fully agreeing with W. H. Eaves as to the superiority of compound shunt winding wherever a varying resistance is likely to occur in the circuit, yet I feel that to amateurs the greater efficiency and easier make of the series-wound dynamo will ever make it a favourite. I cannot follow W. H. Eaves as to the jerking of the cog armatures; I can only say that I have never noticed such to occur.

The dynamo under consideration consists in a cog armature, 7in. diameter from cog to cog; thickness of ring, 1in.; outside diameter of ring (exclusive of cogs), 5¾in.; thickness of cogs, ½in.; depth of channel, ¾in.; number of cogs, 12; width of ring, 6in. Wire on armature, No. 14, double cotton-covered in six layers, about 70ft. to each channel, or 840ft.—say, 18½lb. The total resistance of this wire was 1·44 ohm, but the running resistance was only 0·359 ohm. The field magnets consist in two bars of cast iron, carefully annealed, slightly oval in section, being 4in. in the longest diameter by 3in. in the shortest diameter, the length of the wound portions being exactly 1ft. in each. These fit into two pole pieces of soft iron, bored out to receive the armature. When fitted, the pole piece is to form a cube 8in. high, 10in. wide by 5½in. deep. A heavy cross bar of cast iron is bolted to the top ends of the F.M.'s.

The field magnets are wound with 96 coils of No. 12 wire, seven layers deep, the entire length being about 1,680ft., or 63lb. The resistance in series was, as nearly as possible, 1·53 ohm, or about five times as great as that of the armature when running.

Driven at a speed of 1,400 revolutions, this little dynamo lights easily and well 30 20-candle power Swans. After a four hours' run, the machine was sensibly hot, but not too hot for the hand to bear. The E.M F. at terminals was 55 volts; the indicated current was 30 ampères. The dynamo is driven by a 2½ horse-power engine, which is certainly not overtaxed. **S. Bottone.**

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## "ENGINE-MAKING AT HOME."

[24108.]—IN reply to "X." (letter 24093), the only objection which I see to the use of gas for small boilers is the expense. It does not follow that because gas is cheap when used as an expansive agent in engines, it would be cheap when employed for heating purposes. In the best-constructed boilers 1lb. of coal will evaporate 10lb. of water; but if we take the evaporative power of coal gas as equivalent to 1·31lb. of water per cubic foot of gas (given in D. K. Clark's Rules, Tables, and Data) 1,000ft. would be required to evaporate 1,310lb., being therefore the same amount of work which could be done by 131lb. of coal. But 131lb. of coal at, say, 8d. per cwt., would cost only 9 3d., against, perhaps, 3s. per 1,000ft. of gas. This is a good and sufficient reason why coal gas is not used in boilers. But I think, in an amateur's workshop, it would still be advantageous to employ the cleaner agent; not only as being cleaner, but for the reason that it can be quickly turned on and off. The lights could be arranged much as they are arranged around the interior of a cooking stove.

With respect to the second query, the reason why oscillating cylinders of the model-maker's type are not used for larger engines is, that there is no chance to render them steam-tight for any length of time. When the faces begin to wear, the steam must escape. Oscillating cylinders, to be serviceable, must have the points set in trunnions where the valve case can be furnished with stuffing boxes.

As to the rate of speed of a small engine with a pressure of from 10lb. to 30lb., you clearly cannot get more work out than you put in. The limit to speed is governed by the pressure, and the strength of the moving parts; 300 revs. per minute, is a high speed for small stationary engines; and, although locomotive pistons have a much higher rate of travel, it must be remembered that all the moving parts are very strong, and the steam of a high pressure—120lb. about. The only engines that reach 1,500 revs. per minute are the three-cylinder ones of the Brotherhood type, and then only those of the smallest bore. Steam of high pressure is used, and the pistons are not moved by a directly reciprocating rod, but by an eccentric. They run at a terrific speed, and are therefore used for dynamos and centrifugal pumps, where space is a consideration. This is the only kind of engine in which it would be possible to attain 1,000 revs. and more per minute. **J. H.**

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## LECLANCHE BATTERIES.

[24109.]—IT may interest some of your readers, especially amateurs, to know how the above batteries can be made of an efficient character, and at a reasonable rate. The following gives the cost of a set I have just completed, having had a similar set in use for many months:—

| | | |
|---|---|---|
| 8 jars, Stiff and Sons, 85 A., at 6d. | 4 | 0 |
| 8 porous cells Stiff and Sons, 7 A., at 6d. .................. | 4 | 0 |
| 8 carbons, headed, Blackwell's, 6 × 1½, at 1s. ................ | 8 | 0 |
| 8 zincs, my own make, 8lb., at 5d. | 3 | 4 |
| 6lb. coke, Griffins, at 4d. ...... | 2 | 0 |
| 4lb. manganese, Griffiths, at 6d... | 2 | 0 |
| 5lb. sal-ammoniac, Blackwell's, at 8d. ......................... | 3 | 4 |
| Amalgamating zincs ............ | 1 | 0 |
| Connecting wires, solder, tallow, paraffin, sealing-wax, varnish, &c. ......................... | 2 | 4 |
| 8 cells, at 3s. 9d. each | £1 10 | 0 |

The jars are greased an inch deep at top inside, to prevent creeping. The cells are paraffined 1½in. at top, using a small bore lead tube as an inverted siphon to let out the air from the inside when dipping the cell mouth downwards in the melted paraffin. The zincs are battledoor slated, 7in. long, the blades being 4¼ × 2⅜ and ¼in. thick, thinned off to the edges, and weigh one pound each. A hook soldered on the shank hangs them on the edge of the jar. Three inches of the blade are amalgamated, the remainder and the shanks coated with sealing-wax varnish, as also are all the wires, to keep them from the action of the inevitable ammonia fumes.

The connectors I use are those figured at p. 340, Vol. XXIX., with the improvements as at p. 367, Vol. XXXVII., which are most convenient in use. The sal-ammoniac used is half a pound to each cell, and one pound dissolved in hot water added in equal quantities to each porous cell, in order to start the battery quickly, and the jars are filled so as to cover the amalgamated portion of the zincs.

This makes a useful, cheap, and powerful battery, easily examined, cleaned, and repaired, and one which I prefer to the well-known glass jars.

**Rho.**

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## A NEW INEXPLOSIBLE BOILER.

[24110.]—A BOILER of a new system, which received the name of Générateur Tricyclique Inexplosible, has been invented, which differs from all those hitherto produced. The metallic surface submitted to the action of the fire does not touch the water; in no condition can the boiler get red hot; it is enveloped all over by the same temperature, hence an immense vaporisation. Steam can be produced to the very last drop of water without the least danger. The spheroidal state, the decomposition into gas of the water, the elicitation of electricity in the metal, are thus avoided; the tremendous loss of heat now existing is diminished to such a degree, that with half the usual quantity of fuel a power more than fifteen times greater is obtained, and the steam-pressure can rise at will to 10, 15, 20, 30 atmospheres, and more, without fear of explosion. It appears that with some modifications the principle can be applied to existing boilers, but with less advantage.

**Ch. Rabache.**

Morchain, Somme, France.

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## INTERCHANGEABLE MANDRELS.

[24111.]—I MUST apologise to "E. J. S." if I have mis-read his letter. I am glad to see that he does *not* advocate a long cylinder-fit as a substitute for the Edmunds' wide mandrel face with a view to prevent angular variation. But in this case, the questions raised by "E. J. S." are merely of theoretical interest, and I am not the man to assist in discussing them.

The general propositions set out in the first part of "E. J. S.'s" letter I fully admit, and I have already said that as we extend our bearing surfaces so we diminish pressure and lessen abrasion. If the cylinder base were, for the sake of argument, made by "E. J. S." a foot long, this axiom would still hold good. But "E. J. S." seems to forget that elongation of the cylinder base involves also the elements of time and distance travelled, as well as the division of the pressure over a larger surface, and the result is, that his argument is a fallacy whether he extends the cylinder base to a foot, or only, as he proposes, to an inch. The distance travelled and time taken up in screwing surfaces an inch long over each other are new elements in the problem, and have not been taken into account by "E. J. S." If, also, we put a cylinder base of one inch in length on our mandrel, we have an impracticable construction, and, as "E. J. S." expressly disclaims advocating it, what is the use of my attempting to discuss such a construction of mandrel head?

The question whether "two conical surfaces offer less difficulty in the attainment of truth than four surfaces at right angles to each other?" is interesting and important, and goes to the root of principles which need to be understood by all practical fitters. In my judgment, "E. J. S." is wrong in saying that this is so. If conical surfaces can be ground in together, it would be true; but in the "multiple fittings," which are required for mandrel heads, Dr. Edmunds is *perfectly* correct in saying that the two coned surfaces are less easy to make and less sure in their action than the four rectangular surfaces which he advocates. It seems to me that "E. J. S." has not fully studied the valuable papers which have been written by Dr. Edmunds on these points. I confess that I have perused Dr. Edmunds' papers in the *Journal* of the Amateur Mechanical Society (No. 25) and in the English Mechanic, with much help to a clearer understanding of the principles of our transfer chucks and interchangeable fittings.

The analogy which "E. J. S." draws between the interchangeable drills which I have for many years made does not hold. These drills have a long cone of great acuteness, and offering a very large contact-surface in proportion to their cutting edges. With a face-plate on a lathe mandrel these proportions are more than reversed, and, therefore, the same principle of fitting would not apply. Generalisings of this kind are often very misleading. As a practical man, I think that the coned mandrel-head will never compete with the screw-nose, and I believe that the Edmunds model mandrel-head, with its wide face for eliminating angular variation, and its cylinder-base for excluding eccentric variation, is a vast improvement upon the best mandrel-heads hitherto constructed. If this be so, we are only interested in points of detail, and one of these points which I am still debating is whether the nose-thread should have eight or ten turns per inch? Considering the large use of wood chucks, there is much to be said for adopting a thread of eight turns per inch, and then reducing the bore of the mandrel. From a private note which Dr. Edmunds sent when he lent me his model, I believe that he thinks this also. Will our contributors help us by giving their attention to this point?

In cutting V screw-threads with a milling-cutter, the correct practice is simply this. Use the milling-cutter for removing quickly the abundance of material, not for finishing; the point-tool for bringing up accurate sides, and the V lap-wheel for putting on the polish and the dead accuracy—no more—and that must be most carefully and delicately done; too much grinding here is like any other similar process; the abrading material cuts away where you don't want it, by collecting in heavier masses at one place than another. There is, however, no necessity to prolong a discussion upon the merits of a revolving lap, for either finishing a hardened lathe-mandrel, its cylinder base, shoulder face, or V-thread-nose of 50° angle; it has been done, and is regularly done, with an accuracy that none can dispute. And here, in my shop, may be seen an 8in. centre lathe which has been in use for years, having a V-thread screw-nose of $1\frac{6}{16}$in. diam; $7\frac{1}{2}$ turns per inch of 50° angle, and a shoulder-face of $2\frac{1}{8}$in. diameter which was so finished. The screw-thread is not hard, but about spring temper—a hardness obtained in the process of hardening that portion which runs in its hard steel collar, and the chucks are so good a fit to-day that a very small portion of dust will render them difficult to screw on.

Mr. Wenham's letters seem personal and offensive. As a sample of "dodging about," I advise our readers to study Mr. Wenham's last letter by the side of what has gone before. In every practical point which is in question, I venture to say that Mr. Wenham is also wrong. As a practical man, who worked at the bench and at the screw-cutting lathe for many years, I was obliged to differ from him. He then, after a rigmarole about hardening mandrels—which is misleading in every particular—turns round and suggests that, because my lathe mandrel-noses are soft, my tools are bad. Mr. Wenham either knows nothing about lathe mandrels, or he has said what he knows not to be true. When brought to book by me he simply "runs away," and writes about other matters. As I have already said, every reader who has a fine ornamental lathe, made either by myself, or by Holtzapffel, or Evans, will find that the nose is soft; yet Mr. Wenham neither retracts nor apologises.

Mr. Wenham's rigmarole, about softening the nose with a red-hot poker, can only amuse practical men. We never soften the noses at all, because we never harden them. We have methods by which we harden absolutely our mandrels on their running parts without hardening either the nose or the pulley portion. When Mr. Wenham is asked to give the addresses of "the best lathe-makers who now turn down their hard steel mandrels by a diamond splinter," he makes a paltry excuse about not wishing to advertise his friends by mentioning their names.

The specially-constructed steel I mentioned, was, I believe, originally made for Sir Joseph Whitworth and Company, expressly for tap-making. It is now to be had as a regular article in commercial use. I have used it for making my mandrel-taps for several years with the utmost satisfaction, and will send "Bow" a sample if he gives me his address.

Griffin Works, Norwich. **Edward Hines.**

## INTERCHANGEABLE MANDRELS.

[241 2]—Letter 24077 contains a question as to what are the requirements for making chucks interchangeable, and I am able to give the correct answer, which I do in this wise—viz.:—

1. As to "a cone-fitting [query—what is the proper angle?] to act as a guide to the chuck," I answer, Have nothing whatever to do with a cone-fitting at all.

2. "A shoulder to prevent the chuck jamming on the cone." Have a shoulder by all means. A true one, of moderate width. If you are in the habit of making chucks out of plank-wood, a broader shoulder is desirable than is required if you use metal chucks. In the latter case $\frac{3}{16}$in. is sufficient for a non-geared 5in. lathe with $\frac{5}{8}$in. nose, and one $\frac{1}{4}$in. is ample for a geared lathe of the same height of centre, with 1in. nose.

As to the "screw (not necessarily good fitting) to hold the chuck to the shoulder." Answer, I am not in favour of tight fits for the screws, and they may be very slack fits indeed, and yet accomplish all that is desired of them, subject to one only condition, and that is that they are good screws.

If you have a good screw-nose to your mandrel—and I fear that not many are to be found in a thousand to deserve the title—you may go on your way rejoicing, and consider yourself perfectly independent of all other centralising arrangements. If your screw is not well cut, no cylinder-fits or cone-fits, or any of those "jims" will be of the slightest avail towards the accuracy at which folk are now aiming. I never yet saw one so bad that it was not quite within the limits of correction by a few judicious touches in a screwing-lathe. It cannot be done otherwise.

Now I wish to say, once for all, that I do not intend to be led into any discussion: that has been done all ready to my hand, and I am not going to bother myself going through all that has been written. What I say I do not offer as an opinion, but as what I know from every-day practice, and what I know that I know. **J. K. P.**

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[24113.]—We have to thank "E. J. S." for some ably-reasoned letters on the question of coned mandrel heads *versus* the screw-nose and mandrel-face, and for an interesting critique upon the model mandrel head which I have suggested. The question of coned mandrel heads is one of great workshop importance, and I shall follow carefully the discussion which will probably ensue among practical men.

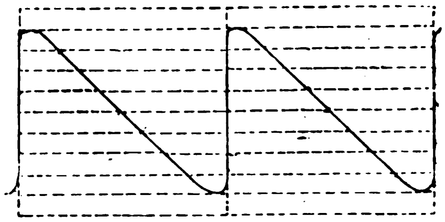
In case of sudden stoppage of the lathe, it seems to me that the cone and bayonet-catch will be unable to hold the chuck on safely. In one case, where such a coned mandrel-head was in use, I have heard that an accident happened, and that a flying face-plate injured a man severely. The fact that none of our great engineers have adopted so simple and obvious a principle in the construction of their foot-lathes is also heavily in favour of the practical superiority of the screw-nose and face-fitting.

I think that the one-cone fitting, though so simple in theory, is more difficult to make so as to fit solid from end to end than the two rectangular surfaces. As I have shown in a former letter, these multiple fittings cannot be perfected by grinding in.

The dead centre turning must always be more certainly accurate than turning on the live mandrel and one dead centre. The live mandrel must be truly concentric and quite in line with the poppet centre, and this is difficult to insure. In ordinary metal cylinder-turning, the live centre is not rigidly attached to the work, and acts only as a turnspit for work which adjusts itself by a sort of Hooke's joint to its own axis between the live and dead centre. Here the live centre needs only to be ground up true "in air" on its own mandrel, and its being perfectly in line is not necessary. This is next door to turning between dead centres. Turning in air also gives great accuracy.

It occurs to me that "E. J. S." has in some points allowed his algebraical forms of thought to carry him on to conclusions which may be fallacious by reason of the fact that his premises are more rigidly defined than his conditions can be. In one point (Fig. 5, p. 83) I would ask "E. J. S." to consider whether the line B.A. should not be reckoned each way alternately instead of only one way? I think that in every case the hold upon the chuck will be from the bite of the south side of the screw-thread to that point of the periphery of the face-zone, which is 180° therefrom in longitude. The south side of the screw-thread at C will only bite when the resistance at B acts. When the resistance at D acts, then the bite of the screw-thread will be on the other side.

This would make a vast difference in the comparison, though practically the solid bite which will be got in all cases upon my mandrel surpasses anything that can be got on the coned head. But I shall follow the remarks of practical experts with great interest. Another question as to thread-form for lathe-noses was raised by me ("E. M." No. 892, April 28, 1882), but hitherto has passed without discussion. In that letter (19973) I gave the following drawing:—



This thread was used by Sir William Armstrong for the breach pieces of his rifled cannon. It has the biting side normal to the axis of the cylinder, and the other side at 45°. By sharpening the angle so as to allow for truncation, this thread may be cut in the square, and therefore as deep as the length of its base. It is the strongest of all threads; it incurs no wedging, and the least possible abrasion.

If in this discussion we mix up the coned mandrel-head with one upon a different principle we shall all be at sea. The complete discussion of coned mandrel-heads and fittings is very practical and interesting. But we might first settle the remaining details of the modal form of the present screw-nose mandrel-head. I agree with "Vulcan," that "if the threaded nose is to be retained, there is little room for improvement" upon the model now before us. The only points that I see open for further consideration are the thread-rate, the taper of the centre-cone, and the outline of the shoulder. If the screw-thread have eight turns per inch instead of ten we get a thread less liable to jam the metal chucks on, and better for the wooden chucks so largely used in all delicate work. In this case the bore would have to be reduced from ·4in. to $\frac{9}{16}$in., so as to leave more substance in the nose for the deeper thread. "E. J. S." seems to take about the same taper as I have done for coning out the nose, but on this there has not been adequate discussion. What taper is used for the Morse drills and for the American chucks? For the model mandrel-head we require a taper which will hold the centre firmly without being so acute as to endanger the spreading out of the mandrel-nose under any reasonable pressure that can be given between centres. In my model the nose is turned out at 5° from the lathe-axis, and so as to leave the base of the hollow cone ·5in. in diameter. If the mandrel-bore is reduced to $\frac{9}{16}$in. the cone would have to be reduced to a base of ·4in. in order to leave proportionate substance in the screw-nose. As to the shoulder of the mandrel, the question is whether that might not be squared down further, so as to keep its outside diameter to 2in. The eccentric plate for the ellipse chuck has to be considered.

At page 124, "T. U. L." gives us a charming and perfectly-proportioned sketch for a combination of the screw-nose with double-coned centring surface. Theoretically, this is perfect, and it is most artistic. But, in practice, there would be so much difficulty in locating the four coned surfaces in their axial distance, that I fear this construction must be shut out from a design for multiple fittings where final grinding-in is not admissable.

**James Edmunds.**

## LATHE MATTERS.

[24114.]—I must reply to "Bow" in some sort, as he has such an astonishing memory for old utterances of mine, some of which I may now regret, and many of which I have forgotten long ago. The letter to which he refers, in Vol. XVI., is, I see, from our old friend, the late "H. B," and that it commences by saying that he is not "J. K. P.," and does not pretend to possess practical information approaching his on lathe-making, as his own experience dated back only about half-a-century. Well, I am not quite so old as that, yet it is forty years this month since I was head of the workshop at King's College, and it is not much less than thirty-two years since I first wrote "Civil Engineer" after my name. So I am now getting towards that period of existence at which I dare say I may be thought a bit of an old fool, and only fit to poke fun at, just as, when I was younger, I fear I was too much inclined to think of "H. B." I regret it now extremely.

Hollow mandrels, such as that letter describes, used to be in vogue some years ago, and something like them is, I am told, made in America now. Mr. Clements had several, that descended to his nephew Mr. Wilkinson, and I have now one that was copied from them. I would not make another, and though I like that fitting for drill-spindles used in slide-rest, I do not hold in the least with the need of having any such fitting with cylinders or cones for lathe chucks, provided always—and this is absolutely essential—that the screw-nose is well cut. It must be done in a screwing-lathe, as it is impossible to do it by hand. I have two pairs of mandrels—one pair of 1in. and the other of ⅞in. diameter, each with Whitworth's ordinary bolt-thread, which is the strongest thread that can be found, meaning by "strongest," that which will endure the most work with the least deterioration; and those four noses will, two and two, bear the same test as those recently made and exhibited by Mr. Evans. I showed that gentleman two of them screwed into one chuck a few weeks since; but as I have taken the chuck for another purpose, I am not able now to exhibit. The other two are likewise so accurate that I make and finish the chucks intended for one of them on the other one, as the latter happens to stand in a more convenient position in my shop.

Now, going back to Vol. X. p. 476, the expression "capital result," referring to the facility of doing the job with a circular cutter, as compared with the attempt, or, rather, the failure, to accomplish it with a single-pointed tool in a weak lathe, and not to the resulting thread, which is not of a very good shape. As to cutting screws in hard materials, as a matter of practice, I must leave Mr. Wenham to defend himself, as he plainly understands what it is that he is writing about; also writes in a language understood by the general public, and may as well be left alone. There are one or two things that I may say: such as, If you use a circular saw-cutter, or grinder, to cut a groove (I was very near writing "zone," only that I tremble lest a zone should turn out after all to be a piece of a plane, and not of a cylindrical surface, and I therefore be corrected)—well, say a groove, in a cylinder, with the slide-rest stationary, and your cutter running in a plane perpendicular to the axis of the cylinder, you do get a groove which is the counterpart of the cutter used, and in this one instance no attention need be paid to height of centre. The only other position in which you obtain a counterpart of the cutter is when the cylinder is stationary, and the cutter placed and moved horizontally. You then, by repeating the groove at intervals, get a thing like a fluted column. When the cylinder revolves, and the cutter is drawn along simultaneously, as in screw-cutting, the nearest approach to a counterpart is gained by placing the cutter at the same angle as that which the desired thread has at its mean depths, but as that angle is not the same as the angle of the top of the thread, nor yet as that at the bottom, the result is that the groove, when completed in outline, is not like the cutter that produced it. In this case the strictest attention to height of centres is imperative, or the thread will be lopsided, in addition to its other defect. A cutter made for a screw of any particular number of threads will not do for any other number.

As to poppet cylinders, and tightening the same, I very seldom take the trouble to tighten mine, which happens to fit, and has the steady-pin vertically under the top set-screw. I think for small lathes the screw on top is handiest, but in big ones, where the work is often swung into the lathe by a crane, it would run great risk if so placed. I once saw one which had three sliding keys inserted between the cylinder and the barrel, and forced up by what on a steam pipe would be called a "union," which was screwed on to the projecting nose of the barrel.

"Mild steel," "homogeneous iron," or "Bessemer steel" is now sold by Pfeil and Co. in Broad-street, Bloomsbury, and in St. John-street, Clerkenwell. I believe it to be very various in quality from different makers. I have some that came from Vickers's Don Steelworks, Sheffield, some years ago, that turns like annealed cast steel, so hard is it. Some from Pfeil's is as soft as charcoal-iron. I have had mild-centred steel from Stubbs's and from Vickers's. I am told that it is mild steel with an extra treatment in the carbonising furnace, or is it carburetting? I know not.

The fitting referred to in last paragraph but two of letter 24074, is very like one that I have used for the wrought-iron lever handles of a planing-machine screwed into a central boss, and for that purpose is, I think, better than any. I think it would be a very bad one for chucks, and supremely difficult to fit.

J. K. P.

## LATHE MATTERS.

[24115.]—In reply to "Bow" (24073), I have to state that as Bessemer steel has now superseded iron for the spindle work of all small machines, it is kept in stock at most of the large ironyards, such as Moser's in the Borough, but they will not cut a piece off a bar for you. There is also a fine mild quality, suitable for lathe mandrels, known as Atlas steel, as made at the Atlas Works, Sheffield. The special steel with the "mild core," mentioned by Mr. Hines, cannot be cast steel, and therefore, as it is not homogeneous, I would rather not use it. I know of no process by which an ingot of steel can be cast with a "mild" centre, and poor steel carbonised up to get it to harden is fit for nothing as a tap, or any cutting tool. I can recollect the time when a bar of blistered steel (that is, all covered with bosses just as it left the cementing trough) drawn down with hammers from a welding heat, was thought good enough for some cutting tools; these bars, of course, had an iron or soft centre.

As to the milled and afterwards lapped screw-thread, the argument seems to be drifting into the ways of doing it, instead of the question of utility and practicability. What is the use of making a milling cutter "of the true curve and shape," to fit the form of the thread, or that will drop through somehow? This cutter, with a distorted periphery, should have every tooth or cutting edge relieved backwards, in order to be an efficient workshop tool, and this would have to be done by hand-filing—a most careful piece of work. Any workman that would waste a week of his employer's time in attempting to make an accurate screw by such means, would forfeit his character for skill, and perhaps his place too. A lopsided thread for a mandrel-nose is not desirable, as a chuck or piece of work has sometimes to be tried on the reverse way, and for this reason alone the screw-thread should be equal-sided.

F. H. Wenham.

## STANDARD MANDRELS.

[24116.]—My last note (24098), page 129, requires the following addition and correction: Paragraph 5, line 2, "shaped as" should be "shaped similarly to one." A cutter shaped strictly "as," would produce a true axial section, as is usual in screws. Last word of last but one paragraph is a misprint of "both" for "bolts." The V-point tool referred to as normal in paragraph 2, is, of course, the form of tool in question.

I have resolved, the following being the main whys, to give my definite adhesion to the Edmunds mandrel. I am convinced—

1st. It is the simplest centring mandrel forthcoming, or likely to be so.

2nd. It has been proved efficient, and has met the approval of ornamental lathe makers.

3rd. A reliable male cone fitting cannot be made with so short overhang.

4th. There is nothing to jar loose and cause disaster.

5th. Existing mandrels may be utilised and adapted.

6th. For my special needs of frequent change, &c., I can easily "match-piece" to it my coned nose, with pin-key, sleeve and check action to prevent jarring loose, and the other improvements "too numerous to be catalogued," and that without increasing overhang.

7th. The expense for multiple fittings will be comparatively slight, as there is no broad departure from present workshop practice.

Any mandrels for lathes I may in future make or obtain, will be, as far as possible, the same as Mr. Evans has stated his intention to introduce.

I hardly think the "E.M." correspondence represents general opinion, and I am tolerably assured that introduction by makers is all that is needed to cause general adoption.

The minutiæ perhaps still need those developments that practice alone can lead to; but that, I think, is all.

Vulcan.

## DIAMOND TOOLS.

[24117.]—I use a diamond for trueing up emery wheels, or turning to definite forms for sharpening, milling and other cutting tools; but the diamond does not in this case act as a cutter, for it is in reality a blunt piece of stone without any sharp corners; its action is rather one of bruising up, and dislodging the particles of emery. As my own manipulation is now principally with small tools, for grinding these, instead of the dirty, sloppy, wet grindstone, I prefer a hard-grit dry stone always at hand, run in an old lathe. This soon gets smooth and clogged up with the abraded steel; to continue to use it in this state would cause the edges of the tools to get heated and softened, therefore the grindstone has to be frequently cleaned and trued up. I do not employ the diamond for this purpose, but set the T-rest of the old lathe rather high, and about an inch away from the stone revolving forwards. I then take up a piece of spring or busk steel, and hold it against the stone; this causes a horrible noise, but the steel chatters out a series of cross grooves in the edge of the stone, which cause it to grind the steel very rapidly without the risk of overheating, and I thus always have a grindstone running perfectly true.

The extraordinary durability of the diamond, or carbonado, is most apparent in the operation of facing, or, as it is termed, "cracking" a millstone—that is, covering its grinding face with fine furrows. The French burr stone is a most intractable substance, and is, in fact, equal to flint in hardness, and full of pores and cavities; when the surface had worn smooth and required to be redressed by the old means, a dozen or so of mill picks, ready sharpened and made of the hardest steel, were given to the workman, who armed his hand with a leather guard to prevent the flying particles from penetrating his skin, and who then dexterously chipped out the grooves, as if he were cutting a file, the fire from each blow appearing to sink into the stone. As soon as one pick got blunt, another was taken up, and the whole stock would be required to complete the job. Now one little piece of carbonado, set in an ingenious sliding or dividing frame, does all this work, without any deterioration or diminution in size, but in action is not that of a cutting tool: it furrows out the millstone by a percussive action.

"Z. Y. X." is no doubt familiar with all the uses of diamond for a cutting tool. He mentions 2s. 6d. or 3s. as having been the price of a piece of carbonado the size of a pea. That may have been the case at its first discovery, before its value was known; now such a piece would cost as many pounds as he has named in shillings. The material for making the slicer for a lapidary's mill is well-annealed charcoal iron, such as is used for the best tinplate before being tinned; but it is difficult to get this anywhere in London; and if the tinned iron is to be used, all the tin must be wiped off while hot, and the last trace of it removed with a piece of wet pumice or gritstone: otherwise the slicer will be spoiled by pieces of diamond sticking in the sides. As to an agate roller for charging the edge of the slicer, this is just the material most unsuited to the purpose, for the diamond would speedily pound and dig out a rut around the edge. The diamond powder imbedded in the edge of the slicer has very little action on hardened steel. It merely grazed the edge of my roller. I could have wedged this fast or used it sideways like the usual burnisher, but I did not, because it acted best as a roller. One of the worst applications of diamond powder is to use it for abrading malleable metal, wherein it fails to act. When I first began to use diamond turning tools, I lost some pieces from the imperfect mode in which they had been set. I therefore had to devise means of setting them securely, in order to stand rough usage. Several years ago I described my methods in the "E. M."; but as this subject is now again brought to the fore, I will do so again—in the next issue, if I can find leisure.

F. H. Wenham.

[24118.]—I propose in future to drop my title "Z. Y. X."

I wish all persons interested in diamond tools, and their use for stone or hardened steel, would send me all information they can, as I think (but do not promise) of writing a full description of the use and origin of the carbonado tool—not the use under continuing patent of the same material, but expired patent only.

Dr. Edmunds will perhaps exchange letters with me on the subject.

By the way, is it true that the Amateur Mechanical Society have decided against Dr. Edmunds in his Interchangeable Mandrel question? A question in which, 15 to 20 years ago, and since, and still at the present moment, I agree with him.

I agree with Mr. Wenham in his remarks, p. 126, under letter "Cutting Screw-Threads," where he says that when laps are used, &c., &c.; if he means (but, query, Does he not mean the contrary?) that there is a danger of the diamond (or emery) getting into the steel which is being turned. This is not chimerical, for I have, within the last week, heard of makers of arbors of watches coming to grief through using adamantine; the result being that the arbor became charged with the adamantine, and so the jewels were in a short time cut, and the watches returned as faulty.

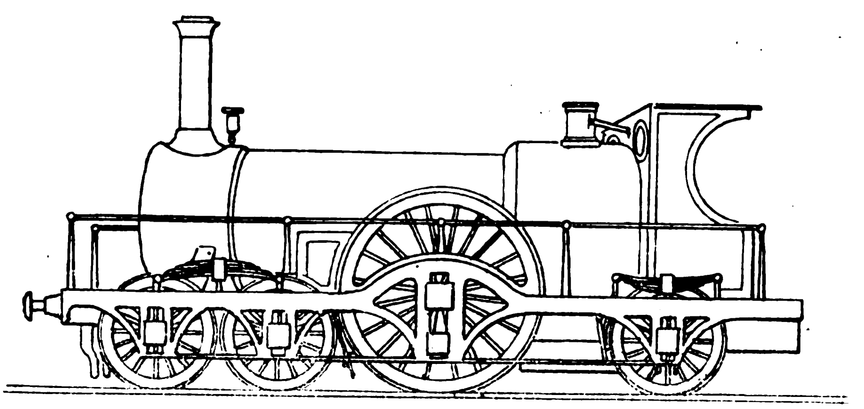
A. P. Bower.

35, Mecklenburgh-square, W.C.

## THE CASSEGRAIN—THE MUSICAL SCALE.

[24119.]—Writing in both cases very hurriedly, I seem to have made mistakes in both my letters. I should have referred to the Gregorian small mirror as receiving diverging instead of converging rays (though the principle to which my remark applied is the same in both cases); and, as pointed out by Mr. Hunt, I incorrectly described his table of ratios. As regards the latter subject, I trust to continue the correspondence next week; my time is too much occupied to do so at present.

A. S. L.



## ACCELERATION OF TRAINS, BRAKES, &c.

[24120.]—In answer to Mr. Lawrence (letter 24033), I send sketch of G.W.R. B. gauge 8ft. single, and will send sketch of G.W.R. B. gauge 6ft. 6in. coupled if desired. I will find out whether the N. gauge rails are laid from Bristol to Penzance.

Could Mr. Lawrence or some other correspondent kindly send sketch of M.S. and L.R. 7ft. 6in. single?

**G. A. T.**

## THE "ROCKET."

[24121.]—I should feel obliged if someone amongst your numerous railway readers should be able to reply to the following query. I think I may venture to assume that the question is of considerable historical interest to many.

What kind of valve-gear was fitted to the "Rocket" when she competed for the prize on the Manchester and Liverpool Railway in 1829?

Was it of the simple kind, with eccentrics independent of each other, but loose upon the axle, driven by "snugs," as was the case in many of the early locomotives, and which is still in use on the penny boats plying on the Thames; or, was it of the modified arrangement of gear which is illustrated and described by Pambour, in his work published in 1836, in which the two eccentrics, although loose on the axle, are permanently fixed together on discs, which are larger than the eccentric sheaves being fixed to the outer side of each, and concentric with the axle; each disc having an aperture near the circumference, the whole being movable transversely on the axle by a lever from the footplate, and can be thrown in or out of gear with either the right or left hand "driver" for forward or backward motion, these drivers being fixed permanently on the driving axle in the proper positions, and having projections which may enter either of the apertures in the discs above-mentioned.

Now, the first-mentioned simple gear does not admit of the motion being reversed until the engine is first stopped, and the valves shifted by hand previous to re-starting in the opposite direction. The second and modified arrangement does admit of the reversal of the slides without bringing the engine to rest.

A few words contained in an old book has suggested this query.

It should be observed that the gear now in the "Rocket," at South Kensington, is of the kind last described, but the transverse displacement of the eccentrics is effected by a pedal lever on the left of the foot-plate, which, by treading, would move the eccentrics into gear with the right-hand driver, but no means are apparent of moving them in the opposite direction.

It seems somewhat strange and unaccountable that so little is known, or has been published, respecting the interesting details of this most celebrated engine.

**Telegraphist.**

## OLD LOCOMOTIVES.

[24122.]—Your correspondent "Nun. Dor.," page 108, No. 55933, has referred to the fact that a locomotive was used on the Canterbury and Whitstable Railway. The engine in question was built by Messrs. Stephenson, in 1830, and ran at the opening of this early railway, 3rd May, 1830, being driven by Mr. E. Fletcher (afterwards of the North-Eastern Railway). It was named "Invicta," and was sent by the South-Eastern Company to the Stephenson Centenary, 9th June, 1881, upon which occasion I made a sketch of it. This old engine ran upon four wheels, of 4ft. diameter, coupled; the cylinders being placed diagonally outside the smoke-box.

As the "Invicta" was sent to Whitstable, and was at work for twenty-six days *before* the Act for making the Swannington line was passed, it is perfectly certain that the author of "The Midland Railway: its Rise and Progress," made a serious error in stating that the engine sent to Leicester in 1832 was the first locomotive that ever ran south of Manchester. As "Nun. Dor." remarks, historians too often record what they *believe* to be true, instead of being sure of their facts and dates; thus an error or incorrect statement is perpetuated, and handed down to future generations.

Leicester, 13th April. **Clement E. Stretton.**

[24123.]—In the English Mechanic of the 3rd inst., under the heading of "Old Locomotives," I see a correspondent refers to the Canterbury and Whitstable line. Allow me to inform you that this was opened for goods and passenger traffic on the 3rd May, 1830. It was worked by stationary engine from Canterbury through the tunnel to Tyler Hill, where the engine was fixed. There was another stationary engine farther on at Clowes Wood, from which the train ran down a declivity, drawing the rope out behind it to a level called Boyshole, the rope being left there ready for the engine to draw the train upon the return journey from Whitstable. On arriving at that place from Canterbury, the locomotive engine "Invicta," with the ramping horse on the side of it, took the train on to Whitstable, and brought the next train to this point, where the rope, as I have already stated, was previously left ready to take it on for Canterbury.

You can rely on the correctness of this statement, as I was at the opening, and have been in the office for the last 45 years.

Whitstable, April 7. **Edw. P. Read.**

## ENGINE AXLES.

[24124.]—I hope the great question of crank-axles breaking will not be passed over in silence by our railway readers.

Is iron or steel the best material for making such axles? What are the forces acting on these axles, and where is greater strength required?

**Inquirer.**

## BRAKE FAILURE.

[24125.]—I see on page 128 that a serious failure of the vacuum brake has happened at Kentish Town; but there has since been another, for on Good Friday morning the midnight express, with two engines and some 22 passengers, ran all the front part past Bedford and had to be pushed back. Could "Meteor" also give the cause of this?

**A Passenger.**

## NEW MIDLAND ENGINES.

[24126.]—It seems that since "Locomotive" wrote his letter, some alterations have been made in No. 1675, and on Thursday, 9th inst., she had yet another try to run the 10.35 from London. However, she made a poor show, losing 5½ minutes with this important Scotch express, on a nice day, with a moderate train of only 12 vehicles.

Is it true that these big engines have 100ft. less heating surface than the 800 class? If so, it accounts for all lost time. **One of the Passengers.**

## MINERAL-OIL LAMPS.

[24127.]—I have read with some surprise Mr. Hughes's remarks on the above question. He evidently advocates the use of non-conducting glass or earthenware (and consequently breakable) containers: my experience in these matters is the reverse. That there *are* metal containers, which cause an inflammable gas to be generated, I do not dispute; but I have found that glass containers possess the same defect to a great degree. I have a "Silber" which has "blown up" several times, and has continued to burn in the container until the air supply it contained was exhausted. This has an opal glass container, and the burner and adjacent glass gets so hot in a quarter of an hour that it is next to impossible to handle it or carry it about, and on taking it from one floor to another, one has to set it down on the stairs to rest one's fingers from the intense heat, for a second stage of transport. I have also found other glass container lamps to possess the same defect.

There is a lamp in the market at the present time called "Martin's Patent Duplex." It has a circular burner and a metal container. This lamp, from its ingenious and peculiar construction, obviates the defects of both bad metal and glass lamps. First of all, there is no space communication with the reservoir, neither through the wick-channel nor through the base of the burner, which unfortunately exists in too many, in the shape of a small round hole about $\frac{3}{16}$in. diameter (quite sufficient to allow of an explosive gas being ignited). The wick is in two halves, and is fed up the burner by two pinions instead of one, and these being independent of each other, the flame can be adjusted to the greatest nicety, that abominable defect called "steepling" being thereby reduced to a minimum; but the most beautifully useful and ingenious part, perhaps, in the whole lamp, is the "radiator," or heat dissipator, which consists of a flat perforated metal disc about 4in. diameter, which is slipped on to the burner just below the flame. The office of this radiator is to get rid of the heat generated in the burner, which it most effectually does, both by convection and radiation, and it performs this office so completely that on placing one's hand on the burner itself, one can only just distinguish a slight pleasant warmth, whilst the reservoir is at the same temperature as that of the room, and this after burning 15 hours. My lamp before me now, by which I am writing this, has its reservoir as cool as if the lamp were not alight. Therefore, I think Mr. Hughes must admit that metal containers are not only good, but can be immeasurably superior to the glass or earthenware ones now in use, even if Martin's burners were applied to them; for, in the case of the metal container, no accident *can* happen from fracture or the generation of inflammable gas. I may mention that, light for light, I have found the Martin's lamp more economical than any other I have used. It further has a very ingenious and cleanly appliance for trimming the wick, whereby the use of scissors is done away with.

**P. Ward.**

[24128.]—J. Hughes is informed that some time ago I had the temperature of mineral oil in copper reservoirs tested every hour during ten hours' burning at full combustion. After the first hour the temperature was 68° Fahr.; the highest reached was 69·2° Fahr.

As he claims for himself great practical experience, he ought to know that overheating is caused by the metal wick-tube being in the oil, but that the slight warmth conveyed by the wick alone is not a cause of mischief.

The wick-tube at the flame end is at great heat, and only less hot at the other end, which, therefore, should be as short as possible, and not touching the oil. **J. D. Shakespear.**

## CURIOUS OPTICAL EFFECT.

[24129.]—The appearance observed by Mr. Culley (letter 24087) formed the subject of a question in the papers for the Mathematical Tripos at Cambridge last May. The several rings are due, not to interference, but to the number of internal reflections necessary for the rays to meet the eye. The distances from the eye, placed close to the end of the barrel, are $\frac{1}{3}$, $\frac{1}{5}$, $\frac{1}{7}$, $\frac{1}{9}$, &c., of the length of the barrel.

**Pi.**

## CHOLERA BACILLUS.

[24130.]—My attention has been drawn to the remarks of Mr. Nelson, in your issue of the 20th ult., upon my claim for the discovery of the cholera bacillus 35 years ago by two Englishmen. I was prepared to find that my views would be questioned; but certainly not upon the grounds of the two objections laid down by Mr. Nelson. Staining with aniline dyes most likely was not in use at that date; but there were other ways of preparing objects than by staining, and as this has supplanted other methods, so it will, in all probability, itself in time be superseded.

With regard to Mr. Nelson's second proposition, is Mr. Nelson prepared to argue that because Malpighi was not in possession of the improved instruments of the present day, and staining reagents were not in use, it is, therefore, doubtful if he discovered the Malpighian Corpuscles in the kidney, or that the discoveries of Leeuwenhoek, Swammerdam, and others, can be impeached because their instruments were comparatively defective? It is well known that many of the most important discoveries have been made with inferior instruments. Mr. Nelson is fortunate in living in an age when the microscope and objectives have each been brought to their present perfection, and when objects can be demonstrated more clearly by the method of staining; but surely he does not therefore conclude that nothing so minute as the "Comma Bacillus" cannot have been previously seen and described as far back as 1849. I would beg to refer him to the literature of that period to dispel his illusion, should he still remain in doubt.

A friend who has seen Mr. Nelson's remarks in your journal has written to me to say that "with a Nachet's" No. 5 objective of about that date, he has seen and shown to another party the acknowledged "comma bacillus" both in the dry and wet state, *unstained*, the magnification about 450″. As a matter of fact the lens used by Dr. Brittan was a 1-12th Andrew Ross; that used by Dr. Swayne was a 1-8th Powell and Lealand, both of sufficient power to well show the curved bacillus, for I possess a 1-6th objective by Andrew Ross, and can with it, and without the aid of an achromatic condenser, distinguish the "comma bacilli" in an impure gelatine cultivation, *unstained and mounted wet*. The descriptions furnished in the recent original and valuable investigations by Dr. Koch, so closely correspond with the statements by Drs. Brittan and Swayne, and the general evidence is so strong, that it will require far more valid arguments than Mr. Nelson offers, to disprove the claim that these gentlemen were the original discoverers of the curved bacillus, which by its supposed relation to cholera, so seriously engages attention at the present time.

**Francis Fowke.**

## MICROSCOPE CONSTRUCTION.

[24131.]—I may, perhaps, be permitted to inform "Nemo" (24084) that many letters and papers have appeared in the English Mechanic on microscope construction. The plan which I should advocate for those who wish to construct anything of the kind, is to look over the back volumes, and decide upon the kind and class of article they wish to make, and should a difficulty arise, to put a definite question. I can say, without fear of contradiction, that anyone who is a decent mechanic, and who has access to the back volumes of the "E.M.," can make a microscope without further instructions. There are plenty of back volumes to be purchased cheaply, and there are figures, without end, of microscopes, also pattern making, lacquering, &c. With a little ingenuity it is perfectly possible to make one almost entirely in the lathe, so that vice work should be reduced to a minimum.

I am quite sure there are very many readers of the "E. M." (amateur mechanics) who can execute the brasswork of a microscope which will give results equal to one of the most expensive kind which can be purchased from an optician; glass grinding is, of course, out of the question. No sane amateur would think of doing this. No one should attempt such work unless he has seen and examined at least one instrument. A mere copyist will experience more difficulty than a workman who can modify the design to suit his own capacity, and the tools which he happens to possess. The glasswork must be purchased; but a really intelligent man who can use his lathe ought to be able to make for 20s. that for which he would pay an optician £10.

**Os.**

## MICROSCOPICAL.

[24132 ]—With regard to "R. D. R.'s" letter (p. 110), I should like to say that many professional readers would be delighted to hear of a cheap Stephenson's erecting binocular with *very short* tubes (not having too great a slant), and fitted with two powers, one like Zeiss's *variable* low objective, and the other, say, about ⅔in., so as to give a range of powers from 20 to 60. If this *ideal* microscope could further have wood support applied to stage (for hand rests), and be supplied at £5 to £6, I may safely predict it would have an enormous sale, and would *do all* that any binocular can for natural history, dissection, &c. With such an instrument, and *one other* for high powers, the scientific worker would be completely armed. With regard to the high power instrument, a very short monocular one is best. The fine adjustment must be *perfection*, must be supplied with a good achromatic condenser of low angle (say 100°—80°); draw tube (so as to suit all makes of o.g.), and three powers one-third of 60°, one-sixth of 90°—100°, and 1-16th of N.A. 1·33 (oil or what not); two or three eyepieces, powers from 100 up to 1,000 or so. Such an instrument can be had for about £20. I think it is as gross a mistake to expect the one stand to do all manner of work, as to exact every, no matter how different, requirement from the one object-glass. (The binocular is not of the slightest advantage for high powers. The rest it affords the eye can as suitably be obtained by other plans without its expense and cumbrousness.)

For goniometric, polarisation, and spectroscopic observations a totally distinct instrument, or rather set of instruments, should be used.

I am sure my remarks will be borne out by the experience of practical men. If makers would give more of their attention to perfecting a *set* of instruments to suit the varying requirements of different workers at as low prices as possible, I think a decided improvement would set in. By all means, let us have object-glasses *perfect*, and, as a necessary corollary, *perfect* fine adjustment, and *perfect* illumination devices; but why hamper us, in our seach after these, with the fruitless attempt to make one instrument suit all needs? Producing huge monstrosities—monstrous for price as well. Because we require magnifications, must every magnification tool attempt the function of every other magnification tool whatsoever? I do not mean to contend that *all* attempts at combination are impossible, but only that such combination *in the main* limit, and do not extend, the advantages of the instruments so combined. A statement I think most will agree to be not only true, but trite.

Let the motto of the artist be that of our artist mother Nature, "Specialisation of function, with (where possible) simplification of organ—simplification with specialisation."

I should be very glad if anyone having had experience of them, can give me an opinion as to Seibert's water immersions: they are very cheap. A $\frac{1}{16}$ I have resolves Amphipleura pellucida, with mirror alone at small inclination only, and with central light from condenser. Are the higher powers good?

Dublin, April 5th. **Francis D'Agen.**

## LAMINATED ARMATURES.

[24133 ]—I was rather surprised to see Mr. Chaster's letter, 24041, after Mr. Bottone's paper, where he described his experiments with both the solid and laminated armature, which clearly shows the laminated armature to be far superior in every way to the solid, both in dynamos and motors.

That Mr. Chaster should recommend to amateur electricians the old solid form, in preference to the new laminated or discs, which I consider simpler to construct, it requiring but little turning.

Respecting the insulation of the wire being cut through by the discs setting up a small counter rotary motion, and exposing sharp edges to the wire, I suggest that the discs be mounted on a square spindle turned up at the ends for the bearings and tightening screw.

West Dulwich. **W. Habgood.**

## A FEW MORE WORDS ON THE NEW TIME.

[24134.]—Various circumstances have prevented me from replying to "Nun. Dor.'s" letter (23961, p. 57) criticising my remarks on the "New Time" (letter 23949, p. 36); but now that an opportunity occurs, I may say that though your correspondent states that he "cannot agree" with me, his letter really confirms the opinion I expressed respecting the general adoption of the new-time nomenclature.

It may interest "Nun. Dor." to know that I had Sir E. Beckett's objections in my mind at the time I penned the words, "it is a matter of considerable uncertainty *at present* (I italicise these words as they appear to have escaped "Nun. Dor.'s" notice) whether the 'new time' will ever become part and parcel of our everyday life." It may or may not be as "Nun. Dor." affirms "a long fly from here to 'ever'"; he must remember that I did not use the word *never*; and when we take into consideration the divided state of opinion respecting the advantages of the "new time," and that Sir E. Beckett, as president of the Horological Institute, may be considered to have some influence amongst those most affected by the proposed change, I am inclined to think that your readers will agree with me that "at present" at least it *is* uncertain whether it will ultimately become the civil mode of dividing the day.

"Who are the people," asks "Nun. Dor.," that are "confused" by railway time-tables as now arranged? To this query I can only reply by saying that several persons who are generally included in the phrase "the masses," have told me that when they have had occasion to refer to the time-tables to see when they would arrive in London from Scotland or Ireland, as the case might have been, the frequent "a.m.'s" and "p.m.'s" have not a little bewildered them; and, moreover, one of the British delegates at the Washington Conference, who is a distinguished mathematician and astronomer, admitted before a meeting of one of the leading London scientific societies, that on one occasion he was misled through mistaking "a.m." for "p.m." in a railway time-table; a mistake into which it is needless for me to say he could not have fallen had the "new-time" nomenclature been used.

However "priggish" it may seem to Sir E. Beckett—with whose opinions on many subjects but this I agree—and however "vague" it may appear to "Nun. Dor.," I must still adhere to the "notion" that the "new time" nomenclature is of a much more sensible and scientific character than the present; and I shall be obliged if he will show me in what way it is not, apart from such mechanical considerations as the striking of the hours and division of the dial, which are difficulties (?) we may leave to practical horologists to surmount.

The division of the day into two parts, "ante meridian" and "post meridian," was a quite natural and reasonable division when the flight of time was marked by the shadow of the gnomon of the sun-dial; but now that species of time-measurer is no longer employed excepting for ornamental purposes, I contend that such a division of the day and the retention of what, for want of a better phrase, I may call the sundial nomenclature upon the dials of modern timepieces, is one of those things that might be altered with advantage.

Forest-gate, E., April 6. **B. J. Hopkins.**

## MUSICAL SCALE.

[24135.]—Mr. Hardie (letter 24020) will have great difficulty in proving that the musical scale in melody is different from that used in harmony, although he states this as a fact on page 522, No. 1038. Melodies are almost invariably harmonised, either in full or by accompaniment, and such a difference would lead to confusion worse confounded. "A. S. L," on page 499, No. 1037, says that "W. H.'s" letter, page 477, will be a great help to him in the matter he has in hand, evidently considering the monochord proportions there given to be the correct ones, because they appear in the English Mechanic; but under the heading "Letters to the Editor," we are told that the Editor does not hold himself responsible for the opinions of his correspondents, so we must weigh before accepting, and let the present letter be no exception. For this reason I think no doubtful matter should be allowed to pass without challenge, as some readers may get incorrect ideas if both sides of the argument are not presented for their consideration.

On page 81 of No. 1044, Mr. Hardie takes exception to the statement that musical ears demand simplicity of ratio between the notes of the scale, and says, "All that musical ears demand is only that the notes of the scale shall sound *in tune*." Will Mr. Hardie kindly say what property the notes are to possess that they may sound in tune, as he leaves us in the dark on that head, only saying that this property is not necessarily simplicity of ratio? What is the difference between the notes of a violin when stopped by a good performer, and consequently in tune, and when stopped out of tune by a beginner? One of simplicity of ratio unquestionably, for it can be clearly demonstrated that the ratios in the first case are far simpler than in the second. Those given in my letter on page 10, No. 1041, may certainly be called simple—although denied by Mr. Hardie—as the products of the numerators and denominators of the various fractions are the smallest compatible with the positions of the various notes in the scale—viz., between 1 and ½, and the most complex there is simplicity itself compared with some in Mr. Hardie's scale, especially after a little modulation. For instance, his A sharp would be 32768/59049, while mine would be 72/125, and his F double sharp 1048576/1594323.

We shall be safe in assuming that Mr. Hardie's ear will acknowledge the scale as in tune if given the proportions named by him on page 37, No. 1042, and also in his division of the monochord, page 477, No. 1036. Now, I will not pit my ear against his by saying that these proportions do not satisfy my requirements of being in tune, as it may be said my personal equation is unknown; but I will ask, is it not a fact established by the consensus of all the musical ears of pianoforte-tuners and others, that the major-third of the equal temperament tuning is considerably too sharp, and that if the fifths are tuned too perfect these major-thirds will be unbearably sharp? Now his measure for E in the key of C is 64/81, and as the comparative values of decimal fractions is more easily seen, we will convert it into $\cdot\overline{790123456}$. The correct measure is 4/5 or ·8, and the equal temperament measure is $\sqrt[3]{\frac{1}{2}}$, or ·7937005, because three major-thirds are made to equal an octave. Compare these figures, and it will be seen that although the equal temperament major third is as sharp as the ear will allow (and sharper than some can stand), yet Mr. Hardie makes his considerably sharper, and wishes us to accept it as a note in the natural scale. The ear clearly says it is not so, and what else shall we set up as judge? All his major thirds have the same error, and as the minor sixth is an inversion of the major third, all these have the same error inverted —viz., they are too flat by a like amount, his measure being ·6328125, the correct ·625, and the equal temperament ·6299605. His major sixths are too large and minor thirds too small by a greater amount; also his major seventh is too large and his minor second too small; my proof of all which would be the same as above, but omitted here for brevity. As we are arguing simply for the purpose of arriving at truth, I ask Mr. Hardie to examine this, and if he cannot advance a reasonable objection, to admit the point in the interest of readers who are not in a position to test the matter, and yet might wish to make use of the measures.

The only correct intervals in his scale, with the exception of the acute major second, are the fourth and fifth; but why he should say an ear that accepts any other proportions than ¾ and ⅔ for these must be defective, I am at a loss to understand, as no one has set any other values on them.

True, you cannot modulate indefinitely by perfect fourths or fifths; but this is what Mr. Hardie seeks to do, with the result of getting A flat below G sharp, and like errors. It is not necessarily fatal to a musical scale that it needs more than one note changed to fit it for modulation into the next remove—indeed, the ear asks for a change of three notes in the composite scale, which includes the major and all the minor scales in a key, and which I give on page 10, No. 1041. This cannot be considered as built on the harmonic theory; but on the principle of simplicity of ratio, for the harmonic theory fails on arriving at the seventh partial, the ear objecting to any division by seven or any higher prime; beside the dissonances are evolved by modulation.

It may not be possible fully to explain why the ear accepts as in tune notes that bear a simple proportion to each other; but it is clear that the presence or absence of this quality determines the matter. The investigations of scientists have left no doubt that the effect which we recognise as difference of colour is due to differences in the vibrations of the luminiferous ether, and simplicity of ratio here also has been found to produce harmonious results.

I believe these differences of opinion as to the measures of the notes are hindering practical men from attempting to solve the problem of practical application, or putting them on the wrong track.

**S. E. Hunt.**

## REPLIES TO QUERIES.

◆

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[54825.]—**Salt, &c.**—Perhaps "Marienberg" will tell us by what "agencies" cereals do reproduce themselves and multiply, if not by natural ones? By whom was man taught the unnatural cultivation of cereals? Is the cultivation of, say, rose trees, fruit trees, vine, &c., also non-natural, &c., &c.? In fact, is there anything which man has had a hand in natural? How do the savages in all parts of the world, who live entirely on "natural products" of their countries, exist if nature is not enough for them? If the primitive ancestors of our race were civilised, where are the records of their civilisation? Do the geological strata contain the slightest traces of them? Surely if primitive man cultivated "cereals," we should find a "fossilised ploughshare" somewhere.—F. W. H.

[56015.]—**Steam-Hammer Valve.**—Replying to "Essar" (56015), allow me to say that twelve months ago I asked, through your valuable paper, for information upon the best valves, and their action for working steam hammers. From indifference, or want of knowledge, I did not get any reply from your correspondents. If "Essar" can, in a concise manner, give this information with illustration, I would thank him to do so. It would be appreciated by a greater number of users of hammers than by makers. The best valve and its motion that I know of wastes a great amount of steam. If "Essar's" knowledge of valves is practical, and especially if he can suggest improvement, I hope he or any of your correspondents will favour us with it through the Mechanic. But do not waste the paper by giving borrowed knowledge from exploded ideas.—E. Turner

[56025.] — **Trueing Grindstone. — Patent Law.**—"Nun. Dor." is very hard on me. I see that I transposed the words of the patent, and said, "Make, use, vend, and exercise." The words of the patent are, "Make, use, exercise, and vend," and occur in the granting part, which also in its language is also a prohibition. The words are:—"Victoria," &c., &c. "We, of our special grace," &c., &c., "do, by these presents, for us, our heirs and successors, *give* and *grant* unto the said patentee our especial license, full power, *sole privilege*, and authority that the said patentee, by himself, his agents, or licensees, *and no others*, may at all times *make, use, exercise, and vend* the said invention within," &c., &c., "and that the said patentee shall have and enjoy the whole profit and advantage from time to time accruing by reason of his said invention during," &c., &c. "And to the end," &c. Then follows the further prohibition, as quoted by "Nun. Dor." Now, one of two things must have happened—1st, Either "Nun. Dor." must have been splitting one of his hairs rubbed off by the cap he found to fit so well; 2nd, or "Nun. Dor." must have carelessly read the patent, and omitted to see the words I have given, or at least have failed to see their true import. Moral.—When correcting another, always be as sure as possible that you are yourself right. This I try, when writing, to do; but I am conscious that I often fail.—Z. Y. X.

[56032.]—**Enamelling Steam-Gauge Dials.**—There is nothing special in this work, except that the dials must be enamelled, not painted. The dials are covered with frit, made of, say, red lead 8, calcined borax 1, powdered flint glass 6, powdered flints 4, which are fused together for about 12 hours and poured into water. They are then reduced to powder, mixed to a paste with water or other suitable liquid, spread on the dials, and fired. The figures are usually put in with oil of lavender and vegetable black. If you really intend to do such work yourself, look up back numbers. There is a good article on enamelling in colours in No. 952.—Essar.

[56034.]—**Boiler for Engine.**—This querist should look up back volumes. I think he will find what he wants in the last volume; but I hope, if he intends to use 50lb. pressure for his 1in. by 2in. cylinder, he will make the boiler very much more than strong enough.—Essar.

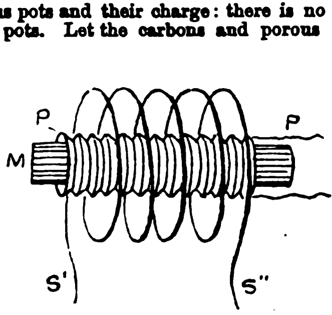
[56036.]—**Steam Boiler.**—It should evaporate 9lb. of water for each pound of coal consumed.—Essar.

[56041.]—**Gun-Metal** is a bronze usually composed of copper, tin, and zinc. Cast gun-metal (copper 8 parts, tin 1 part): specific gravity, 8·153; weight of a cubic foot, 509½lb.; weight of a bar 1ft. long and 1in. square, 3·54lb. (Tredgold); expands in length 1° of heat $\frac{1}{99090}$ (Smeaton) will bear on a square inch, with permanent alteration, 10,000lb.; and an extension in length $\frac{1}{980}$ weight of a modulus of elasticity for a base 1in. square, 9·873·000lb.; height of modulus of elasticity, 2·790·000ft.; modulus of resilience, and specific resilience not determined (Tredgold). Compared with cast iron as unity, its strength is 0·65; its extensibility, 1·25; and stiffness, 0·535.—J. C.

[56041.]—**Gun-Metal.**—I observe (p. 130) that "Z. Y. X." still doubts whether iron forms any part of "true gun-metal," and as the question thus turns on what is "true gun-metal," I confess I cannot help him, for I know of no authoritative decision as to what is and what is not "gun-metal." I remember the Uchatius steel bronze and the Aich metal, which, as they were used for making cannon, were, I suppose, "true gun-metal"; but I am contented to leave that point for "Z. Y. X." to settle: probably he knows what is a "true gun-metal"—I do not. I imagined, from his questions on p. 66, that he was asking for information when he requested to know whether "Nun. Dor." was poking fun by suggesting that gun-metal is sometimes made of a mixture of copper, tin, zinc, and iron, and I replied by giving a few facts to show that the statement was not a "slip." I have something better to do than to dispute with "Z. Y. X." or anyone else, whether an alloy containing iron is or is not a gun-metal: all I know is that some alloys called gun-metal do contain iron, and I must leave it to "Z. Y. X." to determine whether they are properly so-called or not. I leave it to your readers to discover who is "poking fun" and who has made a "slip." It is not much of a "puzzle," but as we are all anxious to learn, perhaps "Z. Y. X." will now tell us what is a "true gun-metal," and explain what he meant by asking on p. 66, "Is it really the fact that these four metals can be melted together?"—Nun. Dor.

[56054.]—**Hardening Lock Springs.**—Make them a cherry red, and drop into water the same as any other steel goods. But is that what you want to know? Is it not that you want to get the spring temper? If so, you will find the process described over and over again.—Essar.

[56064.]—**Troublesome Battery.**—I am glad that Mr. Parsons finds the advice given some use, and I am sure the result will not be only temporary. Now I understand Mr. Parsons better as to the porous pots and their charge: there is no need of fresh pots. Let the carbons and porous cells be cleaned from the old charge: replace the carbon in the porous cell, and fill up with a mixture of four parts of black oxide of manganese, and one part of powdered gas carbon, to which has been added a little strong ammonia. It was the charge, and not the pots, which was at fault in my opinion, unless the junction of the binding screws with the carbon was so dirty that no current could pass. Try to remedy this first, and if no better result is obtained proceed as above. 2nd. As to where to attach the handles in a shocking coil, in the annexed diagram P being the primary coil and S'S" the terminals of the secondary coil, these terminals must be brought to binding screws on the coil base, and the handles from which the shock is obtained connected to them. Yes, the core does come out; the secondary current being then weakest, and I would therefore advise Mr. Parsons to actuate his contact breaker by a small electro-magnet separate from the core M. There is no objection to your using iron pipe for the case to the core, only you are then making the magnet larger, for the iron pipe will become magnetised; but it will act all right. A battery of the size quoted should work the coil. Two layers of primary wire are sufficient, because the secondary wire must not be removed too far from the core on account of the influence it exerts on the secondary current while a magnet. About ten or twelve layers of secondary will be sufficient.—J. Kean, Northampton.



[56067.]—**Embossing on Brass.**—A mixture of pitch and resin is used for the pitch-block. Thickness of brass about 1-30th of an inch, or more if you like.—Nun. Dor.

[56072.]—**Road Locomotive.**—This query is answered by saying: Yes; it is quite practicable, and will, no doubt, be done when required.—T. M.

[56082.]—**Telephone Transmitter.**—"T." should look up the last few volumes of this journal, where he will find valuable information from Mr. Strangways, Mr. F. Dowling, and others, who describe various forms of transmitters wherein the carbon is adjusted as in the Blake transmitter. This form is the most difficult to make, so I should suggest the Johnson or Crossley form, in which pointed pencils of carbon are loosely fixed into blocks of carbon, in which blocks are small cavities for the ends of these carbon pencils. The blocks are fixed to the diaphragm. The carbon in these requires no adjusting. If, however, the distance be not more than one mile, I would advise the use of the Hunning's form of transmitter, which is the simplest to construct, and requires no induction coil. All these forms can be easily got into the space you mention. If you require more information I shall be pleased to assist. The patents of the above are all held by the United Telephone Company, so it behoves you to look out for legal squalls.—John E. Chaster.

[56096.]—**Amalgamating Zincs.**—The falling off of the current from Daniell cell is owing to either complete saturation of the liquid surrounding the zinc, or insufficient supply of sulphate of copper. The Daniell cell can be set up in different ways. If the zinc be in a dilute solution of sulphuric acid, it is necessary to amalgamate the zinc; but if, as is generally the case when constancy is required, the zinc is surrounded by some such half-saturated solution of a neutral salt as, for instance, salt or sulphate of zinc, amalgamation is not only unnecessary, but harmful, in that it assists the local action caused by the endosmose of the solution of sulphate of copper through the porous partition, which deposits metallic copper on the zinc. In this case, if the zinc be amalgamated, the metallic copper also combines with the mercury and the zinc, forming an alloy, whereas, if unamalgamated, the copper does not combine with the zinc. Presuming, however, that the zinc is in an acid solution, the best method to amalgamate is to steep the zincs in a solution of caustic soda, which is better used warm. This removes the grease, which always adheres more or less to new zinc; then thoroughly wash in water to remove any caustic soda. They may then be rubbed over with a diluted solution of sulphuric acid contained in a shallow vessel, in which is also a little mercury, taking care to flood the mercury over the zinc. A better plan, I find, when dealing with a quantity, is to plunge them in a solution of sulphate of mercury, and, lastly, mercury alone, then allowing to drain. The mercury you have would appear to be all right, seeing that it leaves no "tail."—John E. Chaster.

[56103.]—**Electric Accumulator.**—If "C. S. B." wishes to court trouble, expense, and disaster, he can do so with certainty by using the combination he proposes. The Daniell cell requires daily attention, and the Leclanché is of no value for working on a closed circuit for any length of time. There is no battery known that would work continuously for 29 days without attention. Moreover the accumulator would give out an exceedingly small percentage of the energy put in, owing to leakage and other causes. As it is a matter of dissolving zinc in any event to obtain your power, you would do far better by having some form of bichromate battery that will give you the power whenever you require it, by simply depressing a lever. Such a battery has been patented by Mr. R. A. Lee, of 76, High Holborn, which is automatic in its action, the elements rising out of the liquid by the gravitation of the cells. For the solution to use, see my reply to 55986, which, by a printer's error in "E. M." for 27th ult., is numbered 55916.—John E. Chaster.

[56110.]—**Mill Bills.**—As "P. M." has received nothing better, I have a recipe for hardening and tempering mill bills, formerly used and given in this paper many years ago by one of the best millers in the kingdom. If "P. M." likes I will look it up, and he can have it for 2d. postage from—HINCKLEY MAN.

[56112.]—**Chemical.**—Arsenic occurs in wall-papers, &c., in the green pigment, as either Scheele's green (cupric arsenite) or Schweinfurth green (cupric arsenite and acetate). 1st method. Finely divide the article to be examined and place in a small porcelain vessel. Add strong HCl and $KClO_3$. Place on water bath and add occasionally a crystal of $KClO_3$. Lastly, evaporate to dryness to remove any free Cl. The residue is dissolved with $H_2O$, adding a little $H_2SO_4$ and examined in a Marsh's apparatus as described by Mr. Keen in his reply to you. 2nd. Finely divided substance to be allowed to stand in cold strong HCl for one hour, then gently heated. A small portion of this liquid placed in test tube with strong solution of stannous chloride or piece of pure tin foil. If As be present, a brown colouration or brownish-black ppt. will be the result. 3rd method. The simplest and most ready test is to place the substance in a test-tube and add ammonia. After a time a blue colouration will result if As be present, owing to the copper contained in the arsenical greens, and to which attention is called. Verify by methods 1 and 2.—JOHN E. CHASTER.

[56112.]—**Arsenical Testing.**—The test given by "Stud.Inst.C.E." will only succeed with certain compounds of arsenic, notably with Scheele's green, but it would fail with the sulphide of arsenic. In this form the presence of arsenic is best ascertained by scraping off some of the pigment from the paper, carefully avoiding the presence of organic matter, *thoroughly drying* by gentle heat, and heating in a test-tube with *perfectly dry* carbonate of sodium and cyanide of potassium in equal parts, when arsenic will produce a bright metallic ring in the tube. Absolute dryness is essential to the success of the process.—PI.

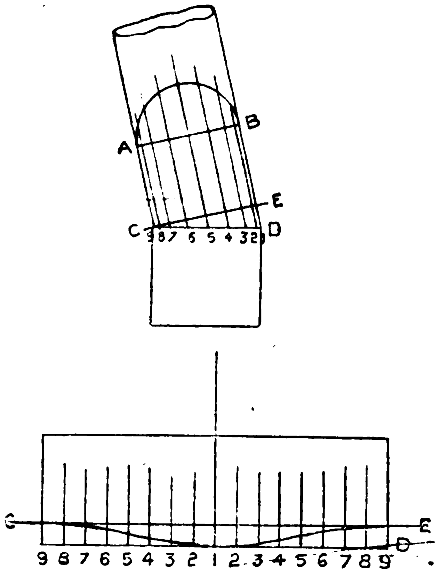
[56115.]—**Gilding Watch Movements.**—To prepare watch-plates for gilding: Take a smooth flat piece of bluestone, place a cork in vice, and a pan of clean, cold water beneath. Place your work on cork, and hold lightly with left fore-finger and thumb; with right, rub stone across, keeping as wet as possible and shifting work gradually round, to keep it flat; this to get all scratches and file-marks out. The "nice matted surface" is a trouble to the amateur. I have tried to get it in vain, the plates being invariably smooth and the stone marks showing. The gilders, I believe, heat the plates to a dull red, and plunge momentarily in dilute nitrous acid. As this softens the brass, it is objectionable. Mr. Watt, in his "Electro-Metallurgy," gives the following:—"First, place the work in a weak solution of caustic potash for a few minutes, then rinse in cold water; dip in nitrous acid for an instant, then place immediately in cold water, rinse in hot, and place in bath for a few seconds. When gilt sufficiently rinse in hot water, scratch-brush, rinse, and return to bath for an instant to give good colour; rinse in hot water and place in boxwood sawdust to dry." From the above you will see the necessity of being clean with work. The pivot holes are untouched, and if your fingers, ale, and brush are clean (with copious stream of ale) you will have no scratches.—YOUNKER.

[56117.]—**Pacinotti Ring.**—The method of winding a Gramme ring, as sketched by Mr. Bottone, is rather of the Brush arrangement, and surely Mr. B. is in error in describing the collecting slips as a "commutator." Such an arrangement is a collector, according to the idea of—ELECTRA.

[56142.]—**Wheatstone's Bridge.**—I desire to thank "A.S.T.E." for his kind reply and offer of further assistance, which I hasten to avail myself of. Will he say lengths, diameter, and approximate resistance of the carbon-rod most easily obtainable. I have about 3lb. various sizes uninsulated German-silver wire, which I purpose making up into coils as described on page 307, Vol. XXXV. The bridge described in my query has four openings, $\frac{A\ \ B}{C\ \ D}$. Suppose I require to make up a copy of a resistance coil: I have bought, say, 5 ohms. I put this in A; into C I insert the length of wire, increasing or decreasing till I balance. How do I fill up B and D again? I have an ohm from which I wish to produce 10 ohms. I insert the ohm in A, the wire to be balanced as 10 ohms in C. Should I be doing right by inserting 1 decimètre of No. 18 German silver wire in B and 1 mètre in D, and then shifting C till I balance? This, seems to me, ought to be 10 ohms. Will "A.S.T.E." kindly say if I am on right tack? If so, I will start making the apparatus accordingly.—J. O. M.

[56183.]—**Force in Motion.**—"Acier," in answer to the above query last week, says the man will drag the boy by exerting a fraction more effort than the boy is capable of doing, and the strain on the rope is equal to that of the boy only. Will "Acier" kindly tell us what becomes of the fraction?—say about one pound—as I cannot help fancying that it has just a little to do with the strain on the rope, and oblige—A COUNTRY CHIP?

[56132.]—**Cutting Pipes.**—I suppose it is for a chimney for marine boiler. Mark your chimney down full size, or to scale A B C D; draw a circle



as shown in sketch A B, divide this into as many parts as you like round the circle, then make a line, down the centre, and carry the other lines down parallel. Number these as shown, 1 2 3 4 5 6 7 8 9, lay your plates down, then divide them into as many lines as you have in A B. Beginning from the centre each way, strike line C E, then measure the distance on each line from E D; make the lines on plates C D the same. You will have to make the bottom part equal in circumference to C D when the development is cut.—BOILER MAKER, Sunderland.

[56156.]—**Chemical Action in the Bichromate Battery.**—To "J. T. S."—The complete reaction of the bichromate battery is as follows:

$$\underset{295}{K_2Cr_2O_7} + \underset{195}{3Zn} + \underset{686}{7H_2SO_4} = \underset{567}{K_2SO_4Cr_2 3SO_4} + \underset{483}{3ZnSO_4} + \underset{126}{7H_2O}$$

or for every pound of zinc dissolved there is required 1·5lb. of bichromate of potash, and 3·56lb. of sulphuric acid. There will be yielded by the battery, as by-products, 5·1lb. of chrome alum, containing 43 per cent. of $H_2O$, and 4·4lb. of sulphate of zinc, containing 43 per cent. of $H_2O$. The difficulty would be to crystallise out the chrome alum from the sulphate of zinc. The solution becomes a dark green, owing to the formation of chrome alum. When the chrome alum is crystallised out the salt is a dark purple. Chrome alum has a market value in Lancashire, and is an article manufactured. The market is very limited, however, and this also applies to sulphate of zinc; so that if these two substances be ever collected on anything like a large scale, they would immediately glut the market.—JOHN E. CHASTER.

[56207.]—**Clock Repairing.**—I imagine that we have in our house a clock very similar to that of "Many Years' Subscriber's"; and, although it is now about 42 years old, keeps excellent time, and all that has been done to it during this time is that a couple of the holes, through wear, have been closed with simply a few blows of a light hammer; but chiefly (and this is why I write) the escapement wheel has been moved on its axle, or arbor, three times to bring the teeth to bear upon a new part of the escapement pallets; for although only a soft brass wheel, it has cut a deep channel, first in the centre of the hard steel pallets, then to one side, and now upon the second side. Let "M. W. S." try this simple plan before resorting to more drastic measures, such as refacing with watch-spring the pallets; also examine more carefully the pivots and holes of the escapement-wheel that they have no play, but fit true in the plates.—CÆSAR.

[56207.]—**Clock Repairing.**—You have an eight-day clock which stops. The clockmakers tell you it is worn out. Probably they are correct, although you doubt their assertion. You do not state whether it is of English or American make—whether striking or not. I assume it is an American striking one. Remove the movement from the case, take out the pallets or verge, and allow it to run down gently, by placing one finger upon the third wheel. Do same with striking train. Take out plate-pillar pins, and lift off top plate; take out all wheels, &c. Clean and polish both plates, also the holes, with peg wood; clean and polish every wheel and pinion. Now examine every bush with its pinion in. Notice which are worn egg-shaped, or too large. Make these a trifle larger, and into each one insert a bouchon firmly. Examine pinion leaves; if any are loose or worn, replace the loose ones with new wire, or the worn ones may be scraped with a graver. Examine escape-wheel teeth. If any are budged, bent, or not of uniform thickness, straighten the bent ones with fine pliers, and file up the budged ones with fine file from the back. Have every tooth of the same angle, length, and thickness, particularly at the points. Examine pallets; if these are pitted, rub them smooth with oil-stone slip. If too far gone, replace with new one of same size. Put up the movement, place on the pallets, adjust the pendulum-spring to be equal in beat. Oil every bush with one drop of oil, not omitting the pallet-tail slot, through which the pendulum-wire passes. Wind up, and the clock will go if you have followed out the above directions carefully, and properly executed the usual repairs.—FRED. HUNT, Widnes-road, Widnes.

[56216.]—**L. & S. W. Express Engines.**—There was a misprint in my letter on L. and S. W. Express Engines on p. 35. The length of tubes is 10ft. 6$\frac{5}{16}$in., not 10ft. 0$\frac{5}{16}$in. as stated. This will make the heating surface as given, correct. I am obliged to "E. M." for working out the figures, as I should not otherwise have detected the misprint.—METEOR.

[56239.]—**Acid Filter.**—Four years ago, having to fit up plant for purifying $H_2SO_4$, manufactured from Spanish ore, containing a large percentage of arsenic, I had the same trouble to contend with as "F. G. S." I tried asbestos cloth, which was an utter failure: it was impossible to remove the precipitate, although removed and washed each time the asbestos cloth was used, it soon became quite rotten and worthless. I then got a wood tank made, about 6ft. long by 4ft. wide, and lined it with lead. I placed in the bottom small boler flints for the first layer and afterwards crushed flints of different degrees of fineness, covering the whole with a perforated sheet of lead punched full of small holes not more than ¼in. diameter, over which I placed a thin layer of white sand (not acted upon by the acid). The precipitate may be scraped off with sand with but little labour. A filter of this description will last for a great many years. A little sand must be replaced after removing the precipitate.—CHEMICAL WORK.

[56240.]—**Tug.**—The hull of the dimensions stated could be made into a creditable racer if fitted with the following:—Boiler, cylindrical (no steam dome), riveted, 15in. long by 8in. diameter, of 18 Stubbs's W.G. thickness; firebox, 6in. by 5½in. diameter at mouth to 5in. at tube plate; top of firebox to be flattened to a radius of 6in., the distance from crown to shell to be 1¾in. Tubes, brass, 40 in number, $\frac{7}{16}$in. dia.; thickness of metal in tubes, 26 to 30 Stubbs's W.G.; length about 9¼in., or sufficient to extend from tube plate in firebox to ditto at smokebox, leaving about ⅛in. projecting, which may or may not be swelled out. Smokebox must be arranged to take off readily for cleaning tubes. Have two funnels 1¾in. dia., the forward funnel to have a damper, and to fit in a tube 1¾in. diameter extending from centre of firebox crown to shell. This, you will find, is an immense advantage and convenience when getting up steam, and for stoking with small coke and charcoal when racing. This boiler, properly riveted, must stand a test of 120lb. cold water, and work at 60lb. All joints should be tinned before putting together, and sweated after riveting up. Engine.—A pair slide-valve cylinders, 1¼in. diameter, 1¼in. stroke, fitted with a feed pump; ¼in. plunger, ½in. stroke, and brass ball valves (no other valves work so well at this pressure). Take steam from boiler by a ¼in. bore brass pipe, with stopcock connected to a tripping gear fore and aft for stopping and starting. Carry exhaust by a pipe $\frac{1}{16}$in. larger than steam pipe to after funnel, the nozzle to point straight up the centre to get full benefit of blast. Connect propeller shaft direct to engine shaft; there is no necessity for gearing. A hand-feed pump forward is absolutely necessary, and this I find must be arranged to pump without valves if to be depended upon. Spring safety valve to be ⅜in. diam. with a knife-edge seating (a mitre seating is not to be thought of if life is worth anything), spring to have a pull of 7lb.; water gauge should have a glass about ⅜in. diam. external, and should be long enough to show water level from crown of firebox to shell of boiler. With the ordinary gauge-glass fittings, as shown in model shops, it is not always convenient to fix them on the boiler to show as much, and a modified form is now used by nearly all model steamboat sailers in the London parks. As to the propeller, the size, pitch, and number of blades is entirely a matter for experiment in these models. A screw of low pitch lets the feed-water gain, and one of high pitch, or too large in diameter, lets the feed come in too slow. You might try several screws first, and fix on the one which propels at the fastest rate, and adjust the stroke of feed-pump to keep the water in boiler at one level. If water should then go low, a few strokes of the hand-pump will soon bring it up. Details of boiler, engine, or fittings I will give you with pleasure if required.—S. Austel.

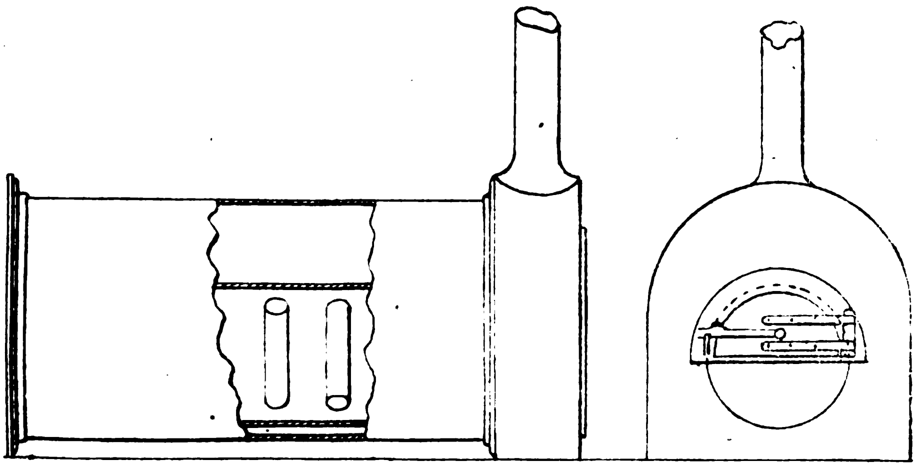
[56242.] — **Relation between E.M.F. of Dynamos and their Size and Speed.**—While thanking Mr. Eugene Brown for his answer to my query, I am sorry to have to say that the said answer does not contain the information for which I ask. I wish to know not merely the rate of variation of the E.M.F., with variations of speed, field-intensity, and turns, but to get some definite quantitative results for given values of these variables. Can Mr. Brown or Mr. Bottone send detailed particulars of dynamos, together with statements of E.M.F. at various speeds?—Wm. John Grey, F.C.S., analytical chemist, Newcastle-upon-Tyne.

[56243.]— **Fuses for Projectiles.**—To "Garrison Gunner."—Very many thanks for your kind and very complete answer to my query. I shall not ask you to take the trouble of looking up the "changes in war stores," for the information you have given is enough as it stands. Your description of the new fuses has so much interested me, that I am writing to the Director of Artillery for permission to procure from the R.L. drawings of the fuses you mentioned. And I presume that the drawings, like all good drawings, will explain themselves.—Ex-Garrison Gunner.

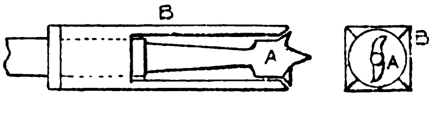
[56250.] — **Engine-Making at Home.**—I am in a fix this time, for I don't know whether I have to make the bed-plate out of the solid mahogany or make it in pieces; but I am very sorry for troubling you, but if you could give me suitable sizes for a good working model, I will take the parts in detail.—Snooks.

[56269.]— **Collimation.** — To "Rosicrucian." —By Cipher 51, wire I. is distant from the collimation centre 29·37s. (reduced to equator). Wire I. is distant from the main wire 27·8s. Hence the main wire is distant 1·57s. from the collimation centre. Similarly wire II. is distant from the main 13·8s., and from the collimation centre 15·47s., and hence the main wire is distant 1·67s. from the collimation centre. The mean of these two determinations is 1·62s. The collimation centre is on the side of the main wire away from wires I. and II. All stars transiting the wires in the order given for δ Orionis require the correction 1·62s. × sec. declination. The wire intervals, however, cannot be determined from a single transit; nor can the collimation be inferred from the observation of a close polar with reversed positions of the transit axis, unless the azimuth error of the instrument is approximately known, as the star might not be moving in a direction perpendicular to the wires. The position of the mean wire with respect to the individual wires (wire-intervals, as they are called) is usually determined from the transits of three or four hundred stars.—G. L. T.

[56271.] — **Portable Engine.** — The simplest form is that shown in sketch herewith. It is a modified Cornish boiler. A shell plate with internal fire tube; dimensions should be—length, 24in.; diameter of shell, 12in.; diameter of furnace tube, 7in., with six cross water tubes in flue beyond the bridge, these tubes being 1in. internal bore. The tubes should be set to cross one another, as shown in part broken away. The shell might be, in your case, of iron $\frac{3}{32}$in. thick, and the furnace tube the same, the smokebox being of lighter metal still. The end view will show how the plate is carried down to form a stand for boiler, and the smokebox the same. Very light angle iron can be used to secure the plates of shell and furnace to the ends, and, if put on as shown, no difficulty will be found, because the angle ring being welded to the shell, the last ring of rivets are all external, and can be got at both sides. I trust the drawing will make all clear to you; if not, write again.—Invicta.



[56285.]—**Drilling Square Hole.**—George A. Walton may, perhaps, be seeking for some such tool as the above (copied from Luke Herbert's "Engineers' and Mechanics' Encyclopædia," 1837). A is a centre-bit working in a sort of cast-steel squared box with chisel edges B. This latter must, of course, be prevented from turning round with the centre-bit, and it is easy to see how this could be done in the lathe, either by holding it or resting its lower side on some flat surface, whilst both borer and hollow square were forced forward into the wood. The square cutter has openings at the side for the discharge of the chips. Mr. Thomas Hancock is stated to be the inventor.—Richard Inwards.



[56290.]—**Water Gauge.**—In my practice I have met with at least one instance wherein a vacuum in the boiler caused the water to rise up and fill the glass gauge without increasing the quantity of water. This peculiar action is like carrying oneself in a bucket: it is nevertheless a fact though unexplained. Remedy—open any one of the cocks about the steam space sufficient for a moderate escape of steam, and leave it thus for the night. The air will rush in and prevent a vacuum forming. This plan should be strictly followed when steam is allowed to cool itself down in any boiler; the vacuum, or external pressure of 14lb. to 15lb., would have little chance of straining the riveted seams in the direction opposite to that of the general working strain. The advantages are obvious.—Yama.

[56294.]—**Chemical.**—The decomposition which takes place when chlorine is passed into milk of lime, and indeed into other metallic hydrates, is not thoroughly understood; but chlorides and hypochlorites are supposed to be formed as in the equation—

$$2Cl_2 + 2Ca2HO = CaCl_2Ca2ClO + 2H_2O.$$

—Epworth.

[56301.]—**Flowerpots.**—I have used plumbago well-rubbed on the moulds for ornamental bricks, tiles, &c., made from plastic clays, and they leave the moulds well.—M. W. S.

[56309.]—**Spica and the Star of the Magi.** —If Mr. Arkwright desires some curious information on the above, and the constellations generally, as typifying fundamental Bible truths, he should consult "The Testimony of the Stars," an abridgement of the late Miss Rolleston's "Mazzaroth," and published by Rivington's, London.—Arthur Mee.

[56316.] — **Eight-inch Spark Coil.** — The spark became more continuous, and its thickness sensibly increased, when cells of a larger size were used. In order, however, to obtain the best effects which the stronger current was capable of exciting, it was found necessary to increase the condenser surface; and after the required alteration had been made, the coil no longer worked satisfactorily with the small cells first employed. This was precisely what my experience had led me to expect. The adjustment of the condenser is so delicate a matter, that the addition or removal of a single pair of foils produces a surprising difference when the right capacity is approached, whilst the length and frequency, colour and thickness, of the discharge, and even the sound which it makes in breaking through the air, may be modified by material changes of the condenser capacity. If the capacity be sufficiently increased the spark may be extinguished, the large condenser (say of from seven to ten micro-farads' capacity, as an extreme case) producing the effect of a low-resistance shunt between the contacts of the break, and absorbing the current so completely that there is practically no interruption of the circuit when the points are opened—acting, in fact, much as the earth-connections of a telegraphic system are supposed to act by a certain school of thinkers. Considerable alterations of the battery-power give rise to effects similar in kind, although limited in degree, and the composition of the core also exercises an immense influence on the character of the discharge. In the course of some rambling experiments upon this influence of the core, I had the misfortune to mechanically injure the coil described in my letter of January the 4th, 1884, and a growing internal leakage was set up, which made it necessary to unwind the secondary wire. During the progress of this task, I detected several faint indications of the passage of sparks through the paraffined-paper partitions, and in one of them, at a spot near the centre of the coil, two very large holes had been burnt so as to produce a "short-circuit." The edges of the holes were charred and blackened, and altogether the disc presented a significant and picturesque appearance. In rewinding I adopted thin sheet ebonite for the material of the partitions, or discs; and followed a plan to which I had been led by experience, gained after the completion of the original 8in. spark coil, and chiefly in connection with the construction of a little instrument which, having only two and a quarter miles of secondary wire, gives a continuous 4in. spark with a battery power of five one-pint Grove cells; that is to say, I considerably reduced the number of the compartments, made them wider and a little deeper, and increased the thickness of the insulating covering of the wire, using three coatings of silk upon a proportion of the secondary. The rewound coil excels its precedessor in all respects save one: an additional cell is required to work it, because the altered build carries the bulk of the secondary rather further away from the core. Unless Mr. Harcourt is willing to expend what many students would deem a large sum, I should advise him, in the absence of a better model, to copy closely my original 8in. coil (to which he refers), using single-covered wire, but substituting ebonite discs for the discs of paraffined paper. Suitable sheet ebonite—No. 24, B.W.G.—can be obtained from the Silvertown Indiarubber Company, at a cost of about seven shillings per pound, and a couple of pounds would probably suffice for the purpose. I shall be glad to help Mr. Harcourt with any further information which is within the limits of my experience.—Ernest Baugh, Haverfordwest, Pem.

[56311.]—**Chemical.**—According to the equation, $2NaNO_3 + H_2SO_4 = 2HNO_3 + Na_2SO_4$. 170 parts of sodium nitrate require 98 parts of sulphuric acid to produce 126 parts of nitric acid. Therefore one ton of sodium nitrate will produce $\frac{2240 \times 63}{85} = 1,660\frac{1}{4}$lb. of pure nitric acid; but acid of sp. gr. 1·42 only contains 70 per cent. of pure nitric acid, so that we must multiply $1,660\frac{1}{4}$ by $\frac{100}{70}$ to obtain the quantity of nitric acid, gravity 1·42, which can be obtained, which is 2,371·8lb. Again, 170lb. of sodium nitrate require 98lb. of sulphuric acid; therefore 2,240lb. will require $\frac{2,240 \times 98}{170} = 1,291·3$lb. of acid of 1·842 gravity, this being the gravity of pure sulphuric acid. 170lb. sodium nitrate will produce 261lb. of barium nitrate. $2NaNO_3 = Ba2NO_3$, so that one ton will make $\frac{2,240 \times 261}{170} = 3,439$lb of barium nitrate.—George H. Hurst, Salford.

[56311.]—**Chemical.** — This query is rather "mixed"; assuming, however, that "soda" really means nitrate of soda, the reaction for the production of nitric acid is

$$\begin{array}{ccccccccc} 2NaNO_3 & + & H_2SO_4 & = & 2HNO_3 & + & Na_2SO_4 & & \\ 170 & & 98 & & 126 & & 142 & & 268 \end{array}$$

from which we get

$$170 : 98 :: 1 : x = ·576 \text{ ton } H_2SO_4$$

as the theoretical quantity needed to decompose one ton of Chili saltpetre. The quantity of nitric acid sp.gr. 1·530 theoretically yielded, is given by the proportion

$$170 : 126 :: 1 : x = ·741 \text{ ton}$$

but the acid at 1·42 sp.gr. contains only 70 per cent. of $HNO_3$, so the yield of that acid would be 1·06 ton. In practice 240 parts of sulphuric acid are used to decompose 305 parts of sodium nitrate, and yield 363 parts of acid at 55 per cent. $HNO_3$. Presuming that the barium nitrate is produced by double decomposition the theoretical quantity is 1·535 ton per ton of Chili saltpetre.—Wm. John Grey, F.C.S., analytical chemist, Newcastle-upon-Tyne.

[56313.]—**Cylinder.**—There are plenty of alloys I could mention which would harden the metal; but the real question is the getting a brassfounder to melt so small a special quantity as your cylinder would need. If you have a gun-metal cylinder at all, the ordinary mixture will serve you as well as any special one. The small size of your cylinder does not necessitate its being of specially hard metal. Thickness of sides of cylinder may be $\frac{3}{8}$in.; flanges, say, $\frac{1}{4}$in.—Invicta.

[56317.]—**Royal Exhibitions and Scholarships.**—I cannot give "Eldhin" much information as to future prospects, and so must leave this query to others; but I may say that, unless he really cares for science, he would be foolish to try for these positions merely as commercial speculations. There are so many now who love science for herself, that he who only woos her for what she may give him has but a wretched chance.—Wm. John Grey, F.C.S., analytical chemist, Newcastle-upon-Tyne.

[56323.] — **Vegetarianism.** — In reply to "A Regular Reader" in your current number, I may state that I shall be glad to send him a packet of literature containing a small cookery book and other information which will help him in reforming his diet. The *Food Reform Magazine* will be found to contain a list of publications upon vegetarianism. The packet I have mentioned will be sent upon receipt of a stamped and directed envelope from "A Regular Reader," or anyone seeking information upon food reform.—F. P. Doremus, Hon. Secretary National Food Reform Society, Finsbury-square Buildings, 1 and 2, Chiswell-street, E.C.

[56324.] — **Sunlight at Great Depths.**—Thomson, in his "Depths of the Sea," gives no exact figures; but has this remark: "It would appear that the rays capable of affecting a delicate photographic film are very rapidly cut off, their effect being imperceptible at the depth of only a few fathoms."—Arthur Mee.

[56326.]—**Sketching.**—A camera lucida would assist "Artist" in sketching; but though portable itself, it must in use be fixed to a level table. It is sometimes employed in determining the leading points and lines of elaborate buildings. Last year at Squire's, the artist's colourman, in Oxford-street, I saw an ingenious French plan, called "L'Orthorama," designed to help the unskilled draughtsman. The part which enables the sketcher to obtain a correct outline consists of a light wooden frame, on which is stretched a sheet of black gauze. This stands vertically between the eye and the view to be taken. At right angles to the frame is a sliding wooden rod, to which is attached the eyehole. The sketcher adjusts the distance of the eyehole from the frame so as to embrace the view he desires to draw, then keeping his eye fixed at the eyehole, he traces with white chalk the outline of the view on the gauze. When finished, or a sufficient number of points are secured, he places the gauze on his canvas, or paper, and goes over the white lines with charcoal. The abraded charcoal passes through the gauze, and leaves a dark outline on the canvas, or other material. The instrument, including a stool, three legs to screw into the containing box, which then serves as an easel, is, when packed up, of the size of an ordinary French wooden oil-colour box, and costs, I think, about £2. After all, these are both purely mechanical ways of obtaining a sketch. Would it not be better for "Artist" to practise drawing till he can dispense with such appliances? The pencil held at arm's length, at right angles to the line of sight, will then enable him, by moving his thumb till the end and his nail subtend the same angle as the distant objects, to obtain with sufficient accuracy all the relative dimensions he may have to represent.—Eye-witness.

[56326.]—**Sketching.**—I believe such an instrument as "Artist" desires is described in a little book, "Systematic Drawing and Shading," published by Cassell.—Arthur Mee.

[56327.]—**Transferring Pictures to Glass.**—I do not know if the following is what "C. P." wants; but it is the plan adopted by framers for large pictures, the price for framing which will not pay for a stretcher. Damp the picture thoroughly from the back, then lay face upwards upon a table, having the glass (previously cleaned) cut of a size to allow about a quarter of an inch all round to overlap. It will save trouble at the corners to cut off small pieces. Place the glass upon the picture nice and straight, then paste the edges both of paper and glass with a strong paste (shoemaker's) and stick down on to the front of glass. In drying this will tighten up to, and look as if "painted on, the glass." When dry go round with a sharp knife, cutting off to within an eighth of an inch of the edge, which will hold it quite tight. The rebate of frame will hide the remainder.—R. H.

[56328.]—**Vertical Boiler.**—The only practical way is to drill a small hole through the suspected plate; it need not be more than, say, $\frac{1}{4}$in. diam. At 60lb. pressure you must be careful. Vertical boilers of the common construction expose the funnel tube, where it passes through the steam space, to the hot gases from the furnace, with the result that angle iron, ring, and the plates round suffer not only from the intense heat, but also from the continued contraction and expansion. By no means despise the visible evidence of corrosion and oxidation, but see at once how the plates are; leave nothing in a steam boiler to *chance*.—Invicta.

[56329.]—**Crank Throw.**—Your lathe crank having a stroke equal to 5in., and your cylinder 6in., it would mean that you would have $\frac{1}{2}$in. clearance at each end of cylinder instead of a theoretical $\frac{1}{4}$in. or $\frac{3}{32}$in.; it will do all right; the only thing being that you neither get the full power out of the cylinder, and also that a small quantity of steam will be thrown to waste through the exhaust. I will at any time help you with great pleasure.—Invicta.

[56331.]—**Chimney Pipe.**—Have you tried a joint made with borings and cement, or an ordinary rust joint?—Invicta.

[56334.]—**Launch Engine.**—To "Invicta" and others.—Most assuredly you can nearly double the engine power as it is. We will assume that the two existing cylinders are utilised as high-pressure ones. And you then add a third cylinder, which you would use as a low-pressure one. If the pressure in the boiler be high enough, you should get a good result from such an arrangement. If you, as you should do, condense the exhaust from the low-pressure cylinder in a surface condenser, you would have a most efficient arrangement. The surface condenser need not be either a cumbrous or costly matter. And on this or any other point of detail I am always ready to help you or others.—Invicta.

[56334.]—**Launch Engine.**—I always find that if the exhaust is in any way retarded, that an engine loses a great deal of its power.—D. G. T.

[56335]—**Potter's Kiln.**—It is not stated of what quality of clay the terracotta is to be made—ferruginous clay, or of fireclay; nor the articles it is proposed to fire: thick blocks for architectural purposes, or thin vases, busts, and the like for indoor use. If the querist will define these points specifically, some of the readers of the "E.M." will doubtless endeavour to assist him with suggestions.—Pottery Tech.

[56338.]—**Pattern Making.**—If "Busby" has Nos. 983 and 985 in Vol. XXXVIII. of the "E. M." he will find instructions therein relative to the making of the principal patterns for a slide-rest. The leading screw for a 6in. lathe should be $1\frac{1}{4}$in. in diameter, and $\frac{1}{4}$in. pitch, neither square nor vee'd in section, but having the sides inclined at a slight angle. I don't quite understand your last query; but if you allude to the back-gear spindle, it is either thrown in and out of gear with a small eccentric and handle, or by being slipped endways, and kept from shifting by means of a pin. If you have an oblong hole, it appears as though the intention is to slide it backwards. The pinion for screw-cutting is put in the mandrel by being slid on a key feather slightly tapered.—J. H.

[56339.]—**Stops to Photo. Lens.**—"Gwent" says he does not know what the "equivalent focus" of his lens is! It is the distance of the optical centre from the ground glass, arrived at by measuring the size of the image on the glass as compared with the original, at a given distance. But unless "Gwent" wishes most accurately to compare his lens with some other, he may for practical purposes regard a point midway between the two lenses, when focussing for a distant object, as the equivalent focus. The value of the standard diaphragms referred to is that they have a relative aperture, which "Gwent" can easily prove if he will measure the diameters, and by squaring the diameters he will know the relative apertures, instead of making them of accidental sizes which have no definite relation one to the other.—A. Pumphrey.

[56341.]—**Cheap Gas.**—If "Glatton" will apply to Mr. A. Brotherhood, of 127, Redcliff-street, Bristol, I daresay he will give him particulars of the "Dowson" gas and apparatus, which costs 3d. per thousand cubic feet. He will also give you names of firms who are using it. I think Crossley Brothers use it in connection with the Otto gas-engine.—D. G. T.

[56341.]—**Cheap Gas.** — To "Invicta."—To mention names and addresses would be to break what I believe is a rule of this journal, and with which I entirely agree. If "Glatton" likes to ask any question through these pages, all the information I have is at his service, and if he likes to afford a channel by way of the Address Column, I would then in private give him names and addresses of makers, as also some information respecting the more recent improvements with which my apparatus is fitted. I might just mention that I am under the impression that the improvements in question are separate patents—not the property of the original patentee.—Invicta.

[56342.]—**Public Lighting.**—At Wimbledon "Surveyor" can see a good specimen of petroleum lighting, through inability to agree with the gas company, of about three years' duration, with about ten shillings per lamp per annum saved in the expenses of same.—A Country Chip.

[56342.]—**Public Lighting.**—There are at least several townships in Ireland lighted by a special form of lamp, the gas being produced from paraffin or petroleum in a small container forming part of the lamp-fitting itself. The system seems perfectly satisfactory, and works well enough. The lamps themselves are terribly dear—in fact, out of all reason. And this is, in my opinion, the reason why the apparatus I have in mind is not in more general use. For the reason stated in my reply to query 56341, I forbear to mention names; but will be happy to put "Surveyor" in connection with the makers if he so desires.—Invicta.

[56344.]—**Rubber Belting.**—Cut the ends at an angle of 45°, and overlap them twice the width of the belt. Lay the belt straight; mark the ends on to the belt, then split it in halves right up to each mark. Have some rubber solution at hand, and smear over all the joint; place the halves together, and press them with weights. Leave undisturbed until dry, which will be hastened by the operation being performed in a heated room. Rubber belts should not be cut narrower, because in doing so the selvage edge is removed. The best method of cutting is with knife and straightedge on a zinc plate.—Arefes.

[56346.]—**Sellers's Screw-Thread.**—In the American or Sellers's system of screw-threads the sides of the thread are inclined at 60°, and a depth equal to $\frac{1}{8}$ of the pitch is cut square off at top and bottom of the thread. The pitch is—

$$p = 0{\cdot}1\,d + {\cdot}025 \text{ nearly} \ldots\ldots\ldots\ldots \quad (1a)$$

$$d_1 = d - \frac{1{\cdot}299}{dn} = 0{\cdot}87\,d - {\cdot}03 \quad \ldots\ldots \quad (2a)$$

—Thomas L. Reid, Crewe.

[56350.]—**Electro-Plating.**—Nothing will prevent the silver peeling off your plated articles in their present condition. The time to prevent this is before immersing in depositing vat. Articles of copper, brass, or German silver must first be properly cleaned, then dipped into a solution of nitrate of mercury, or of cyanide of mercury and potassium; then well washed in water, and immediately suspended in depositing vat. If they are placed in the vat without this preparation, the deposited silver does not firmly adhere. Always regulate the current by the battery itself, raising or sinking the battery plates deeper in their liquids, as you wish to increase or decrease the quantity of metal deposited. If a hard, bright deposit is wanted, employ a current of small quantity and high intensity; but if the deposit is wanted soft and less coherent, employ greater quantity and less intensity. The time required for the process cannot be exactly determined, as it depends on the quantity of metal requiring to be deposited, battery power, size of articles, and the solution being in good working order; but you might safely keep the articles suspended till they appear well coated.—Bobadil.

[56352.]—**Lacquer for Lamp.**—I should think that you might effectually deal with the lamp as follows:—First, well clean the whole of the metal-work you wish to decorate, and be sure to remove all grease or oil. Now paint over as thinly as possible the metal-work with gold size, and just as it gets "tacky" brush over it with a flat camel-hair brush some bronze powder. You can get this of various shades, either copper or gold. Brush off all the superfluous bronze, and allow the work to thoroughly harden. When dry, say in 24 hours, give a coat of hard spirit or coach varnish. The effect will be to convert your lamp from a tin into apparently a brass or gilt one. If properly done, the appearance is exceedingly good.—Invicta.

**Intelligence of Tortoises.**—Anecdotes in the *Revue Scientifique* appear to show that these creatures must be credited with a considerable amount of intelligence. M. Boucard writes of one which lives in his garden, and, when called aloud by its name, "Laideron," would immediately run towards the voice with all the speed a tortoise can muster. The *Testudo mauritanica* of M. Boisse showed even more intelligence, learned to come when called by a hissing sound, followed its master like a little dog, relished caresses bestowed on its head and neck, gave gentle bites to show its affection, and would climb upon its master's boots or pull at his clothes to draw his attention.

# UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

55819. Microscope Fine Adjustment, p. 506.
55828. Swedish Gymnastics, 506.
55829. Chime Barrel, 506.
55831. Drying Room for Starch Factory, 506.
55833. Legal, 506.
55335. Workmen's Time Check, 506.
55836. Repairing Gun, 506.
55842. Stampings, 506.
55846. Circular Saw for Wood, 507.
55854. Centring Glass, 507.
55855. Measuring Height of Solar Prominences, 507
55856. Brass Castings, 507.
55857. Pressure for Stamping, 507.

56031. Reservoirs, p. 19.
56039. Explanation Wanted, 19.
56044. Baths, 19.
56047. G.B. Paper Enlargements, 19.
56050. Platinotype Paper, 20.
56056. Photographic Lenses, 20.
56060. Nickel, 20.
56068. Adjusting Telescope in Dumpy Level, 20.
56069. Photo. Amateur, 20.
56073. Clock Query, 20.
56074. Photography, 20.
56675. Hot-Air Engine, 20.

# QUERIES.

[56356.]—**Telephone Battery.**—Will some one inform me of the kind of battery used in telephone exchanges? I have been using Fuller's battery lately, but find it rather too expensive and troublesome.—Phono.

[56357.]—**Telephone Switch.**—Could anyone give me a rough drawing of the automatic switches in use by the Post Office, I believe, in some of their exchanges? It is inclosed in a square box with hinged cover under lock and key, the telephone suspended by a hook projecting underneath.—Phono.

[56358.]—**Chronic Cold.**—I have suffered from my youth upwards from a chronic cold in the head. I have been to one of the first doctors in London, but he has failed to cure me. His first recipe was cod-liver oil and iron, which I took for a couple of years, and then an injection of Tidman's sea salt to clear the nostrils. If any reader has therefore had some practical experience and cure in the above, he would indeed be a friend in need to—Ora et Labora.

[56359.]—**Coiling Thin Metal Strips.**—Will any of "ours" kindly inform me how to coil German silver strips? They are different widths, mostly under ½in. metal size 1, and are flat on the front with square hollow edge each side. They must be round, 2in. diameter, with edges inside. I have tried winding, but find they sink in on the front. Having seen them finished thinner and also smaller, perfect, any hints as to how to make them will be thankfully received.—Urgent.

[56360.]—**Tandem Bicycle.**—Will some bicycle friend kindly assist me in following? I have made a tandem bicycle after the Rucker fashion; the wheels 50in. and 52in.; the connection, inch square iron, allowing 6in. between wheels at nearest point; the hind head is open and works with connection pivoted in centre. I have tried to ride this with different riders, but without success; cannot find out where fault is. I might add I never saw a real tandem, but made mine from what I could learn from Messrs. Rucker's list.—Bike.

[56361.]—**Telephone System.**—Will any reader inform me how to connect, in circuit, six telephones, each station having its own number of calls from one to six: whether a series or multiple system would be the best, and whether a line return would be preferable to earth?—Micro.

[56362.]—**Chemical Nature of Hemp.**—Can any one give us the chemical nature of hemp, and also of syole which is mixed with it for twine spinning? An article like that on The Chemical Nature of Cotton, p. 28, would be useful.—J. O. W.

[56363.]—**Pasteur's Vaccine for Splenic Fever.**—Do any of your readers know whether any experiments have been made with Pasteur's splenic-fever vaccine in this country; if so, by whom, and with what results?—Grouse.

[56364.]—**Wire Blinds.**—Will some one kindly help me in the following? I had some wire blinds to gild; but found that if the holes were not filled up the gilding looked very weak; filled holes up but could not get sharp edges. What is the best way to obtain same?—H. H.

[56365.]—**Flat Foot.**—I found, after much walking, the foot is apt to become flat, giving pain about the heel and causing me to be quite lame. As I am very fond of walking, this is a serious drawback to me. Could I get special boots made to brace up the foot? I wear stout lace boots (light shooting) carefully made to measure, but they do not support the arch of the foot sufficiently. Age 30. Weight 13st. 11lb. I ride a bicycle daily.—Pedestrian.

[56366.]—**Screwing Machine.**—I want to make a hand screwing machine to screw bolts up to ½in. Should feel obliged if any one would give an easy way of making one?—X. Y. Z.

[56367.]—**Cocoanut Oil**—What is the best means of purifying cocoanut oil, as supplied to soapmakers, so as to render it perfectly white, as supplied by chemists?—J. H. Thompson.

[56368.]—**Ventilator.**—Some time ago I saw a model of a ventilator suitable for halls and public places. The model was supported on a glass tube in which was a ball of cotton wool; on exposing the model to a current of air, the wool rose to the top of the tube, showing that a current of air was drawn up through the ventilator. This was accomplished by the peculiar position of a set of vanes in the ventilator (it was not on the Archimedian principle). A sketch, showing how the vanes are arranged to accomplish this, will much oblige.—C. L. Tweedale.

[56369.]—**Short v. Long Focus.**—Will some practical brother inform myself and others, what is the shortest focus a refractor should have, or may have, without suffering loss in definition or otherwise? I understand the power is greater with long focus; and the field, and of course light, is greater in short focus instruments. With some makers, the diameter of o.g. to the focal length, is as 1 to 12; while with others it is as 1 to 18; both these are extremes. Am I right in supposing a 5in. o.g., of 5ft. focal length, will give a field half as wide again as a 5in. o.g. with a focal length of 7ft. 6in. and, of course, using the same eyepiece or same power? "F.R.A.S." and others could give a very useful note on this point, showing the proportions, which would help many besides—Perciverance.

[56370.]—**Repairing Boilers.**—Will some one give me an idea how the boiler of Lord Charles Beresford's steamer was repaired, if, as stated, the round shot went through it when going to Sir Charles Wilson's rescue? Do the navy carry appliances made as suitable as possible for clapping on a hole such as would be made by a shot of any kind, and how would the patch be held against the pressure of the steam? I am sure it would be very instructive if an account were published, giving extent of fracture and method of repairing same in so short a time, and under the conditions the boiler was in.—J. Perry.

[56371.]—**Spoiled Negative.**—In printing from a dry-plate negative, I did not notice that it was not perfectly dry and the paper stuck to it, but came off easily when soaked in water, leaving a yellowish deposit on the gelatine. How can I get this deposit off as there are some figures on the plate which I do not wish to destroy?—Sepia.

[56372.]—**Flowerpots.**—Would S. Arlidge please to say how his moulds are made and how used, and of what material?—and oblige—M. W. S.

[56373.]—**Cane Window Screens — Ornamental.**—What is the process of making the above—the material, the mode of joining? Are patterns sold, if so, where?—Cazlab.

[56374.]—**Globe Telephone.**—Will some of "ours," acquainted with the construction of above instrument, kindly help me out of my difficulty? I have two of above, but cannot understand what the three wires leading out of the case are intended for. Will someone enlighten me?—Micro.

[56375.]—**Microscopical.**—I am anxious to stain and mount some sputum, so as to show the Bacillus tuberculosis. Will some kind friend who understands the process kindly assist me?—some medical friend, or perhaps Mr. Nelson may understand the process.—A. Bonnar.

[56376.]—**L. C. and D. R. Locos.**—Will some correspondent kindly give dimensions and weights of the new Bogie express locos. on above railway, as No. 861, also of the new tanks as No. 75?—L. B.

[56377.]—**Electrical.**—I have an electro-magnetic machine with double magnets. The bobbins are wound with wire about 24 cotton-covered; would the power be increased if I wound the bobbins with finer wire, and silk-covered? The power seems intermittent, and goes with far less power than it did at first.—Uninitiated.

[56378.]—**Draught of Launch Boiler.**—I have a steam launch, the boiler of which has no draught. I shall be glad if any of our practical friends will help me to remedy the defect. The boiler is horizontal return tubular, 3ft. 6in. diameter, by 4ft. 3in. long, with 30 2in. tubes; funnel 9in. diameter, by, 6ft. long; fire-bars, 2ft. 6in. long, by 1ft. 8in. broad; fire-brick bridge built at end of furnace. There is a steam jet into funnel, and also the exhaust pipe leads into funnel, but I cannot get steam to put the jet on; the smoke comes back through furnace door. I have sent my name and address for insertion in Address column, and shall be glad if any practical friend will communicate direct to me, when I can give any further particulars if required.—Wear.

[56379.]—**Bichromate Battery for Lighting.** I have one constructed as follows:—The lid is made of wood, into which are inserted ten zinc plates, and ten carbon plates; one carbon and one zinc are side by side, but the zinc of each pair is connected with the carbon of the next pair, and so on till the ninth is reached, the zinc of which is carried by wire to the lamp, and the carbon of the tenth to the other side of lamp. The lamp is a ten candle-power Swan incandescent one. The ten cells are of wood, pitched in and out, and the solution used 2½oz. bichromate of potash, 1oz. of sulphuric acid, to 1½ pints of water to each cell. All the connections are good, but the cells leak into each other. Can anyone tell me why I cannot obtain a light, and the remedy to make it right?—In the Dark.

[56380.]—**Colonel Drayson's "Glacial Epoch."**—I have been lately looking over the above work (1873 edition) and should like to ask our astronomical authority, "F.R.A.S." what mathematicians think of the author's position? If, as he states, the pole of the earth describes a circle, not round the pole of the Ecliptic but round a pole some 6deg. from it (29° 25′ 47″ N.P.D. 17h. 45m. R.A. in 1872), it appears to me that he makes out a very strong case. But that "if" is the difficulty, and I am not competent to solve the problem: hence my appeal to our kind friend.—Edward M. Richards.

[56381.]—**Legal.**—Forty years ago a mother made over to her daughter, by deed of gift, two houses "for her and her heirs for ever." Some time after, the mother being in want of money, effected a mortgage on the houses, the daughter giving consent and signing her name. Eventually the person who advanced the money called his money in, and that not being forthcoming, the houses were sold, the person who advanced the mortgage money buying at a sum not much in excess of what he had lent on them. The sons are now men, and have been told that the proceeding of the mother and daughter was decidedly illegal, and that the sons could claim the houses by taking the necessary proceedings against those concerned. The mother of the sons is alive, the grandmother is dead. The question is, Have the sons any reasonable chance of obtaining what they are assured is their own? If so, what is the best possible way for them to proceed in the affair?—Gwent.

[56382.]—**The Solar Eclipse in September.**—I purpose taking a trip to Wellington in September next to witness the total eclipse of the sun, and expect to be accompanied by two friends. I have a 3½ Wray refractor, my friends have reflectors 6 and 6½. I should be glad of any information to enable us to turn our observations to useful account. One of my friends purposes searching for intra-Mercurial planets, my intention is to try to photograph the corona. As my instrument is too small to use the principal focus, I purpose putting a shutter on the 60 eyepiece and attaching a chamber to receive the dry plate. I photographed the transit of Venus by a similar contrivance with a 3in. instrument, but the picture was not sufficiently sharp owing to neglecting to adjust for chemical focus. To make sure this time, I intend practising on sunspots beforehand. I shall use the ordinary ¼ plates sold at the photographic stores, but am in doubt whether the corona will require a longer exposure than the full sun. As there will be no time available for developing, I should be glad of any information on this subject from any of "ours" who may have tried a similar plan, so as to prevent disappointment.—John Grigg.

[56383.]—**The New Station at Birmingham.**—What are the dimensions of the New-street Station, Birmingham, and how do they compare with that at York? Is it true that the platform at Gloucester is 612 yards long?—Lever.

[56384.]—**G. W. R. Speed.**—Is it true that the G. W. R. 11.45 down train will be accelerated in June, and run to Bristol without stopping in two hours?—Lever.

[56385.]—**Victoria Dynamo.**—I am making a Victoria dynamo with eight field magnets, 2½in. by 1in., armature 6¼in. diameter; inside measurement of armature 3¼in. by ½in. thick. Would any reader of the "E.M." tell me what size wire to wind the armature and field magnets of the above machine with, what quantity I should require, also what light I should expect to get from such a machine?—A. W. H.

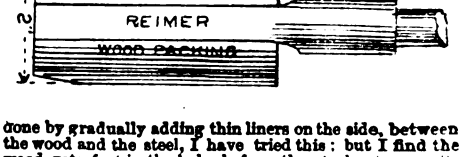
[56386.]—**Shuttles. — Compressed Teak.**—Can anyone inform me of what kind of boxwood shuttles are made? Is it Turkey box? What are the requisites in the wood? Is the teak to be compressed to give a weight, or what? Are not the shuttles shod with iron in the parts subject to friction? Any information on the subject of shuttles and the wood for them will be appreciated by me, as I have a son in foreign parts who might, if he knew the stuff required, be able to find a wood that will answer without compression.—Z. Y. X.

[56387.]—**Battery.**—I have a battery composed of four large zinc plates and sixteen carbon plates; the whole of them are fastened to a piece of wood, and all to be immersed in an earthenware jar. Which is the best and cheapest way to charge this battery, in order to produce a current of two hours' duration? I am, at present, using spirits of salts, but the action is too rapid on the zinc plates.—D. W. G.

[56388.]—**Motor.**—Will Mr. Bottone say how I can best trace the cause of my motor starting and giving off good power and then after a minute or two gradually coming to a standstill? There is no short circuit that I can find. When the battery current is divided between the armature and field magnet, the machine will hardly go at all (although the resistances are nearly equal) no matter what position the brushes are in. I have rewound both armature and magnet, but to no purpose. At present the machine has 16 on field magnet and 18 on armature, which is of Siemens form, 4in. long and 1½in. diameter.—Chingford.

[56389.]—**Incandescent Lamps.**—Given a lamp absorbing electrical power of, say, 50 volts, does it matter whether the power is obtained from large current and small force, or from large electromotive force but small current?—Ignoramus.

[56390.]—**Reamer.**—Inclosed is a sketch of a wood-packed reamer, the diameter of which is 2in. Will any of your readers kindly tell me how I can clean out a hole to 2¼in. diameter, with the same? I believe it can be done by gradually adding thin liners on the side, between the wood and the steel, I have tried this: but I find the wood gets fast in the hole before the steel gets near its work, owing to its being larger in diameter than the steel.—Beginner.



[56391.]—**Haydon's Cutter-Bar.**—Some short time ago I procured a Haydon's cutter-bar and a set of cutters for steel, iron, and brass; but having been previously only accustomed to the ordinary forged slide-rest tools, I do not seem to be able to turn out such good work with the cutter bar as I feel I ought to do, seeing that the Haydon cutter-bar has a very good name for general utility. Will someone please say if any special care or particular method is required in using them? Are they intended only for fine cuts? I am using them with a 4in. centre screw-cutting lathe, worked by the foot. What is about the greatest safe depth of cut they will stand on steel, wrought and cast iron, and brass—say on a bar 1in. in diameter? On account of the bend in the cutter-bar, the tool overhangs the top of the rest, much more than a forged slide-rest tool need do; is not this less rigid, and a drawback? It seems to me that without some special grinding apparatus to hold the tools when being repaired, it is difficult to maintain the side and plan angles of the cutters as they are sold, which, I presume, is essential to their doing good work. Will some other users of this cutter-bar kindly give me their experiences therewith? Of course I keep the point of the tool exactly level with lathe centres, so want of doing first class work is not due to any neglect on this score; I presume it is also correct, in turning straight cylindrical work between centres, to keep the shank of cutter-bar square with axis of mandrel?—BELLICOSE.

[56392.]—**Cubic Feet of Air per Minute.**—Supposing I have a pipe 12in. diameter, supplying air to a reverberatory furnace, by means of a mechanical blower. I should like to know how many cubic feet of air would enter the furnace per minute, when a water gauge shows a pressure of 3in. Please say also how the result is arrived at.—J. SMITH.

[56393.]—**Steam.**—If steam is issuing from a pipe 2½in. in diameter, and at a pressure on the boiler of 50lb. per square inch, what weight or volume of water would this steam represent per minute if it was condensed?—J. SMITH, Plumstead.

[56394.] — **Medical Battery.** — I have a medical continuous current battery, 40 ebonite cells, 1¼in. by 1¼in. by 3¼in., and get but a very slight current through it. I have recharged it with a strong solution of sal-ammoniac. Will one of "ours" please say if I have done right—if not, what should I use?—P. O. LINEMAN.

[56395.]—**Microscopical Staining.**—Will some reader kindly inform me how to use indigo carmine, i.e., sulphindigotate of soda, as a stain for vegetable tissues? —TYRO.

[56396.]—**Carbon in Cast Iron.**—We read that cast iron, when fused, has the property of dissolving an extra quantity of carbon, which is rejected on the iron cooling. Will any of our chemical readers kindly say what quantity of carbon is the iron able to take up in this manner, and in what manner is it to be done? I have an injector furnace by Fletcher, of Warrington. I melt the cast iron in it. Now, what I want to know is, in what manner am I to add the extra carbon so as to dissolve it in the iron, and what sort of carbon (graphite, lampblack, charcoal, &c.) should I use? I shall be thankful for any information on the subject. — EX-GARRISON GUNNER.

[56397.]—**Feeder for Organ Bellows.**—I have a small organ, and the feeders for the bellows act only one way. I want to make a feeder, 18in. wide, 4ft. 6in. long, to feed the bellows, with the up-and-down stroke; having enlarged the organ, I find the feeder too small, only working one way. Will any brother reader oblige? —LINOS.

[56398.]—**Boiling White.**—Can any reader tell me the way to tin brass work by boiling? I have tried boiling them in a solution of grain tin and cream of tartar in an iron saucepan? I have boiled for about six hours, but could get no deposit. Can any reader tell me where I am at fault?—A COUGHDROP.

[56399.]—**L. and N. W. Compounds.**—Can any one give dimensions of Mr. Webb's compound express engines, also some results in their working regularly?—G. D. SEATON.

[56400.]—**Harmonium.**—I am making a small harmonium, 3ft. long. I want one row of reeds, about 30 keys. Would some reader of the "E. M." kindly give me instructions how to make the reeds, where I can procure the brass, how I can tune them, and a few general instructions; and also where I can procure them already made, and what would be the cost of one set of reeds?—WORKING MAN.

[56401.]—**Faulty Induction Coil.**—I have an induction coil which seems to have broken down, giving only ½in. spark instead of 2in. Would steeping the secondary in hot paraffin (making tin cylinder to fit and placing over gas stove) until thoroughly soaked, restore the insulation, or would the process injure the ebonite tube and discs? The coil is disc wound.—FIFTEEN YEARS' SUB.

[56402.]—**Calculating Power Required.**—Will any reader favour me with a rule to calculate the power required to drive a machine, the first motion of which makes 400 revolutions per minute. With a lever attached, and 20lb. hung on it 20in. from the fulcrum, the machine begins to move?—M. E.

[56403.]—**Skrivanoff Battery.**—To "BOBADIL."—Many thanks for your answer to my query. Will you kindly answer the three following questions? 1st, Which chloride of mercury am I to use, the black or the red? 2nd, What salt should be formed after boiling, and is it necessary to boil for three hours? 3rd. What is the E.M.F. of the battery per cell?—ACCUMULATOR.

[56404.] — **Overflow in Water Waste Preventer.**—Lately new, supplied by Bodlings, of their own make. Various plumbers having been applied to, to remedy the waste, from time to time, without success, perhaps "our" Mr. Davies would kindly say how it is to be treated? At present it is a constant race between the West Middlesex Water Co., and the W. W. Preventer, the latter emptying the cistern as fast as the former fills it.—MONTMARTRE.

[56405.]—**Erecting Machinery.**—Would any of the readers of "Ours" tell me of a good book giving instructions upon erecting machinery, especially steam engines and rolling-mill machinery? I should be glad if some one would tell me the proper way to set about erecting a beam-engine with cylinder and motion in engine house, connecting rod and crank-shaft outside on a separate frame?—J. G., Bristol.

[56406.]—**Oleine Oil for Calico Prints.**—There is in the market, just now, a first-rate oleine oil for padding the prints before steaming. The goods padded with this oil, when steamed, produce a nice white; so it is certain there is something in this oil to make this change. I would like very well if someone would give me a hint on how to make it?—M. A.

# ANSWERS TO CORRESPONDENTS.

⁂ *All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

## HINTS TO CORRESPONDENTS.

**1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.**

**⁂ Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.**

**The following are the initials, &c., of letters to hand up to Wednesday evening, April 15, and unacknowledged elsewhere:—**

T. J. ELMORE.—Pall Mall Electric Association.—Lord Rayleigh.—C. Rabache.—W. A. McClintock.—Hadfield's Steel Foundry Co.—C. Anthony, jun.—Robey.—Constant Reader.—Sefton Park.—W. Hardie.—Soho.—B. M.—Jno. M. Adams.—J. T. D.—Glatton.—J. R.—R. G.—T. H. L.—Arefes.—W. H. Elphick.—G. Fryer.—Bobadil.—Lt.-Col. Ross.—Silex Seadrift.

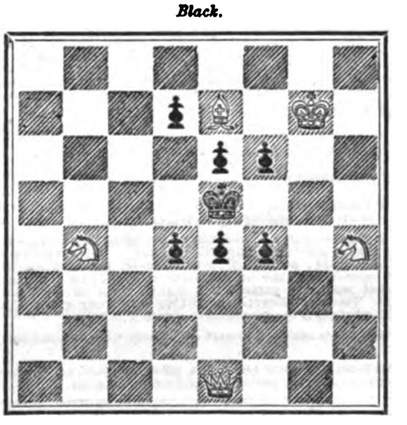
BUSY. (The easiest method is what is now known as the Hamiltonian system—that is, interlinear translations. It is advisable to learn the declensions and the forms of the verbs, especially the irregular ones. A study of such lessons as you can find in the "Popular Educator" would soon enable you to read books of the kind.)—AN AMATEUR. (See many replies in back volumes.)—INTERESTED AMATEUR. (We do not know of any books on the subject. To make incandescent lamps you will require some apparatus to compress the filaments and carbonise them, glass-blowing tackle, and a mercurial air-pump. If you really wish to enter upon their manufacture, you will find full particulars in back volumes.) —S. BEECHING. (No book specially devoted to the subject; but there is a good deal of information in Bourne's "Examples of Steam, Air, and Gas Engines," Longmans, price 70s.; also in his "Catechism of the Steam Engine," same publishers, which gives particulars of many patents. For a complete account of the patents you will have to search at the Patent Office, but you will get some in the volumes of the abridgments published relating to engines.)—F. BASLARD. (So-called self-acting fountains have been described many times; see pp. 402, 425, Vol. XXXIX., pp. 112, 247, 260, Vol. XXXVIII., and Nos. 459, 582, 801.)—AMERICAN LEATHER. (They are preparations of linseed-oil with driers and pigments, sometimes with the addition of gum copal, &c. The "patent" is stoved. See the indices. Thanks for the other matter, but you will find something about it in No. 1002, as well as in back volumes.)—LEVER. (First query not of sufficient interest. You should procure the specifications if they are patented. 2. The term means that a burner consuming five cubic feet of gas per hour gives a light equal to so many standard sperm candles. A standard candle is one that consumes 120 grains of sperm per hour. 3. For such questions you should refer to a cyclopædia. Meerschaum is a silicate of magnesia, obtained principally from Asia Minor, where it is found in veins or nodules amongst the serpentine rocks. Steatite is also a silicate of magnesia, a massive variety of talc commonly known by the name French chalk. Asbestos, too, is a silicate of magnesia, the name being applied properly to the peculiar fibrous variety of amphibole.)—GEO. HAILEY. (Perhaps you will say what new battery salt it is that you mean? If it is some trade article, the question is scarcely likely to meet with an answer.)—W. H. (Your query about musical box has been answered so recently as replies No. 55691. See p. 544, No. 1039.)—W. TWIGG. (It is a modification of one of Prof. S. P. Thompson's patented devices. See p. 144, No. 943. We do not know who sells parts.)—ONE IN A FIX. (Not of sufficient interest. Models of the kind are not worth making; but you can stiffen the cardboard by sizing and varnishing it.) -T. BAKER. (Mix the desired pigment with gum water. Alphabets can be obtained from the dealers in artists' materials, but scarcely books of designs.)—J. W., Cleackheaton. (Use finer and still finer emery, and finally polish with crocus. 2. An artificial seawater is made by dissolving in a gallon of filtered rainwater or boiled water 3½oz. of common salt, ¼oz. of Epsom salts, 200 grains of chloride of magnesium, and 40 grains of chloride of potassium. Put some fresh seaweed in for some time before using. 3. The camera obscura is described in such books as Ganot's "Physics"; but you will find any details about that and the other question in back volumes.)—WOLSEY. (See answer to F. Baslard.)—VOX. (Yes, certainly, or zinc, compo, or tin. You must apply to the company for prices of telephones.)—AN ENGINE FITTER. (See indices; but better spend the money in consulting a medical man.)—W. D. GEORGE. (Use a little cream as the kid reviver. For thought-reading, see the indices of Vols. XXXVII., XXXVIII.; as to the rings, some are split, so that the others can be readily passed into them; but only the solid rings are shown to the audience.)—STAR. (We believe Mr. Eassie, Argyll-street, W., can give particulars of the Cremation Society.)—WORCESTER. (Look through recent numbers; also at p. 133, last week.)—T. B., Rochdale. (Recipes for "lime-juice and glycerine" in Vol. XV. pp. 157, 261. The commonest samples are made of lime-water and oil, with just a little glycerine. A good recipe is olive oil 20oz., lime-water 20oz., glycerine 2oz., essence of lemon 100 drops. If such a mixture is to be put on to the hair, it would be advisable to add a quarter of an ounce of cantharides. That should be added to the oil before mixing. After standing for a day on the cantharides, filter the oil through paper and mix with the lime-water.)—T. B. (The "five-barred gate" in No. 921; the four-barred in No. 924.) —MODEL ENGINEER. (See the indices.)—W. H. T. (If you will say what we are to understand by an "electric engine," we may be able to help you; but you might help yourself by looking to see if there is not something suitable in back volumes.)—ONE IN A FIX, Priestfield. (You had better copy the remaining reeds, or else procure new plates, which you can obtain of any dealer in musical instruments. Steel is better than brass for such instruments; but it is difficult to work. As your plates are not brass, we presume they are zinc.)—A HOBBLING SUFFERER. (If you are not satisfied with the verdict of two medical men, why not go to a hospital, and ascertain what the surgeons think of it? If you feel nothing of it for months together, it is certain it is not a bone out; but how anyone can help you without examining the part we fail to understand.)—W. CHAPMAN. (The question is of no interest, and you have no legal position. You voluntarily accepted the terms, and so far your "loss" is only hypothetical.)—RUSTIC. (The insertion of such a query would produce a variety of replies, simply because it is not definite. Some readers would imagine you wanted a carbon paper, whereas, if we understand you, the process is one of those in which paper with minute perforations is employed. That is tough tracing-paper, which you can make by dressing "bank post" with Canada balsam dissolved in turpentine. See back volumes for other recipes, or p. 88.)—J. J. S. C. (Formulæ for preparing emulsions, both gelatine and collodion, in back volumes.) — FERROTYPER. (Use an ordinary good "white hard" varnish, thinned with pure methylated alcohol. There are several recipes on p. 418, No. 954, and elsewhere in back volumes.)—G. ALLSOPP. (You want a little roller press, which you can obtain of any dealer in photo. materials. For enamelling, see p. 116. No. 915.)—TONSOR. (The cause is constitutional. See the indices. 2. Would it not be simpler to remagnetise the needle? Is it true that it is weighted to keep it in position?)—ONE IN A FIX. (A little fire kept in at night will not do, because you will be heating the conservatory when the air is mild, and allowing it to cool down at night when the frost is outside. Better have no heat at all than that. You must devise some independent heating apparatus.)—ROB. CAUS. (We *do*, of course; but we require more in such cases than we fancy you can give us, and we fear our space would hardly admit of such a series as you propose.)—E. F. J. H. (We know nothing of the school referred to; but it is not necessary to enter there or anywhere else, or to pass any examination, to style yourself a civil engineer.)—IMPRIMATUR. (Pray who is the American "scientist," and what is a "veridical" phantom, and which part of his own body does he evolve his phantom double from? All humbug!)—ANXIOUS. (No one but a medical man who had seen it can say. If he is of opinion that it must be cut out, submit, and be thankful if a cure is effected. If you delay, the doctor will presently have to tell you it is too late to undertake the operation.)—VLADIMIR. (It is utterly impossible to follow your copy as it is arranged. It is bad enough when any MS. is on both sides of the paper; but when it consists mainly of mathematical formulæ, and the sequence of the pages arranged in the fanciful manner you have adopted, confusion becomes worse confounded.)

# CHESS.

ALL Communications for this department must be addressed to J. PIERCE, Llandwrog, Carnarvon.

PROBLEM DCCCCXXXV.—"RESPICE FINEM."

*Black.*



*White.* [5+7

White to play and mate in two moves.

SOLUTION TO 933.

| *White.* | *Black.* |
|---|---|
| 1. Q to Kt 8 | 1. Anything |
| 2. Kt or Q mates | |

(Five variations.)

## NOTICES TO CORRESPONDENTS.

CORRECT SOLUTIONS to 933 by R. A. Bennett, Rev. W. Anderson (Old Romney), W. T. Bayne, F. O'N. H., A S. Olver, A. A. E. Lecluse, Raymond. F. A. Vincent, E. Stanley Follwell (main variations must be published; names of competitors have been given). Exon (neat, no waste of force, second solution cleverly avoided), Streetgate, P. S. Pochin, and J. E. Piper.

To 923, by R. A. Bennett, W. T. Bayne, R. Fison, and R. C. J.

Tourney Problems from "Phono," and "Aut Vincere aut Mori"; also amended problem from "Measure for Measure." Game from T. Bourn.

Ariadne.—Correction made in solution.

L. L. Chivers.—If in 932, R takes R, 1. B-Kt 4 is an effectual reply.

A. O. E. Lecluse.—Name entered.

H. A. Harborrow.—The solution as printed to 931, is quite correct: if 3. P takes Kt, 4. P mates, if 3. anything else, Kt mates. You have overlooked in your solution, that after 2. R-K R 6, 2. P-K 7, 3. R takes P, Black has no move! Your solution to 933, is also incorrect for 2. Kt-Q 7, is not mate, as K can move to Q 3.

Exon.—1. It includes three move-problems as well. 2. There is no entrance fee necessary. 3. About seven months. 4. First prize £1 1s., second, Tomlinson's "Amusements in Chess" (out of print); third, Collins' "Problems"; fourth, Mills's "Problems and Poems"; fifth, Beechey's "Chess Blossoms."

Bethnal Green.—Solution to 931, correct, but not author's; that to 932 is wrong, as if 1. K B moves, 2. K does not discover mate, since B-K can take R.

**Every Workman connected with the Building Trades** requiring a Situation should advertise in "THE BUILDING NEWS," published every FRIDAY, price Fourpence, at 332, Strand, London, W.C.

"THE BUILDING NEWS" is the Principal Journal representing Architects and Builders, and has the largest circulation of any Professional Journal in the kingdom.

Every Workman should insist on seeing "THE BUILDING NEWS" every week at his Club or Coffee House. He will find more "Lists of Tenders" for new work in it every week than in any similar paper, and can thus judge where work is likely to be had. He is also specially invited to make use of "Intercommunication" if he wants to know anything about his trade; to write to the Editor if he has any suggestions to make, and to advertise in the paper when he wants work.

The charge for Advertisements for Situations is On Shilling for Twenty-four Words, and Sixpence for every Eight Words after

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Vols. IV., VII., XXVI., XXVIII., XXX., XXXII., XXXIII XXXIV., XXXV., XXXVI., XXXVII., XXXVIII., XXXIX. bound in cloth, 7s. each. Post free, 7s. 9d.
Vol. XL. now ready, price 7s. Post free 7s. 9d.

All the other bound volumes are out of print. Subscribers would do well to order volumes as soon as possible after the conclusion of each half-yearly volume in February and August, as only a limited number are bound up, and these soon run out of print. Most of our back numbers can be had singly, price 2d. each, through any bookseller or newsagent, or 2½d. each, post-free from the office (except index numbers, which are 3d. each, or post-free 3½d.)

Indexes for Vols. I., VI., VII., VIII., and IX., 2d. each. Post free 2½d. each. Indexes to Vol. XI. and to subsequent vols., 3d. each, or post free, 3½d. Cases for binding, 1s. 6d. each.

## CHARGES FOR ADVERTISING.

| | s. | d. |
|---|---|---|
| Thirty Words | 2 | 6 |
| Every additional eight words | 0 | 6 |

Front Page Advertisements Five Shillings for the first 40 words afterwards 9d. per line. Paragraph Advertisements One Shilling per line. No front page or paragraph advertisement inserted for less than Five Shillings. Reduced terms for series of more than 6 insertions may be ascertained on application to the Publisher.

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| | s. | d. |
|---|---|---|
| Twenty-four words | 0 | 3 |
| For every succeeding Eight words | 0 | 3 |

ADVERTISEMENTS in the SIXPENNY SALE COLUMN.

| | s. | d. |
|---|---|---|
| Sixteen words | 0 | 6 |
| For every succeeding Eight Words | 0 | 6 |

*** It must be borne in mind that no Displayed advertisements can appear in the "Sixpenny Sale Column." All advertisements must be prepaid; no reduction is made on repeated insertions; and in cases where the amount sent exceeds One Shilling, the publisher would be grateful if a P.O.O. could be sent, and not stamps. Stamps, however (preferably halfpenny stamps), may be sent where it is inconvenient to obtain P.O.O's.

The address is included as part of the advertisement, and charged for.

Advertisements must reach the office by 1 p.m. on Wednesday to insure insertion in the following Friday's number.

**Epps's Cocoa.**—Grateful and Comforting:—"By a thorough knowledge of the natural laws which govern the operations of digestion and nutrition, and by a careful application of the fine properties of well-selected Cocoa, Mr. Epps has provided our breakfast tables with a delicately flavoured beverage which may save us many heavy doctors' bills. It is by the judicious use of such articles of diet that a constitution may be gradually built up until strong enough to resist every tendency to disease. Hundreds of subtle maladies are floating around us ready to attack wherever there is a weak point. We may escape many a fatal shaft by keeping ourselves well fortified with pure blood and a properly nourished frame."—*Civil Service Gazette*.—Made simply with boiling water or milk, Sold only in packets, labelled—"JAMES EPPS and CO., Homœopathic Chemists London."—Also makers of Epps's Chocolate Essence

HEARTHRUGS.—The *Catholic Times* says:—"We have this week inspected the Hearthrugs advertised by Nelsey and Co., of Stockport, and can guarantee them to be everything that the firm represent them in their advertisements. They are really cheap and beautiful articles, and we feel sure that our readers will not be disappointed if they intrust their orders to Messrs. Nelsey and Co., and as the goods come direct from the manufacturers, they are enabled to sell them at prices within the reach of all classes."—For advertisement see page VII of this paper.

## NOTICE TO SUBSCRIBERS.

Subscribers receiving their copies direct from the office are requested to observe that the last number of the term for which their subscription is paid will be forwarded to them in a Pink Wrapper, as an intimation that a fresh remittance is necessary, if it is desired to continue the Subscription.

**Holloway's Pills and Ointment.**—Holloway's Pills purge the Blood of the foul humours engendered by unhealthy atmospheres and dangerous occupations. They arrest inflammation, and correct all disorders of the liver, stomach, and bowels. Holloway's Ointment cleanses and heals ulcers, wounds, and abscesses, and allays the pain of Rheumatism and Neuralgia.

## OUR EXCHANGE COLUMN.

*The charge for Exchange Notices is 3d. for the first 24 words and 3d. for every succeeding 8 words.*

**Good Value Offered** (cash or instruments) for all kinds of sound or repairable Scientific Appliances.—Caplatzi, Science Depot, Chenies-street, near British Museum. Established 1862.

Wanted, a good Collection of **Stamps**, also coins and Bric a Brac of every description, good exchange, approval required.—Address, Edward W. Drury, Hull.

**Perambulator Wheels**, with turned axles, ¾ best Rubbers, 54 Wires, Brass Caps, complete, on approval, with pleasure. Exchange offers.—310, Bilston-road, Wolverhampton.

**Lathe Wheel**, 28in., 5 speed, 50in. crank, turned, bored, treadle, complete, lathe standards, 7½ lathe head; 100 "E. M." Exchange.—Smith, Bilston-road, Wolverhampton.

"**English Mechanic**, from commencement, 40 Vols., 19 bound, all in perfect order. No reasonable offer refused, owner going abroad. Will exchange for central-fire gun.—Major Allen, Gosport, Hants.

**Cutter Yacht**, with all necessary sails, ropes, spars, and blocks; built by master shipbuilder; copper fastened. Will exchange for Bicycle or Model Engine, value £4.—A. F. Whisley, Bank House, Brightlingsea.

Will exchange capital Bow **Drill Stock** and ten fitted drills for double-jointed Pencil Compass, Needle Points, or offers.—J. Muir, 9, Church-street, Dumbarton.

No. 3 Breechloading **Pistol**, octagon rifled barrel, cost 30s., and 100 cartridges. What offers of recent volumes English Mechanic.—A. Perks, 18, High-street, Warwick.

"**Balfour's Botany**," nearly new; "Grindon's British Plants"; 26 Nos. "Brook's Botany," incomplete, lot cost 28s. Wanted, ¼ or ½ wide-angle Lens.—C. Roxhead, 606, Dalmarnock-road, Glasgow.

Wanted. **Lathe**, about 4½ centre. Exchange for a beautiful Screen, worth £15, brand new.—D. H., 3, Byron-street, Westoe, South Shields-on-Tyne.

Vol. I. to XIV. "**Mechanic's Magazine**," bound, good as new; 10 Vols. "Family Friend," bound; in exchange for Lathe and Tools, in good condition.—W. S., 78, Viaduct-street, London, E.

What offers for Nine Lop **Rabbits**, seven weeks old and pair of Antwerp Pigeons.—W. Selvidge, Pumping Station, Chalvey, Bucks.

For **Magneto Machine** or French Pocket Coil, a powerful Induction Coil would be given.—Address, William Taylor, 37, Bishop-street, Dublin.

**Barometer**, nearly new, mahogany frame, ivory scales, and thermometer, cost £3. Want microscope, tools, or anything useful.—Godfrey, Ironmonger, Brearley-street, Birmingham.

Wanted, six-keyed **Piccolo**. Exchange two new Swan's Incandescent Lamps and a one brass holder, cost 8s., and money.—Geo. Armitage, 10, Mornington-road, Deptford.

On approval, a **Bass Drum**, Fugel Horn, Trombone, in good order, for 50in. Bicycle, or a day-and-night Telescope; must be on approval, or £4 in cash.—B. Bath, 19, Cwm-street, Abertillery, near Newport, Mon.

Good Collection, over 750 **Stamps**, different, many very rare, in Oppen's album. Exchange offers.—F. Howard, 95, High-street, Kingsland.

Small Balance **Timepiece**, bronze and silvered dial, mahogany stand, glass shade. Exchange. Electric Bell and Battery wanted.—H. Leeson, Coleshill, Birmingham.

Bourne's Patent **Horizontal Engine**, smallest size, with governor and pump, practically new. Two-cylinder horizontal Engine, made for steam launch, found too small, about two-horse, three months' work. Advertiser will exchange for Gas Engine, Ruskin's Works, Hay, Straw, or Oats.—Richard Fletcher, Meadow Bank, near Manchester.

**Circular saws**, 12in. to 15in. Band saws, 15ft. long. Exchange offer.—127, Abbey-street, Bermondsey.

**Hydraulic Jack**, 4-ton, by Tangye. Exchange or offers.—16, Riley-street, Bermondsey.

Harding's **Speed Indicator**, cost £2. Offers. Approval.—Apply by letter to P. G., 4, Elizabeth-terrace, Garrett, Lower Tooting, S.W.

Model **Motor**, with battery, complete, cost 15s. 6d.; pair of Opera Glasses and full fount of Rubber-faced Type, in case; in exchange for Portrait Lens or Photo Apparatus.—J. Foyle, Jun., 1, Starch Green-road, London, W.

Double **Gun**, twist barrels, first-class condition; wanted in exchange, a good Iron Printing Press for handbills, also materials and type.—J. M. Stephenson, Cleckheaton.

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The English Mechanic
AND WORLD OF SCIENCE AND ART.
*FRIDAY, APRIL* 24, 1885.

## STEEL PLATES FOR BOILERS AND SHIPS.

THE loss of the new telegraph ship *Magneta*, which left the Thames early in March *en route* to Singapore, will do something to attract attention to the paper read by Mr. Parker at the recent meeting of the Institute of Naval Architects, for the assumption is that the vessel has foundered in consequence of a collision or through the bursting of one of her boilers. The *Magneta* has not been sighted or heard of since leaving the Channel; but one of her boats was seen 200 miles off Cape Finisterre, and appeared to have been properly lowered, though there was no apparent evidence of its having been occupied. There is too much reason to fear that this new, well-equipped, and well-found steamer has sunk with all hands on her maiden voyage. The vessel, which measured over 1,000 tons, was built of steel to Lloyd's rules, and was a sister vessel to the *Electra*, both being recent additions to the fleet of the Eastern Extension, Australasia, and China Telegraph Company, and both specially designed and fitted for the work of cable repairing. In fact, the *Magneta*, so far as human foresight can go, was as capable of battling with storms as any vessel that ever left port; and although there is great probability that she met with rough weather soon after clearing the Channel, there is no reason to suppose that she foundered from sheer inability to withstand a storm. Her engines were of the usual compound, surface-condensing, direct-acting type, capable of indicating 1,400 horse-power, and were supplied with steam by two single-ended cylindrical multitubular steel boilers, with three corrugated furnaces in each. She had, therefore, ample power for a vessel of her size; and it is not easy to suggest any probable cause for her loss and the total disappearance of her living freight beyond those above indicated. The vessel may, it is true, have been smothered by some terrific sea; but she was not overladen, or anything approaching it, and ought to have weathered any storm that she is likely to have encountered. Collision may have sent her to the bottom, and the other vessel as well; but even then we should expect that some of those on board would have saved themselves in the boats, of which there were six—two lifeboats, two cable cutters, hung in patent davits, a gig, and a dinghy. Most engineers will be loth to think that the *Magneta* was lost through a boiler explosion; but it is not impossible that some of the well-found and seaworthy steamers which have left port and have never been heard of again have foundered in consequence of a boiler explosion. The paper by Mr. Parker, of Lloyd's, above referred to, gave an account of some experience with thick steel boiler plates, and the discussion which followed it shows clearly that very little definite knowledge is available as to the cause of the peculiar behaviour of steel plates occasionally. An ordinary cylindrical marine boiler, 16ft. long and 13ft. in diameter, designed for a pressure of 150lb., burst under the hydraulic test when 240lb. was applied, the fracture extending completely across one of the shell plates, and to a slight extent also into the adjoining plate. The boiler was made by a firm having large experience with the material, and the steel came from works which enjoy the reputation of producing steel second to none in the country. The plates were all tested at the works, and fulfilled the requirements of Lloyd's Register and the Board of Trade; in fact, the sample from the plate stood a tensile strain of 29·6 tons per square inch with an elongation of 20 per cent. in a length of about 8in., whilst strips cut from it were bent almost double cold. The plate, however, was exceptionally large and heavy, being 20ft. long, 5ft. 6in. wide, 1¼in. thick, and weighed 2 tons 16cwt. In making up, all the holes were drilled, and the plate, after being heated in a furnace, was bent to the required curvature in a pair of vertical rolls. The plate, in fact, was treated exactly as other steel plates were and are treated, and yet it failed under a strain of less than one-fourth that sustained by the sample cut from it, the fracture indicating that the metal did not possess any ductility, stretch, or elongation whatever. So serious a result as that naturally produced considerable consternation, and the facts coming to the knowledge of the committee of Lloyd's Register, Mr. Parker was instructed to investigate the matter. On arriving at the boiler-making works he found a sister boiler, which was tested in his presence up to 300lb. and carefully gauged without exhibiting the least sign of deflection or yielding. An examination of the testing appliances showed that it was impossible for an abnormal pressure to be exerted, and as the metal had passed the mechanical tests, it became obvious that some change had been effected in its nature by the manipulations it had undergone in the boiler shop. Accordingly one of the plates was heated and bent in the presence of Mr. Parker, who noticed that the heat was far from uniform, one end being of a dark-red, or nearly black, heat, which gradually cooled down to a blue heat at the other end. The plate was then bent by passing it six times through the rolls, and by the time the operation was complete one end was nearly cold, while the other remained at a blue heat. Such unequal heating as that is believed to set up strains in the plate of a dangerous character, which are aggravated by rolling, and it is generally admitted that it is safer to work steel cold or red-hot than at any intermediate heat. Nothing definite, however, is known as to the intensity of the strains so set up; but from tests made with a number of pieces cut from the fractured plate it was proved that the metal ranged in tenacity from 29·5 to 33·1 tons, while the elongation varied from 21·8 to 28·1 per cent. in a length of 8in. As Mr. Parker says, a range of nearly 4 tons in the tensile strength of a plate of mild steel is very unsatisfactory; but when specimens of the plate were submitted to five independent metallurgists for analysis it was found that the carbon was high, ranging from ·26 to ·33, and that consequently the metal was capable of taking a temper and becoming hard and brittle. With the view of ascertaining the effects of rolling on the ductility and tenacity of such metal, a slab containing about the same amount of carbon as that found in the fractured plate was obtained from the works, and rolled at one heat down to ⅜in. in thickness. Such a slab, if rolled to 1¼in., would have given an estimated tenacity of 30 to 40 tons; but rolled to ⅜in. it was found that the tenacity had been increased to from 35 to 41 tons, with an elongation of from 21 to 24 per cent. in a length of 8in. Some pieces were then made hot and quenched in water, with the effect of sending up the tenacity to 44 and 45 tons, but reducing the stretch to nothing at all. Strips from the fractured plate heated and quenched broke short without any bend whatever. It seems, therefore, to follow that the plate which gave way must have become partially tempered by the heating and cooling to which it was subjected in order to roll it into the required form. The fact that the tenacity of such steel can be raised considerably by the amount of work put into it is well known: it has been increased as much as 50 per cent.; but great tensile strength is of no value at all if the metal is liable to take temper in the course of careless or ignorant annealing. It is doubtful whether there is any better material than mild steel for boiler plates, but it should have a very low percentage of carbon, and the plates after drilling should be thoroughly annealed. The bending into shape may be done either hot or cold; but if the former state is chosen care should be taken that the heating is uniform. As that cannot be always depended upon, some makers allow the plates to cool in the furnace, and when that has become cold they remove the plates and roll them into form cold. Steel makers are nearly all agreed that plates more than 1in. thick with a tenacity of more than 30 tons must contain so much carbon that they are unsuitable for boiler-making; and except amongst steel makers it does not seem to be known that the thicker the plate the more brittle and erratic in its behaviour it must become. The rules of Lloyd's Register require boiler plates to have a tensile strength of 26 to 30 tons per square inch, but the desire to use steam of higher pressures has brought to the Committee many requests from manufacturers and engineers to allow a strength of 32 tons. As the tendency is to use thicker and thicker plates it would seem to be advisable to put the limit at 30 tons and endeavour to insure the use of steel which cannot possibly become brittle under any treatment. Some manufacturers and engineers, however, contend that the mischief is done by putting work upon the plates when unequally heated. If plates of the kind are locally heated and allowed to cool no injury is done, but if, while it is locally heated, the form of the plate is changed so as to disturb its molecular arrangement, then internal strains are set up which may produce cracks. If there is so much risk in fashioning steel plates into the shape required it would seem advisable to limit that risk by insisting on the use of milder steel, and neglecting the demand of some makers for leave to use metal having a tenacity of 34 tons, although the fullest advantages from the use of steel are to be obtained only by lightening the structures. The makers of plates are rarely consulted by engineers as to the best sizes of plates to use: they are simply asked to supply plates of given dimensions, and do so as a matter of business without asking questions; but they know very well that the material they produce if worked when "blue hot" becomes treacherous. They also know that plates 1¼in. thick must contain more carbon than ⅜in. plates to give the same tensile strength. On the other side it is contended that a satisfactory steel can be produced which will have a tensile strength up to even 40 tons. In view of all the facts, or, rather, such facts as are available, it becomes a question whether the makers of marine boilers will not have to reform their patterns, and dispense with plates so thick as 1¼in. Referring to the article on the "explosive energy in steam boilers" on p. 421, last volume, it will readily be understood that a marine boiler is, from the volume of water it contains, a tremendously destructive engine if it should happen to fail when under a pressure of 100lb. on the square inch, and although there is little or no evidence to support the view, it is impossible to believe that boiler explosions never occur at sea. On the contrary, knowing as we do that land boilers do sometimes explode although they have previously passed satisfactory tests, there is ground at least for a suspicion that some of the steamers which have left port never to be heard of again have foundered in mid-ocean because they have been broken in two by the explosion of a boiler. Mild steel has also come into much favour for shipbuilding, and a very excellent material it is for the purpose; but because it has a high tensile strength there has been, in the opinion of many competent judges, too much haste to reduce thickness, and not a few vessels built of steel, or at least having steel plates, have exhibited unmistakable signs of dangerous straining. The subject deserves the serious attention of both the naval architect and the marine boiler maker, and it is improbable that recent events will pass unnoticed by those who regulate the dimensions of boiler plates and the scantlings of vessels.

## THE SPORTSMAN'S EXHIBITION.

THE Sportsman's Exhibition was opened at the Agricultural Hall on the 16th inst. The collection of boats of all kinds is, as usual, a good one, while carriage-building is still better represented. Guns are exhibited in great variety, from the great double-barrelled punt gun to the miniature rifle and the four-barrelled breech-loading hammerless pistol. Messrs. J. Platt and Co. exhibit a waterproof ventilated covert coat, which is so ingeniously arranged that the horseman can keep the driving rain from finding its way between the saddle and his thighs. That is managed by means of an "apron," buttoned inside. This garment is completed with a pair of waterproof gaiters, and certainly conveys the impression that nothing more can be wanted as protection against the weather. The angler will find a good display of rods and tackle, while at the stand of Messrs. Williams he will be able to examine what is said to be the only perfect rod-joint fitting, in the shape of a patent screw cap. Athletic sports, and indoor and outdoor games, are well represented, and there are several stands left from the Building Trades Exhibition, amongst which may be noted Messenger's portable greenhouses, which can be taken to pieces and removed as tenants' fixtures. The galleries are, as usual, occupied by "cycles," but, with the exception of one exhibit, where several "record" machines are shown, there is nothing very attractive or novel. The well-known patterns are shown mostly by agents, which, in one sense, is an advantage, as machines by different makers can be compared at the same stand. Holloway's improved wheel will attract some attention, as it is driven by tangential spokes in the plane of the rim. The two hubs of each wheel are kept apart by rods, and between them is a wheel with arms, which is fixed to the axle, and connected to the rim by spokes set at a tangent. This arrangement makes a very strong wheel, and the weight can be reduced, as only half the number of side spokes are required. The Metropolitan Machinists' Company exhibit several machines, which should be examined and compared with the prices charged. They include a safety roadster and a carrier tricycle. Burdess and Townsend exhibit some of their "Sterling" machines, with the new patent screw-steering device, a feature that is receiving some attention from other makers, and also one fitted with speed and power gear, which deserves the notice of those who reside in a hilly district. Such other novelties as are exhibited we have already described in our notice of the Stanley Club Show, which appeared in No. 1037.

## THE AMATEUR WORKSHOP. — VI.

### Planing Machines—Hand Gear.

FROM the numerous gears open to our choice one is rather puzzled which to adopt, for the number was by no means exhausted in our last article, since we did not so much as touch upon the link-driven machines, to which I hope to make some allusion after I have disposed of those actuated by cogwheels. In reference to these last, my intention is to describe first a hand-driven machine; then secondly I wish to show how the same machine may be driven by power gearing, and lastly how the two—hand and power gears—may be so combined that either may be employed at pleasure.

Taking up the hand gear in the present article, Fig. 55 shows it it in end view, A being the pinion, B the rack, C the pinion shaft, D the cross handle, and E, E the plummer blocks which form the spindle bearings. The pinion (Figs. 56, 57) has 11 teeth of $\frac{3}{4}$in. pitch, and its pitch diameter measures $2\frac{5}{8}$in., while the cross is 2ft. 3in. over. Assuming that the hands grasp it at a radius of one foot only, and exert a pressure of 15lb., we should have a force of

$$1\tfrac{5}{16}\text{in.} : 12 :: 15 : 137{\cdot}4\text{lb.}$$

acting at the pitch lines of the pinion and rack, which would be sufficient for such light cutting as a machine of this kind would be expected to accomplish. But 15lb. is a moderate estimate, since men of ordinary strength will exert a force of from 20lb. to 25lb. at continuous labour of this character; so that without increasing the size of the cross, a cutting force of 200lb. may be safely assumed as within the ordinary capability of this machine.

Then regarding the strength of the teeth. The pinion teeth are strongly drawn (Fig. 58), but are of necessity weaker than those of the rack. Still, these teeth, if made of cast iron of average strength, and unshrouded, would require a load of 204lb. acting at their points to break them off. But I have drawn them shrouded up to the pitch line, by which their strength is increased one half. Further, to ensure durability as well as an increase of strength, I should cast the pinion in gun metal or phosphor bronze, the last named to have the preference. Also note that the rack (Figs. 56 and 57) is shrouded to the pitch line in order that the regular motion of the teeth may be assisted by the frictional contact of the two shroudings. And to assist those who would be unable to strike out their own teeth, I have drawn them by rolling circles appropriate for strength and perfect working, and have given two teeth of both pinion and rack (Figs. 58, 59), to full size, with the centres for the flank curves.

I intended, in the first place, to have constructed the rack of the type shown in Fig. 52 p. 46; but I considered that it would be a little more troublesome to make, and since the table is fitted with outside angle-slides, its liability to tip is *nil*, if the loose strip is kept in place. The friction shrouding, in conjunction with the angle slides, will insure the absence of waviness in the cut, and of chatter in the table.

Since so much depends upon the smooth action of the rack and pinion, too much care cannot be taken with their patterns. The pinion will be made in three pieces (Fig. 57), the body A, the top and bottom shrouds B, C. The body will be turned out of a bit of dry solid mahogany to $3\frac{3}{32}$in. diameter, that being the diameter measured outside the points of the teeth, by 2in. in thickness, the grain of the wood to run with the teeth. It may be chucked between centres, but the better way is to turn it upon the face chuck. This allows of the more ready marking out of the striking lines, and it is also convenient for the boring of a shallow recess upon each face for the reception of studs, fig. 57, D, turned upon the shrouds; the shrouds being of necessity left loose from the toothed body for moulding, yet requiring to be maintained truly central. When turning, therefore, face one side, and strike upon it in the lathe the outer diameter $= 3\frac{3}{32}$in., the pitch line $= 2\frac{5}{8}$in., and the circle of the roots $=$ 2in. Then bore the shallow recess, say 1in. diameter, turn the outside, allowing as much taper only as can be detected by the calipers, and re-chuck by means of the recess, in order to face the other side. That also will receive its lines, and be recessed in like fashion.

Upon one side divide the $2\frac{5}{8}$in., or pitch circle, into eleven points of equal division $=$ the pitch $\frac{3}{4}$in. Draw lines from the centre through the pitch points to the outside of the pinion in two or three places, and square them over to the side opposite, which lines will form the starting points for dividing out the pitch centres upon that side also. Set the spring dividers to the half-width of tooth, and from each pitch point as a centre mark the width of all the teeth in succession (Fig. 58). Strike the roots with a $\frac{1}{4}$in. radius, whose centre is on the circle formed by the points of the teeth; holding a slip of wood curved to the radius of that circle against it, to prevent the divider-leg from slipping. Strike the points with a $\frac{9}{16}$in. radius, whose centre is on the pitch line. Make no difference in the setting of the dividers for the thickness of the teeth for either side of the wheel, since sufficient taper can be imparted to so shallow a pattern in the glasspapering. A hollow is worked in the roots for increase of strength.

Saw out the spaces between the teeth roughly with a tenon saw, and work with a chisel and paring gouge, using a small mahogany straightedge, of about 5in. or 6in. in length, by $\frac{1}{4}$in. thick and $\frac{3}{8}$in. wide only, so that it will slide between the teeth, the straightedge to be coloured with chalk or red lead. The aim should be to work the flanks of the teeth so level that the chalk should whiten almost the entire surface from end to end before resorting to glasspaper. The glasspaper should not be regarded as aiding in any degree in the getting the teeth straight or to shape, but as simply rubbing down the last asperities left by the edge tools. The sides of the teeth should be checked with the trying square, or else with a set square tried up from a level block, upon which the pinion is laid, and if the teeth are square and straight, no taper need be given to so shallow a wheel. I should put none at all in this instance, the better to insure continuous contact along the flanks.

The shrouds, fig. 57, D, are both turned to $2\frac{3}{4}$in. diameter, which allows of $\frac{1}{8}$in. for cleaning up in the casting; their studs fit easily in the recesses at each end of the pinion, and a $\frac{3}{4}$in. print on one or both of them indicates the size of the central core.

The pattern of the rack (Figs. 56, 57, 59, 60), will be made from a straight-grained piece of mahogany planed to 2ft. $1\frac{1}{2}$in. by 2in. by $1\frac{7}{16}$in.; hence the teeth will be cut from the solid—not necessarily however, since they could as well be fastened on. The pitch line, and the two striking lines, and the root-line (Fig. 59), will be gauged from one face upon both edges, and the teeth centres pitched out and squared over. The flanks will be struck with a $1\frac{3}{16}$in. radius from the line A, Fig. 59, the faces with a $\frac{5}{8}$in. radius from the line B, and the working-out will be performed as before.

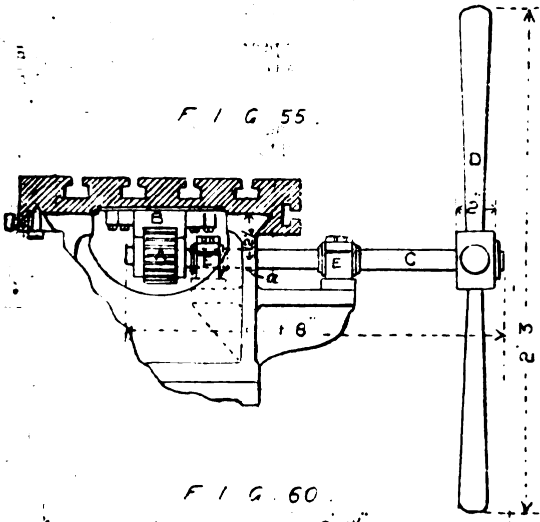
Two strips, each 2ft. $1\frac{1}{2}$in. by $1\frac{1}{4}$in. by $\frac{3}{8}$in., will be screwed upon the sides to form the half-shrouding, and six lugs (A, A, Figs. 57 and 60), $\frac{3}{4}$in. thick, and of the shape and size there indicated, will be attached to these for bolting to the underside of the table. Two will be fastened on near each end, their centres being $\frac{3}{4}$in. in and two in the exact centre.

The form of bearing which I propose employing for the pinion shaft is drawn in fig. 61, the simple boss in fig. 62, and either of these may be selected, a slight modification of the tappet lever being necessary in the different bearings. In reference to the bearing pattern I need say little, since the dimensioned views are plain enough. The semicircular portion of the block, and also that of the cap, will be cut out to $\frac{3}{4}$in. diameter, and if the shouldered portions of the cap which come within the block are made a tight fit in the patterns, the castings will be sufficiently full to allow of a little filing. The collars A A, which increase the length of bearing, are abutted together in halves, and glued on the face-plate with a paper-joint for turning. These must be put loosely upon the bearing-pattern with skewers, but they will be better fastened upon the cap. The cores for the ┳-headed bolts will be set in round prints, and a core-box will be necessary. Or simple studs screwed to a depth of about $\frac{3}{4}$in. may be used instead of bolts. The holes B B should be drilled for the tight-fitting bolts. The bearing will be bored while held on an angle-plate bolted to the face-chuck of a lathe. An oil-hole will be drilled in each cap.

After these are bored it is essential that they be set parallel upon the bracket facings prepared for their reception. The bearing feet and the bracket-facings will be first filed and checked, independently of one another. Recesses will be chipped out upon the brackets to take the joggle pieces on the bottoms of the blocks. Then both will be compared together, and adjusted, until the bearing-centres measure exactly $2\frac{1}{4}$in. below the top of the bearers of the bed. To check this dimension, lay a narrow straightedge of steel or wood along the bottom of the bored hole, and try its parallelism by measurement from another straightedge laid over the top of the bearers; in this case the distance would be $2\frac{1}{4}$in. plus $\frac{3}{8}$in. to the bottom of the bore. Of course, before this can be done, the hole A, Fig. 55, must be drilled through the side of the bed for the spindle, and as this is not a bearing it may be drilled to $1\frac{1}{8}$in.

The spindle should be at exact right angles with the sides of the bed, and the truth of the bearings in this direction may be tested by straining a fine cord from corresponding edges of the bores within and without, and then placing a straight-edge square across the bed just over the cord and sight down, when a slight departure from parallelism will be apparent. When satisfactory results are obtained $\frac{1}{4}$in. bolt-holes can be drilled

FIG 55.



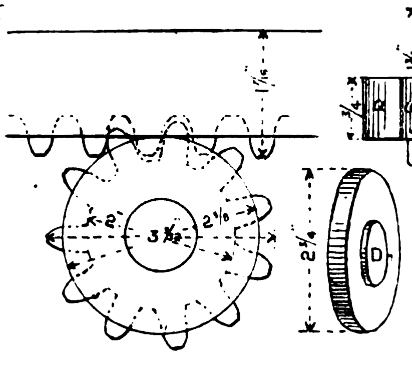


FIG. 56.

FIG. 57.

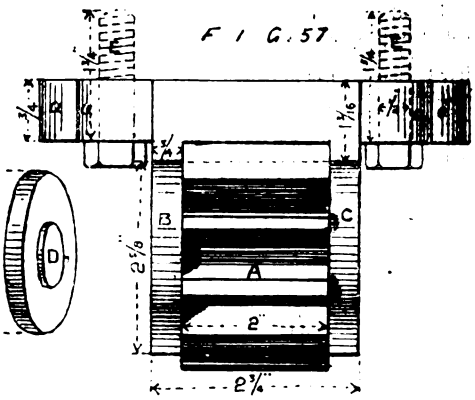
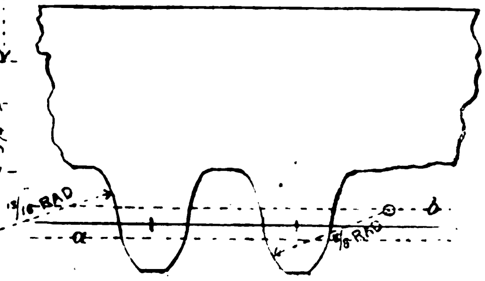


FIG 59



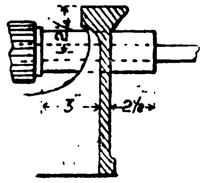


FIG. 62.

FIG 60.

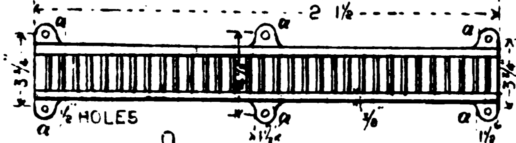


FIG. 63

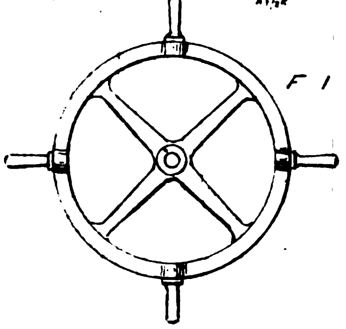


FIG. 58.

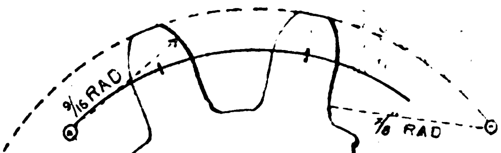


FIG 66.

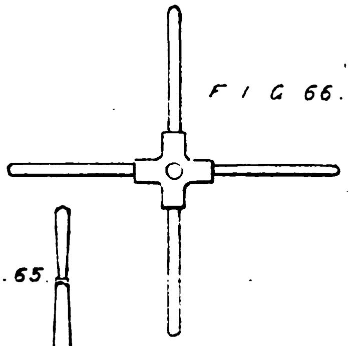


FIG. 65.

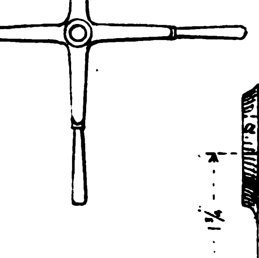


FIG. 64.

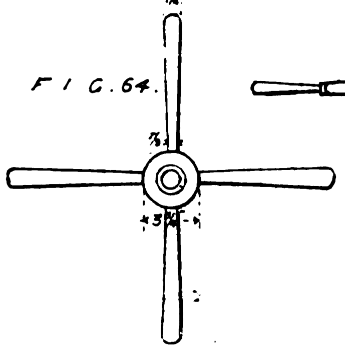
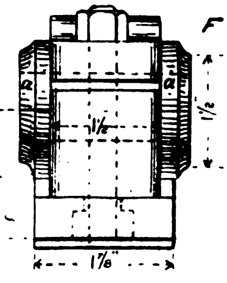
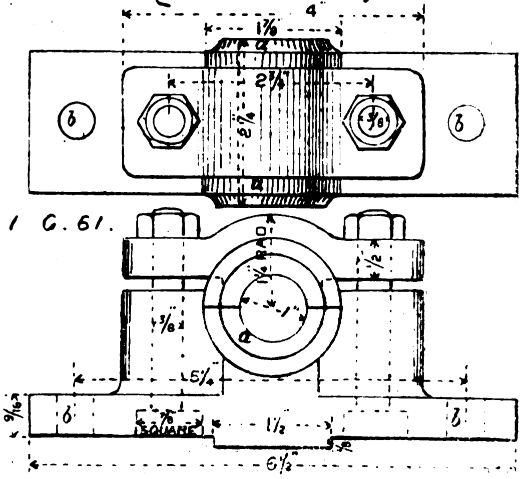


FIG. 61.





at the centres marked, Fig. 61, through blocks and brackets simultaneously, the blocks being cramped in position. Or drill through the blocks first, the holes being marked thence on to the brackets.

Supposing that, instead of the plummer blocks, the bosses shown in Fig. 62 are used, as giving less trouble, the marking of the centre must be done from the top of the bed as before, and the bed placed under a drilling machine. A twist-drill also should be employed for a deep hole, where much accuracy is required. But if a ratchet-brace only can be employed, the labour would be lessened, if the hole were first cast to ¾in. or ⅞in. diameter; but then if it happens to be out of truth, the drill will follow it. In that case the only course is to file the hole fairly true, and nearly to size, and then broach it out. This simply means taking a little more time over the job.

We will now get the castings of the pinion, and the rack, and fit them up. No chipping ships were put upon the back of the latter, but we have five strips instead upon the under-side of the table (Fig. 8, p. 468, Vol. XL.) These strips will now be reduced to ⅛in. thick, and a steady bearing secured thereon for the rack, the filing being continued until the points of the teeth measure exactly 1 3/16in. from those faces of the table which run upon the bearers.

From the tooth points also measure back ¼in. bare, and mark the pitch-lines on both shroudings with a scribe. File or plane those edges to the scribed lines, and check those also with the sliding faces of the table. They should measure uniformly 1⅛in. full from those faces.

The next point is to set the rack sideways, and drill the holes for the set screws, Fig. 60. Its position will be in the centre of the table, and parallel with its edges. A ½in. clearing-hole will be wanted in each lug, ½in. tapping-holes being drilled in the table to centres marked off from the holes in the lugs, and tapped to receive six set-screws to the dimensions of Fig. 57, E E. The rack may then be screwed in place.

The pinion will be bored to 1in. in the lathe, and the shrouds will be turned to 2⅝in. diameter, and one shroud (the inner one) should be faced to run against the bearing. A keyway, ¼in. by ⅛in. will be filed, and a shouldered steel key made, to drive in from the unfaced end of the pinion. A steel spindle, 1ft. 8½in. long, and turned through its whole length to 1in. diameter, will receive the pinion at one end, and the cross-handle at the other, both alike being keyed on.

Since both the pinion and the rack teeth are 2in. wide and half shrouded, the ends of each will need a little easing, to allow of their free working between the shrouding. This easing will be done with a file.

A cast-iron hand wheel having handles screwed into its rim (Fig. 63), has a neat appearance, but involves the making of a special pattern. while the cross, (Figs. 55 and 64), can be made without this trouble. The cross might be made in one of three ways. Thus a smith would make it easiest as a forging welded together and trimmed up afterwards (Fig. 65), a moulder would find it easier to cast four plain wrought-iron rods into a central socket boss (Fig. 66), while a fitter or turner would prefer to turn four handles and screw them into a plain centre of cast or wrought iron (Fig. 64). In either case, the work is of the simplest character.

In the first instance, Fig. 65, the two pieces forming the cross arms would be welded one on the other, the boss being done at a second heat. In the second (Fig. 66), the pattern of the boss piece would have four round points about 3 or 4 inches long, fastened on at the centres of the rods, to indicate their position in the mould, and those portions of the rods inclosed by the bosses would be "jagged" (Fig. 67), to prevent loosening. In the third the ends of the turned handles are screwed into the boss to a depth of about ¾in., a flat being filed or bored to a slight depth to give bearing surface. In either case a hole will be bored, and keyway filed, and steel key made similar to that for the pinion.

Before the pinion is finally keyed on, the caps of the bearings will be loosened, the shaft thrust through from the outside, the table run to one end out of the way, and the pinion slipped over its proper end, and there keyed. The table may then be brought back, when its rack teeth will engage with those of the pinion.

# ASTRONOMICAL NOTES FOR MAY, 1885.

### The Sun.

| Day of Month. | Souths. | At Greenwich Mean Noon. | | |
|---|---|---|---|---|
| | | Right Ascension. | Declination North. | Sidereal Time. |
| | h. m. s. a.m. | h. m. s. | ° ′ ″ | h. m. s. |
| 1 | 11 56 55·73 ,, | 2 35 15 | 15 12 38 | 2 38 18·79 |
| 6 | 11 56 25·70 ,, | 2 54 27 | 16 39 33 | 2 58 1·56 |
| 11 | 11 56 10·18 ,, | 3 13 55 | 17 59 36 | 3 17 44·33 |
| 16 | 11 56 9·32 ,, | 3 33 36 | 19 12 7 | 3 37 27·11 |
| 21 | 11 56 22·32 ,, | 3 53 32 | 20 16 31 | 3 57 9·89 |
| 26 | 11 56 48·08 ,, | 4 13 41 | 21 12 15 | 4 16 52·67 |
| 31 | 11 57 25·69 ,, | 4 34 1 | 21 58 51 | 4 36 35·45 |

The method of finding the Local Sidereal Time at Mean Noon at any other Station will be found on p. 355 of Vol. XL.

Spots and faculæ continue to appear on the disc of the Sun, although, as previously stated, the period of maxima has now definitely passed.

After May 22nd there will be no real night in any part of the British Islands.

### The Moon

Enters her Last Quarter at 8h. 43m. on May 7th, and is New at 3h. 17·5m. in the afternoon on the 14th. She will enter her First Quarter at 5h. 45·1m. in the early morning of the 21st, and be Full at 8h. 30·9m. p.m. on the 28th.

| Day of Month. | Moon's Age at Noon. | Souths. |
|---|---|---|
| | Days. | h. m. |
| 1 | 16·3 | 1 24·2 a.m. |
| 6 | 21·3 | 5 20·0 ,, |
| 11 | 26·3 | 9 12·5 ,, |
| 16 | 1·9 | 1 52·1 p.m. |
| 21 | 6·9 | 6 35·6 ,, |
| 26 | 11·9 | 10 32·3 ,, |
| 31 | 16·9 | 1 42·8 a.m. |

The Moon will be in conjunction simultaneously with Mercury and Mars at 4 a.m. on the 13th; with Venus at 6 o'clock the next evening; with Saturn at 3 p.m. on the 16th; and with Jupiter at 3 a.m. on the 21st.

### Mercury

Is a Morning Star throughout the month, attaining his greatest elongation from the Sun West (21° 45′) at 1 p.m. on the 25th. In one sense he is not particularly well placed for the observer, inasmuch as he does not rise sufficiently long before the Sun to be readily caught with the naked eye. His angular diameter diminishes from 12″ on the 1st to 7·2″ by the last day of May.

| Day of Month. | Right Ascension. | Declination North. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 2 14·3 | 13 23·4 | 11 36·0 a.m. |
| 6 | 2 6·5 | 11 15·7 | 11 8·6 ,, |
| 11 | 2 4·5 | 9 56·3 | 10 47·0 ,, |
| 16 | 2 9·3 | 9 37 6 | 10 32·1 ,, |
| 21 | 2 20·3 | 10 16·1 | 10 23·4 ,, |
| 26 | 2 36·9 | 11 41·7 | 10 20·3 ,, |
| 31 | 2 58·7 | 13 43·9 | 10 22·4 ,, |

This curious-looped path of Mercury lies wholly in a barren region in Aries. Mercury will be in conjunction with Mars at 9 a.m. on the 13th, and again at 9 p.m. on the 30th.

### Occultations of (and a near approach to) Fixed Stars by the Moon.

| Day of Month. | Name of Star. | Mag. | Disappearance. | Moon's Limb. | Angle from N. Point. | Angle from Vertex. | Reappearance. | Moon's Limb. | Angle from N. Point. | Angle from Vertex. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | h. m. | | ° | ° | h. m. | | ° | ° |
| 2 | 29 Ophiuchi | 6 | 3 14 a.m. | Bright | 52 | 62 | 4 22 a.m. | Dark | 301 | 321 |
| 11 | 44 Piscium | 6 | †3 27 ,, | | 199 | 160 | | | | |
| 16 | 130 Tauri | 6 | 6 31 p.m. | Dark | 96 | 137 | 7 27 p.m. | Bright | 257 | 298 |
| 19 | α Cancri | 4 | 10 52 ,, | Dark | 9 | 48 | 11 15 ,, | Bright | 320 | 359 |
| 20 | B.A.C. 3407 | 6 | 12 21 ,, | Dark | 86 | 125 | ‡1 12 a.m. | Bright | 240 | 276 |
| 21 | 35 Sextantis | 6 | 8 48 ,, | Dark | 2 | 26 | 9 18 p.m. | Bright | 312 | 340 |
| 28 | θ Libræ | 4½ | 2 10 a.m. | Dark* | 123 | 148 | 3 4 a.m. | Bright | 222 | 283 |

† A near approach. ‡ Moon has set. * But seemingly bright.

### Jupiter's Satellites.

| Day of Month. | Satellite. | Phenomenon. | H. | M. | S. | Day of Month. | Satellite. | Phenomenon. | H. | M. | S. | Day of Month. | Satellite. | Phenomenon. | H. | M. | S. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | II | Tr I | 11 | 5 | P.M. | 10 | II | Oc D | 8 | 46 | P.M. | 21 | I | Tr I | 9 | 41 | P.M. |
| 2 | II | Sh I | 1 | 33 | A.M. | 12 | *II* | *Sh E* | 8 | 23 | ,, | 21 | I | Sh I | 10 | 57 | ,, |
| 2 | *II* | *Tr E* | 2 | 1 | ,, | 13 | *I* | *Tr I* | 1 | 17 | A.M. | 21 | I | Tr E | 12 | 1 | ,, |
| 2 | *III* | Tr I | 8 | 3 | P.M. | 13 | IV | Oc D | 9 | 58 | P.M. | 22 | IV | Sh E | 10 | 4 | ,, |
| 2 | III | Tr E | 11 | 43 | ,, | 13 | I | Oc D | 10 | 25 | ,, | 22 | I | Ec R | 10 | 22 | 55,, |
| 3 | III | Sh I | 1 | 5 | A.M. | 13 | III | Ec R | 10 | 35 | 42,, | 26 | *II* | *Tr I* | 8 | 10 | ,, |
| 3 | II | Ec R | 11 | 35 | 17 P.M. | 14 | *I* | *Tr I* | 7 | 46 | ,, | 26 | II | Sh I | 10 | 41 | ,, |
| 5 | *I* | *Oc D* | 2 | 3 | A.M. | 14 | I | Sh I | 9 | 3 | ,, | 26 | II | Tr E | 11 | 6 | ,, |
| 5 | I | Tr I | 11 | 24 | P.M. | 14 | I | Tr E | 10 | 6 | ,, | 27 | III | Oc D | 9 | 57 | ,, |
| 5 | IV | Sh I | 11 | 37 | ,, | 14 | I | Sh E | 11 | 22 | ,, | 28 | *II* | *Ec R* | 8 | 39 | 13,, |
| 5 | I | Sh I | 12 | 39 | ,, | 15 | *I* | *Ec R* | 8 | 27 | 49,, | 28 | I | Tr I | 11 | 37 | ,, |
| 6 | *I* | *Tr E* | 1 | 44 | A.M. | 17 | II | Oc D | 11 | 21 | ,, | 29 | *I* | *Oc D* | 8 | 46 | ,, |
| 6 | I | Oc D | 8 | 32 | P.M. | 19 | *II* | *Sh I* | 8 | 4 | ,, | 29 | *I* | *Ec R* | 12 | 18 | 3,, |
| 6 | I | Ec R | 12 | 4 | ,, | 19 | *II* | *Tr E* | 8 | 26 | ,, | 30 | *I* | *Tr E* | 8 | 25 | ,, |
| 7 | *I* | *Tr E* | 8 | 12 | ,, | 19 | II | Sh E | 10 | 59 | ,, | 30 | *IV* | *Cc R* | 8 | 56 | ,, |
| 7 | I | Sh E | 9 | 27 | ,, | 20 | III | Oc R | 9 | 33 | ,, | 30 | I | Sh E | 9 | 40 | ,, |
| 9 | *II* | *Tr I* | 1 | 38 | A.M. | 20 | III | Ec D | 11 | 10 | 36,, | 31 | III | *Sh E* | 8 | 36 | ,, |
| 9 | III | Tr I | 11 | 56 | P.M. | 20 | *I* | *Oc D* | 12 | 21 | ,, | | | | | | |

Ec Eclipse; Oc Occultation; Tr Transit of Satellite; Sh Transit of Shadow; D Disappearance; R Reappearance; I Ingress; E Egress. The printing of a phenomenon in *italics* indicates that its visibility is rendered doubtful, either by the brightness of the twilight or by Jupiter's proximity to the horizon.

### Venus,

Coming as she does into superior conjunction with the Sun at 5 p.m. on the 4th, is actually invisible during the earlier part of May, and practically so during the whole of it; though, even could she be seen, her minute circular disc subtending an angle of 9·6″ only, would present a singularly uninteresting spectacle in the telescope.

| Day of Month. | Right Ascension. | Declination North. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 2 33·0 | 14 18·5 | 11 54·7 a.m. |
| 6 | 2 57·1 | 16 8·8 | Behind the Sun. |
| 11 | 3 21·8 | 17 58·9 | 0 4·0 p.m. |
| 16 | 3 46·9 | 19 37·3 | 0 9·4 ,, |
| 21 | 4 12·4 | 21 2·6 | 0 15·2 ,, |
| 26 | 4 38·4 | 22 13·3 | 0 21·5 ,, |
| 31 | 5 4·8 | 23 8·3 | 0 28·2 ,, |

It will be seen from the above Ephemeris that Venus travels over a good deal of Aries, and about half-way across Taurus.

### Mars,

For the purpose of the observer, is invisible. Of the Minor Planets,

### Ceres

Is rapidly approaching the West. We give, as usual, her places at intervals of ten days.

| Day of Month. | Right Ascension. | Declination North. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 12 50 7 | 9 49·3 | 10 10·7 p.m. |
| 11 | 12 46·0 | 9 18·2 | 9 26·8 ,, |
| 21 | 12 43·7 | 8 29·1 | 8 45·1 ,, |
| 31 | 12 43·8 | 7 25·0 | 8 5·8 ,, |

Starting thus from a point to the South-West of ε Virginis, Ceres travels in a retrograde direction away from that star.

### Pallas

Is nearer the West still.

| Day of Month. | Right Ascension. | Declination North. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 11 42·7 | 18 36·9 | 9 2·9 p.m. |
| 11 | 11 44·7 | 19 31·6 | 8 25·5 ,, |
| 21 | 11 49·0 | 19 55·6 | 7 50·5 ,, |
| 31 | 11 55·2 | 19 54·7 | 7 17·4 ,, |

The path thus indicated carries Pallas from a point some 3° North of β Leonis into the confines of Coma Berenices.

### Juno

Souths a little later on, and is, *pro tanto*, rather better placed for the observer.

| Day of Month. | Right Ascension. | Declination North. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 13 40·2 | 1 55·2 | 11 0·1 p.m. |
| 11 | 13 33·6 | 2 38·1 | 10 14·2 ,, |
| 21 | 13 28·6 | 3 4·3 | 9 29·9 ,, |
| 31 | 13 25·4 | 3 13·8 | 8 47·3 ,, |

The above Ephemeris shows that the short retrograde arc described by Juno lies wholly in a barren region in Virgo.

### Jupiter,

Too, is approaching the West, and must be looked at as soon as it is dark enough. His angular diameter decreases from 36·4″ to 33·4″ during the month, and he will be in quadrature with the Sun at 3 p.m. on the 17th. Of course, he is at vastly too great a distance from the earth to exhibit phases; but the careful observer with adequate telescopic power may now note a perceptible *shading* on that limb of the planet furthest from the sun.

### Jupiter.

| Day of Month. | Right Ascension. | | Declination North. | | Souths. | | |
|---|---|---|---|---|---|---|---|
| | h. | m. | ° | ′ | h. | m. | |
| 1 | 9 | 54·6 | 13 | 58·1 | 7 | 15·1 | p.m. |
| 6 | 9 | 55·3 | 13 | 53·5 | 6 | 56·1 | ,, |
| 11 | 9 | 56·3 | 13 | 47·5 | 6 | 37·5 | ,, |
| 16 | 9 | 57·5 | 13 | 40·1 | 6 | 19·1 | ,, |
| 21 | 9 | 59·1 | 13 | 31·3 | 6 | 0·9 | ,, |
| 26 | 10 | 0·8 | 13 | 21·1 | 5 | 43·0 | ,, |
| 31 | 10 | 2·8 | 13 | 9·7 | 5 | 15·3 | ,, |

So that Jupiter, starting from that part of Leo a little to the North of Regulus, travels in the direction of that Star, and will be found less than a degree North of it on the last night in May.

### Saturn,

Rising and Southing now in bright sunshine, may be held to have left us, for all purposes of the observer, until the autumn.

### Uranus

Souths not long after 9 p.m. at the beginning of May, and towards the end of it is on the meridian in twilight. Hence, he should be looked for as soon after dark as may be. His angular diameter decreases quite insensibly from 4″ to 3·8″ between the first and last days of the month.

| Day of Month. | Right Ascension. | | Declination North. | | Souths. | | |
|---|---|---|---|---|---|---|---|
| | h. | m. | ° | ′ | h. | m. | |
| 1 | 11 | 58·7 | 0 | 58·6 | 9 | 18·9 | p.m. |
| 6 | 11 | 58·2 | 1 | 1·7 | 8 | 58·7 | ,, |
| 11 | 11 | 57·8 | 1 | 4·2 | 8 | 38·6 | ,, |
| 16 | 11 | 57·4 | 1 | 6·3 | 8 | 18·6 | ,, |
| 21 | 11 | 57·1 | 1 | 7·9 | 7 | 58·6 | ,, |
| 26 | 11 | 56·9 | 1 | 9·0 | 7 | 38·7 | ,, |
| 31 | 11 | 56·8 | 1 | 9·6 | 7 | 19·0 | ,, |

This almost imperceptible retrograde path lies to the West of η Virginis, and trends in a direction beneath β in Virgo.

### Neptune

Comes into conjunction with the Sun at 4 p.m. on the 13th, and is, of course, wholly invisible.

### Shooting Stars

Are very uncommon in May. The night of the 18th is the likeliest one on which to watch for them with any prospect of being rewarded.

### Greenwich Mean Time of Southing of Ten of the Principal Fixed Stars on the Night of May 1st, 1885.

| Star. | Souths. h. | m. | s. | |
|---|---|---|---|---|
| δ Crateris | 8 | 33 | 54·16 | p.m. |
| β Leonis | 9 | 3 | 25·25 | ,, |
| β Corvi | 9 | 48 | 27·66 | ,, |
| α Canum Venaticorum | 10 | 10 | 41·60 | ,, |
| Spica Virginis | 10 | 39 | 6·61 | ,, |
| η Ursæ Majoris | 11 | 2 | 54·82 | ,, |
| Arcturus | 11 | 30 | 14·81 | ,, |
| α Libræ | 12 | 4 | 15·82 | ,, |
| α Coronæ | 12 | 49 | 26·00 | ,, |
| α Serpentis | 12 | 58 | 11·78 | ,, |

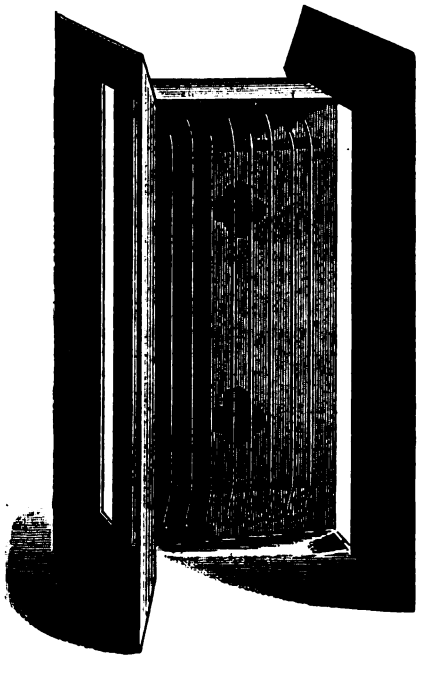
The method of finding the Greenwich Mean Time of Southing of either of the Stars in the above list for any other night in May, as also that of determining the local instant of its Transit at any other Station, will be found on p. 356 of Vol. XL.

## THE ÆOLIAN HARP.

THE following description of the Æolian harp with illustration of an improved form is extracted from an article in *La Nature*:—According to a generally credited opinion, it is to Father Kircher, who devised so many ingenious machines in the seventeenth century, that we owe the first systematically constructed model of an Æolian harp. We must add, however, that the fact of the spontaneous resonance of certain musical instruments when exposed to a current of air had struck the observers of nature in times of remotest antiquity.

Without dwelling upon the history of the Æolian harp, we may say that in modern times this instrument has been especially constructed in England, Scotland, Germany, and Alsace. The Æolian harp of the Castle of Baden Baden, and those of the four turrets of Strasburg Cathedral are celebrated.

We shall first describe Kircher's harp, which this Jesuit savant constructed according to an observation made by Porta in 1558. The instrument consists of a rectangular box, the sounding board of which, containing rose-shaped apertures, is provided with a certain number of strings stretched over two bridges and fastened to pegs at the extremities. This box carries a ring that serves for suspending it. Kircher recommends that the box be made of very sonorous fir wood, like that employed in the construction of stringed instruments. He would have it 1·085 metre (43in.) in length, 0·434 metre (17in.) in width, and 0·217 metre (9in.) in height, and would provide it with fifteen catgut strings, tuned, not like those of other instruments to the third, fourth, or fifth, but all in unison or to the octave, in order, says he, that its sound shall be very harmonious. The experiments of Kircher showed him the necessity of employing a sort of concentrator in order to increase the force of the wind, and to obtain all the advantage possible from the current of air that was directed against the strings. The place where the instrument is located should not, according to him, be exposed to the open air, but must be a closed one. The air, nevertheless, must have free access to it on both sides of the harp. The force of the wind may be concentrated upon such a point in different ways; either, for example, by means of conical channels, or spiral ones like those used for causing sounds to reach the interior of a house from a more elevated place, or by means of a sort of door. These latter, two in number, are adapted to a kind of receptacle made of boards, and presenting the appearance of a small closet. In the back part of this receptacle there is a slit, and in front of this the harp is hung in a slightly oblique position. The whole posterior portion of the apparatus must be situated in the apartment, while the doors must remain outside the window. In later times the Æolian harp has been improved by Messrs. Frost and Kastner, whose apparatus is represented in the figure. It consists of a rectangular box with two sounding boards, each provided with eight catgut strings. In order to limit the current of air and to bring it with more force against the strings, two wings are adapted near the thin surfaces opposed to the wind, so that the current may reach each group of cords on passing through the narrow aperture between the obliquely inclined wing and the body of the instrument. The dimensions of the resonant box are as follows: height, 1·28 metre (50½in.); width, 0·27 metre (10½in.); and thickness, 0 075 metre (3in.). Distance between the two bridges, or length of the sonorous portion of the cords, about 1 metre (39·3in.); width of the wings, 0·14 metre (5½in.). Distance between the sounding board and the wings, 0 42 metre (16½in.). Inclination of the wings, 50 degrees.



The celebrated Æolian harps of the old castle of Baden Baden are entirely different, and merit description. One of them is formed of a resonant box, the construction of which differs from that of Æolian harps with a rectangular box, in that it is prolonged beyond the place occupied by the strings, and is rounded off behind. In the opposite side there are two long and narrow apertures. To prevent the apparatus from being injured by the weather, it is inclosed in a sort of case occupying the recess of the window in the old ruined castle in which it is exposed. Behind the harp there is a wire lattice door, the purpose of which seems to be to protect the instrument against the attempts of robbers or the indiscreet contact of tourists.

## COLOURED LACQUERS.

LACQUERS are frequently required to be coloured, either yellow or red tints. For yellow tints turmeric, Cape aloes, saffron, or gamboge are employed; for red tints, annatto and dragon's blood are used—the proportions being varied according to the colour required. Thus, for a pale yellow, about 1oz. of gamboge and 2oz. of Cape aloes are powdered and mixed with 1lb. of shellac. For a full yellow, ½lb. of turmeric and 2oz. of gamboge, and for a red lacquer, ½lb. of dragon's blood and 1lb. of annatto. The colour is also modified by that of the lac employed, the best pale or orange shellac being used for light-coloured lacquers, and dark-coloured shellac or seed-lac is used for the darker tints. For pale lacquers, sandarac is sometimes used with the shellac. Thus a pale gold-coloured lacquer is made with 8oz. of shellac, 2oz. of sandarac, 8oz. of turmeric, 2oz. of annatto, and ¼oz. of dragon's blood to one gallon of methylated alcohol. The most convenient method, however, of colouring lacquers, is to make a saturated solution of spirit in each of the colouring matters, and to add the solutions in different proportion to the pale lacquer according to the tint required; but the whole of the colouring matters are not generally used by the same makers, and solutions of turmeric, gamboge, and dragon's blood afford sufficient choice for ordinary purposes. The turmeric gives a greenish-yellow tint, and with the addition of a little gamboge, is the colouring matter employed in making the so-called green lacquer used for bronzed works. Another mode of making lacquer: Four ounces of shellac and ¼oz. of gamboge are dissolved by agitation, without heat in 25oz. of pure pyro-acetic ether. The solution is allowed to stand until the gummy matters not taken up by the spirit subside; the clear liquid is then decanted, and when required for use is mixed with eight times its quantity of spirit. In this case, the pyro-acetic ether is employed for dissolving the shellac, in order to prevent any but the purely resinous portions being taken up, which is almost certain to occur with ordinary spirit, owing to the presence of water; but if the lacquers were made entirely with pyro-acetic ether, the latter would evaporate too rapidly to allow time for it to be equally applied.

## HOW AN AMATEUR CAN MAKE A HIGHLY-SENSITIVE GELATINE EMULSION.*

FOR the benefit of those for whom this is written, I will give Dr. Eder's emulsion formula, with my method of working:—Dissolve 24 grammes of pure air-dried potassium bromide in 300cc. of distilled water, 30 to 45 grammes of gelatine are introduced, and the whole, after soaking half an hour, is placed in a water-bath at a temperature of 35° C. to 45° C. (95°—113° Fahr.) till the gelatine has dissolved and become clear; then take 30 grammes of silver nitrate and dissolve in 300cc. of water, and add ammonia drop by drop, stirring all the time, till the precipitate formed is re-dissolved, and the liquid becomes perfectly clear. The above operation can be performed in daylight. Now, by a weak ruby light, add the silver solution to the gelatine, a third at a time, and shake vigorously between each addition, and allow to cool down to 35° C. (95° Fahr.); shake again after the whole of the silver has been added, and at intervals; and rinse out remains of silver with 50cc. of water. Then replace the bottle in the water-bath, which should be at a temperature not exceeding 35° C., let it remain for an hour, allowing the water in the bath at the same time to cool down gradually. The temperature may be allowed to sink as low as 25° C. (77° Fahr.) without any fear of the gelatine setting; but the quantity of water should be sufficient to prevent the temperature falling lower. In this method the chemicals used should be the best procurable. The temperature should never exceed 40° C. (104° Fahr.) in the preparation of this emulsion, or fog will be sure to follow. When it has digested the required time, it is poured out into a large dish to set and to cool for a couple of hours, or a larger dish may be partly filled with water, and the one with emulsion placed in it to hasten its setting. After it is thoroughly set, squeeze it through coarse canvas with meshes about 2 to 3mm. apart into a large bowl of water, and well stir. Have a box about 1ft. square by 4in. deep covered with fine muslin or linen, so that the water may be poured out of bowl into box, which will let all water through, but retain the small particles of emulsion. Repeat the washing four or five times, for here lies the resulting rapidity of the plates. After well washing, allow to drain well, for it contains an excess of water which must be got rid of. After well draining, it is put into a bottle, dissolved, and filtered through chamois leather; it is then ready for coating the plates.

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* By E. G. Wales, extracted from the *Photographic News*.

I will now give a description of the articles I use for heating, filtering, coating, &c. A zinc tray, 18in. long by 9 broad by 5 deep, with funnel soldered in near left-hand corner, to stand ½in. above the level of tray, so as to prevent any water accidentally going down into jugs whilst filtering. In this zinc funnel I place a glass—one which has a chamois leather spread over. The heat of the water in tray is sufficient to cause the emulsion to filter through rapidly. I have a box let into the dark-room from outside, which has a flange 4in. deep all round for the purpose of nailing it to the partition; on one side it has a hole 6in. square cut out, and a small box with flange is riveted on to it, from which the heat in larger box enters. I place my jar to receive the emulsion as it passes through the filter. On the top of large box I place the tray containing the hot water and emulsion-bottle, then I place a small oil-stove in box from outside, which keeps the heat at any desired temperature; by this contrivance all gases are entirely shut out of the room. A support will be needed under the larger box. For coating, I use two small jugs, one for pouring, the other to receive any surplus from plates coated and returned to filter· I use slate slabs for setting, and I find these much cooler than glass. For drying-racks, I use shelves the length of the room, with rows of oval holes cut in diagonally, or so that there shall be a space between the first row and third; the holes are cut larger and wider at the top than at the bottom, so as to prevent any part of the plate becoming damaged. I find this plan exceedingly good. For ventilation I get two stove-pipe elbows, and insert one at one end of the room near the floor, the other I connect with the chimney, thereby securing a good current of air amongst the plates. I find one thickness of the paper supplied by most stock-dealers perfectly safe; it is a good plan to have a thick plate of glass outside to keep inquisitive people from pushing a hole through the paper. I mention this through losing over nine dozen 5 by 8 plates from the attempt of a friend to rear himself up inside my dark room. Almost any developer is good for these plates; but I prefer, for out-door work, ferrous oxalate iron solution, one to four of oxalate solution.

## PHOTOGRAPHY FOR AMATEURS.*

THE amateur of architectural photography has a field of usefulness before him which combines more, perhaps, than any other branch of photography, the agreeable with the useful. Travel, picturesqueness of subject-matter, and a peculiar adaptation of it to the photographer's methods; a remarkable choice of effect in light and shade, and the enjoyment to the highest degree of the peculiar power of the camera; the rendering of detail of the most exquisite delicacy without interfering with the general effect, to such a degree, in fact, that a photographic negative magnified will give details which the unaided eye would never have seen in the object itself, are all combined in architectural photography in an exceptional degree.

To the proper rendering of architecture it is necessary that the amateur should provide himself with a square-plate camera or one with a reversible back. We prefer, and have used for some years, the former, as we find that many architectural subjects are more complete when square than when shorter in one dimension, but the reversible back gives a lighter outfit. It must have a swing back, but the side swing is not necessary, nor, indeed, is it desirable to use it in architecture, as it alters the relative magnitude of the details on the two sides of the view. The lens must be of the symmetrical type, and it is better to have a series of different foci. On a 6½ × 4¾ plate we employ a series of 4, 6, 8, and 10 inch foci, portable, symmetrical lenses, fitting the same flange. For an 8 × 8 plate these are supplemented by a 13-inch rapid symmetrical for both architecture and instantaneous views or groups. It is best to use always the smallest diaphragm possible, for hazy or out-of-focus architectural details are an abomination.

The subject should be studied carefully to get the best light and shade, which is generally with the sun about midway between the back and one side, but so as, at any rate, to secure to a certain extent the three dimensions of the building, if only one view is wanted; but if the architectural elevation is desired it should be taken with the greatest exactitude, placing the camera precisely opposite centre of the façade. The absolute vertical position of the ground glass should be secured by the use of the plumb line, for which we use a conical pistol bullet at the end of a black silk thread. No eye can determine, from the subject as seen on the ground glass, the absolute correctness of the perpendiculars, which is necessary to secure the correctness of the image. Take for instance the east façade of the Parthenon, in which the columns all converge slightly to a point over the centre of the building. There is no absolutely vertical line and no straight horizontal line, so that to the eye there is no rigid measure, but, having the glass absolutely perpendicular, whatever variation from the perpendicular exists in the building is recorded and can be measured on the plate. The side swing is to be avoided, because by swinging one side of the glass further from the lens we increase the image on that side.

Extreme perspective is to be avoided, not because it is incorrect, but because to make it seem correct the photograph must be seen at the distance of the focal length of the lens, but this must be risked when the subject does not come on the plate with a long-focus lens. The focus must be short enough to get in a complete subject, but in any case, if possible, get far enough from the subject to include the whole of it with a lens of not less focal length than the base lens of the plate. Further, if possible, and if the distances, &c., permit, get the whole subject in angle of 40 degrees.

Focus with full opening of your lens on the most distant part of the building, and then stop down to the very smallest diaphragm. We had all our lenses furnished with diaphragm openings half the diameter of the smallest the lens is sent out with—*i.e.*, down to $\frac{F}{80}$. Give abundant exposures, with development to moderate intensity, so that no glittering high lights occur on one side, and no shadows conceal detail on the other. The brilliant effect which is obtained, and is sometimes desirable, in landscape by extreme intensity of light and shade, implies in an architectural subject loss of the general illumination indispensable to it.

Never stop out the sky of an architectural photograph. The views of the classical scenes for sale in Rome and Athens, the views in Venice, &c., by professional photographers, in most cases are "improved" by having the skies carefully stopped out. This destroys all the sky outline, and, like a wash on an antique statue, leaves no indication of where the original has its termination. A spotted or stained sky is not half so grave a defect as the glaring white, hard, painted-out sky which cuts the edge of the subject like tin, and destroys the space and atmosphere, while it leaves the mind in doubt whether part of the view is not cut out as well. In photographs of classical ruins, this defect is destructive of their value, and when to it is added, as it often is, careless levelling of the camera, and consequent converging or diverging perpendiculars, they are really not worth carrying home, because they belie the subject in some of its most important qualities.

## THE FORMS OF LEAVES.

AT the recent meeting of the Linnean Society, Sir John Lubbock read a paper on this subject, dwelling in more detail on some points to which he had alluded in a popular manner in his lecture at the Royal Institution, and entering into some considerations which time did not then permit him to discuss (see p. 533, Vol. XL.) He had long been puzzled at the reason why some plants have cordate leaves, more or less elongated, and others palmate. Starting from a foliaceous expansion of a stem, the former was evidently the simpler type. It might be considered as derived from a simple form, as, for instance, the leaf of a grass. Such a leaf, gradually widened near the base, would give the heart-shaped form. He mentioned several plants which, although when mature they have palmate leave, produce as seedlings one or more rounded ones before developing the final form. He had suggested that the cordate shape was the earlier from which the palmate was developed. The interesting consequence would follow that if in the same genus some species were cordate and others palmate, the latter were of later origin. This explanation presupposed that the palmate form, at any rate, under certain circumstances, presented greater advantages. Sir John suggested that this might have reference to the power of self-support and of resisting wind. The weight of the leaf and the force of the wind might be considered as if they were concentrated on the central point of the leaf. Now in palmate leaves the centre would be nearer the point of support, and the resistance to any given force, therefore, would be more effectual. This point was illustrated by experiment. Broad leaves, however, were of two main types—cordate, with veins following the curvature of the edge, and palmate, or lobed leaves, with veins running direct to the margin. Now, the fibres constituting the so-called veins of leaves contained elongated cells running parallel to the veins. Consequently the sap passing up the leaf stalk and into the leaves moved more readily along these fibrovascular bundles, having fewer cell walls to traverse. It was almost like going along a road instead of across country. The fibrovascular bundles then act as pipes conveying the sap, as it is clearly more economical that they should go straight to their destination rather than wind in a curve. As the sap passes more freely along the veins, the leaf also grows there more rapidly, which seems to explain the common lobed form of leaf with a vein running to the point of each lobe. Sir John Lubbock, with reference to some criticism on his views with reference to the relation between the size of leaves and the diameter of the stem, entered into certain particulars, especially with reference to conifers, pointing out that though the spruce fir, for instance, had shorter leaves than the Scotch fir, while the stem was as thick or thicker, yet the leaves remained on much longer—say seven or eight years, instead of two or three. He also discussed various other interesting problems presented by leaves, for instance, the probable reason for the larch having deciduous leaves, and for the presence of two kinds of leaves on certain cypresses and other trees.

## TIME REQUIRED TO DIGEST DIFFERENT FOODS.

IN a recent number of the *Monitor de la Salud* the results of some experiments lately made by E. Jessen on the time required for the digestion of certain kinds of foods are given. The stomach of the person on whom the experiments were made was emptied by means of a pump; 100 grammes, equal to 1,544 grains, or about 2⅔oz., of meat, finely chopped and mixed with three times the quantity of water, were introduced. The experiment was considered ended when the matter, on removal by the pump, was found to contain no muscular fibre.

It will be remembered that the gramme weighs nearly 15½ grains, and the cubic centigramme is equal to 1 gramme. The 2⅔oz. of meat were therefore mixed with nearly 8oz. of water, before being introduced into the stomach.

The results were as follows:—

| | | |
|---|---|---|
| Beef, raw, and finely chopped . | 2 | hours |
| „ half cooked ............ | 2½ | „ |
| „ well cooked ............ | 3 | „ |
| „ slightly roasted ........ | 3 | „ |
| „ well roasted ............ | 4 | „ |
| Mutton, raw .................. | 2 | „ |
| Veal ........................ | 2½ | „ |
| Pork ........................ | 3 | „ |

The digestibility of milk was examined in the same way. The quantity used was regulated so that the nitrogen should be the same as in the 100 grammes of beef.

| | | | |
|---|---|---|---|
| 602 cubic centimetres, nearly 16oz., of cow's milk, not boiled, required...... | | 3½ | hours |
| 602 cubic centimetres, boiled .......... | | 4 | „ |
| 602 „ „ | sour ............ | 3½ | „ |
| 675 „ „ | skimmed ........ | 3½ | „ |
| 656 „ „ | goat's milk, not boiled........ | 3½ | „ |

## MILLING TAPER WORK.*

HAVING had some experience at trying to make things *perfectly round*, I have some appreciation of the difficulty and expense connected with the process, and would hardly recommend such work to be used for keys, especially since they would be no better than ordinary round wire. I have used pieces of steel wire, cutting it into lengths a little less than the thickness of the cutters. This makes a half-round groove in the arbor, and the same in the cutter, and the advantages are that the distance-washers need not be made to go over the key, but can be left as they come from the key, and there being no key permanently fitted into the arbor, it is much less liable to be sprung out of truth; and there being no square corners in the key-way of the cutter, there is much less liability of starting a crack there in hardening; and, finally, the whole arrangement is cheaper, neater, and more convenient to use than square keys permanently fitted to the arbor in the usual way.

Some time ago, there appeared in this paper a drawing and description of a dog, for use with the Brown and Sharpe Universal Milling Machine, contributed, if I remember rightly, by a foreman of the Morse Twist Drill and Machine Company's Works. This dog was especially designed for use in milling taper work, and was supposed to adapt itself to any and all variations of angle between the centre line of the work and that of the dividing head spindle without cramping, and it was claimed for it that it did away with the only objection to the Brown and Sharpe machine. I believed all that was claimed in its behalf until I commenced to examine it closely, with a view to making one, when I dis-

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* From the *Photographic Times*.

* By Fred. J. Miller, in the *American Machinist*.

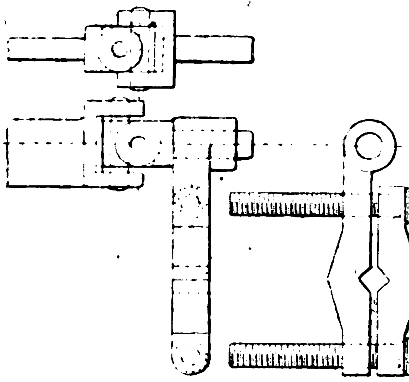


Fig. 1

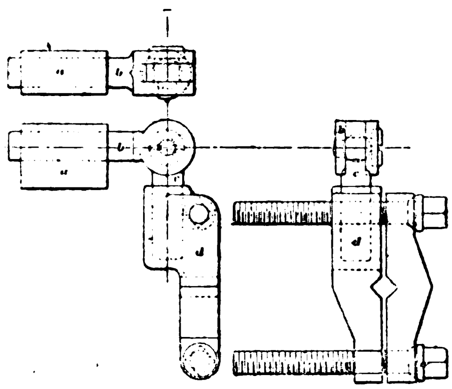


Fig. 2

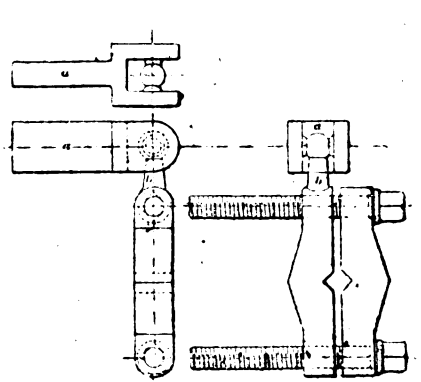


Fig. 3

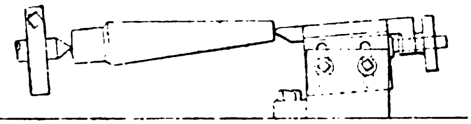


Fig. 6

Fig. 5

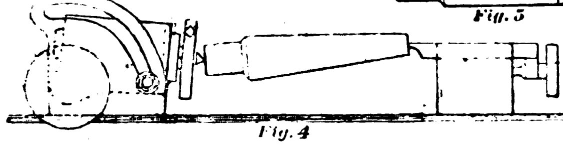


Fig. 4

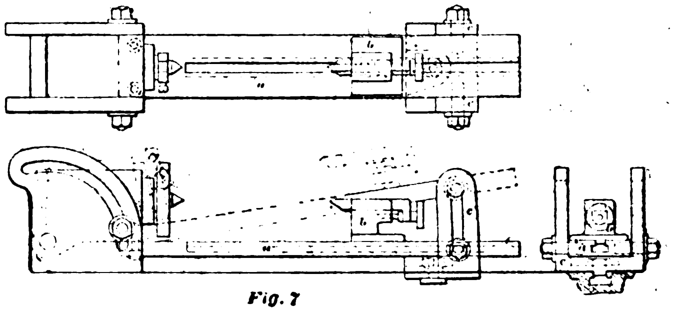


Fig. 7

covered that it only overcame one-half of the cramping difficulty, and that in order to make a truly universal dog it would have to be capable of several additional movements. Several of my mechanical friends became interested in the problem of devising one, and the fruits of our labours are represented by Figs. 1, 2, and 3, one of them being designed by a well-known M. E. They are all of them truly universal; that is to say, they cannot be cramped by any angle which comes within the limit of their motion. I trust they will readily be understood from the drawings; and it will be seen that they all require good workmanship in their construction to make them satisfactory.

Fig. 1, perhaps, needs no explanation: it seems to be capable of a good many motions, but, upon trial, none of them will be found unnecessary. It is a modification of the familiar universal joint.

In Fig 2 the pieces *b* and *c*, when the dog is in use, have a spiral oscillating motion in the pieces *a* and *d*, besides which use will be found for the joint between *b* and *c*.

In Fig. 3 the piece marked *b* has a ball upon its extremity, which is capable of motion of most any kind in the fork of the piece *a*. They all have their friends, some prefering one kind and some another, and the reader can take his choice.

Now, although any one of the above three breeds of dogs will be found to work very satisfactorily, so far as freedom from cramping in any position is concerned, yet I do not think they do away with the only objection to the Brown and Sharpe machine, because one objection consists in the necessity for any such dogs. And now, if, by presenting these dogs, I have conferred any benefit upon the fraternity of toolmakers, I can, perhaps, confer a greater benefit by showing how they may be dispensed with, and a common cur made to answer for all kinds of work.

No matter what kind of dog is used for holding taper work upon centres while being milled, if the centres must be placed out of line with each other, as in Fig. 4, in order to get the required taper, the accuracy of the divisions or indexing is entirely vitiated.

This is especially noticeable and annoying when a reamer such as is shown in Fig. 5, is to milled with continuous cuts or flutes from the small end to the shank *a*. On a piece of this kind it is necessary to depress one centre while milling the taper part; then when the centres are restored to the normal position for continuing the flutes over the straight portion, it will be found that only two of them will correspond at all, these two having been milled when the tail of the dog was in a vertical line above and beneath the centres.

Of course the others can be made to match, but this involves considerable trouble, and after it is done they will not be evenly spaced. The milling of a taper piece of square section would be almost an impossibility under such circumstances. By taking pains to have the dog in the proper position, as indicated above, two sides of the section might be made parallel with each other; but the other two would be neither parallel with each other nor at right angles to the first two, and the section, instead of being a square, would be what the geometricians would call a trapezoid.

A device for overcoming this difficulty is in use to some extent, and consists essentially of an adjustable tail block, or centre, in connection with the ordinary elevating head, something as shown at Fig. 6.

This is ingenious, and may be said to overcome the difficulty, inasmuch as it can be said that by its use it is possible to correctly index taper work. But the centres having to be adjusted separately, one after the other, it is exceedingly difficult to secure the precise adjustment necessary to do a good piece of work; indeed, it is almost what has been called a "corrugated impossibility." Taking the case of taper reamers, for instance: if the proper angle of elevation for the centres bore any fixed relation to the taper of the reamers and was computable, matters would be much simplified. But this is not the case, the angle at which the centres must be set depending upon the pitch of the teeth of the reamer and the shape of the cutter used in milling them, as well as upon the taper of the reamer, so that calculations are impracticable.

This makes it necessary to "cut and try" a process which, with a device in which the centres are capable of movement independent of each other, is anything but economical or pacifying.

I therefore submit the plan shown in Fig. 7, which is an attachment that may be adapted to any machine having an elevating head.

In this device the centres are perforce kept always in line with each other, consequently it is very little trouble to adjust, and it will produce taper work as accurately indexed as straight work can be. When used upon the Brown and Sharpe machine, it enables true spirals to be cut upon taper work, with the well known advantages of holding the work upon centres at the same time. It will also be found useful for bevel gearing within certain limits.

The piece *a* is a sort of supplementary table to the machine, which is attached to the elevating head by two screws as shown. Upon this is mounted the small tail block *b*, and its outer end is supported by the slotted arc *c*, which is secured to the table of the machine by the bolt shown.

It will be found easy to put on and remove from the machine, and obviates the necessity for any fancy breeds of dogs.

# DETERMINATION OF MIXTURES OF MILK-SUGAR AND CANE-SUGAR.

MIXTURES of milk-sugar and cane-sugar, such as are found in condensed milk, offer great difficulties to the analyst. These are such that usually only the milk-sugar is determined, the other being taken by difference. Messrs. A. W. Stokes, F.C.S., and R. Bodmer, F.C.S., describe in this month's number of *The Analyst*, a simple, rapid, and exact means of estimating both sugars volumetrically. They use an ammoniated cupric sulphate solution. Into a boiling measured quantity of this the diluted milk or mixed sugar solution is run from a burette till the blue colour disappears. This determines the milk-sugar. Another part of the milk solution is boiled with 2 per cent. of citric acid for ten minutes. The citric acid inverts the cane-sugar but does not affect the milk-sugar. This solution after neutralisation is titrated as in the former case. Thus the milk-sugar is determined. Results of various known mixtures are given and complete analyses of milks. A table is appended of the values of a quantity of the blue liquid (Pavy's fluid) in percentages of glucose, cane-sugar, and milk-sugar, so that calculation of results may be avoided. The advantages claimed are the sharpness of the end of the reaction, the ease and certainty with which all ordinary operators may rapidly attain the same exact results.

# BLEACHING OSTRICH FEATHERS.

THE following directions for bleaching ostrich feathers, though given on the commercial scale, may be found useful and suggestive:—Wash the feathers with Castile or curd soap and rinse thoroughly with lukewarm water in order to remove all the grease and soap which may stick to the flue; then soak in a bath composed of 1 gallon of ammonia (20° Be.) to every 8 gallons of plain water for about 8 to 10 hours. Take the feathers out of this bath, and squeeze out the excess of ammonia water which is in the flue. Put them in a bath composed of 5 gallons of peroxide of hydrogen, with the addition of 12 to 16oz. of liquor of ammonia; let it work slowly, stirring feathers from time to time, for about 6 hours; after 6 hours' working, put feathers on one side of the bath and add 5 gallons of peroxide of hydrogen and 3 to 4oz. of liquor of ammonia. Stir the bath well, so as to insure the mixture of the peroxide with the ammonia. Then let the bath work for 9 to 12 hours more, after that time add again 2 or 3oz. of ammonia. The peroxide will work for 12 hours more, until it gets exhausted, which may be ascertained by the following process:—Take a small quantity of the bath in a tumbler and throw in a few crystals of permanganate of potash. Should bubbles of gas appear, it is proof that the peroxide is working: if none appear, the peroxide is exhausted. The feathers have then to be rinsed three or four times in lukewarm water, and put into a second bath of peroxide of hydrogen, which is prepared as follows:—To 2½ gallons of peroxide of hydrogen add 2½ or 3 gallons of plain water and 8oz. of liquor of ammonia, and put in the feathers. Let the bath work so for 10 hours, and after that add again 2oz. of ammonia as before, and it will then work 12 hours more until it is exhausted.

It is said that this method will make white the darkest grey feathers—say, 10lb. of feathers, by using about 7 to 7½ gallons of peroxide. After the feathers have been taken out of the peroxide bath they must be rinsed thoroughly with lukewarm water two or three times, and after soaking them again in a soap solution for 6 to 8 hours, rinse them in lukewarm water, in order to remove all soap and dirt remaining in the flue.

# SCIENTIFIC SOCIETIES.

## ROYAL METEOROLOGICAL SOCIETY.

THE usual monthly meeting of this society was held on Wednesday evening, the 15th instant, at the Institution of Civil Engineers, 25, Great George-street, Westminster, Mr. R. H. Scott, F.R.S., president, in the chair, when the following papers were read:—

(1) "Report of Committee on Decrease of Water Supply." This Committee was appointed to take into consideration the question of the decrease of water in springs, streams, and rivers, and also the simultaneous rise of the flood-level in cultivated countries. As far as any inference can be drawn from the records collected by the Committee, it appears that the years 1820, 1821, 1824, 1835, 1838, 1845, 1847, 1850, 1854, 1855, 1858, 1859, 1864, 1865, 1871, 1874, 1875, and 1884 have been periods of marked low water. On the other hand, the years 1817, 1825, 1830, 1836, 1841, 1842, 1853, 1860, 1861, 1866, 1873, 1877, 1879, 1881, and 1883 have been periods when there has been exceptionally high water. In 1852 the water was very low in the early part of the year, while at the end of the year it was very high. In the intervening periods the water has been of moderate altitude. It does not appear from existing records that there is any diminution in the water supply of this country, and the large quantity of water which has been stored or has flowed off the ground between 1876 and 1884 is confirmatory of this view. There appear, however, to be periods when there is exceptionally low water, and these are almost immediately followed by periods of exceptionally high water. With reference to the increase of floods, it does not appear from the records that there is any great increase in the height to which the floods rise in this country. Whether or not the height to which floods have risen in recent years has been affected by river improvements and the greater facility with which floods can be got rid of, or whether there is a diminution in the quantity of water, are questions upon which the Committee have not at present sufficient information to speak positively.

(2) "Report of Committee on the Occurrences of the Helm Wind of Cross Fell, Cumberland, from 1871 to 1884." In response to a letter inserted in the Penrith newspapers, the Committee has received a number of communications bearing on the subject of the Helm Wind. With the view of ascertaining as far as possible the meteorological conditions which exist when the Helm Wind is blowing, all the recorded occurrences that have been received have been chronologically arranged. The first systematic record commences in 1871, and in this Report the Committee deals with all occurrences from that date to the end of 1884. Since that time more detailed records have been commenced at numerous stations in the locality at the instigation of the Royal Meteorological Society. Ninety-three instances of the Helm Wind were recorded from 1871 to 1884, the months with the greatest frequences being February, March, April, and November. On examining the Daily Weather Reports it was clearly seen that whenever the Helm Wind was blowing there was an easterly wind not only in the locality but generally over the entire country. As the Helm Wind seemed to occur so regularly with the easterly wind, the Committee further extended the inquiry with regard to the east wind. The daily weather charts were consequently examined for each day from January 1st, 1871, to December 31st, 1884, and every occurrence of east wind tabulated, the instances with general easterly conditions over the whole country being kept separate [from those instances in which the easterly wind was only partial, though of sufficient intensity to occasion the Helm Wind. This examination showed that, although the wind over the United Kingdom is generally easterly when the Helm occurs, yet the Helm by no means occurs whenever the wind is easterly. Indeed, this step in the inquiry has not at all tended to the elucidation of the phenomenon in question, for it frequently happens that the conditions are to all appearances precisely similar when the Helm is on, and yet no such occurrence has been recorded. This may in part be due to the occasional omission to record the Helm, although it cannot possibly be in the main attributable to such an omission; but it points to other conditions being necessary besides absolute agreement of wind direction and isobaric lines. Possibly the different hygrometric qualities of the air with the existing easterly winds may be an important factor in deciding whether or not the Helm will be formed, but it is not readily conceived why even in this case the Helm wind should not blow. It must, however, be borne in mind that the surface winds can only be examined, whilst those at a comparatively small elevation may be ultimately connected with the phenomenon. From the observations made prior to those started at the beginning of 1885, no idea can be formed of the behaviour of the upper currents even at the time of the occurrence of the Helm winds, far less with the occurrence of each east wind experienced. The society has, however, provided for the extension of the inquiry in this direction in the records which are now being collected, the observers supplying observations of the upper currents by means of the clouds, as well as the direction of the winds at the surface of the earth. As soon as a sufficient number of these observations have been received, the Committee hopes to present a further report, which will tend to explain the phenomenon of the Helm wind.

(3) "Results of Meteorological Observations made at Asuncion, Paraguay," by R. Strachan, F.R. Met. Soc.

## LIVERPOOL ASTRONOMICAL SOCIETY.

THE usual monthly meeting was held on April 13, the Rev. T. E. Espin, B.A. (president), in the chair. The Rev. J. H. Honeyburne, M.A., F.R.A.S., read a paper on "Evenings in Town with a Small Telescope." It was, he said, generally supposed that astronomical observation required an exceptionally good position besides every other convenience; but he had found a 3¼in. telescope in a little back yard in Liverpool quite sufficient to render the science a most delightful pursuit. He had noticed that members generally went in for a study and comparison of star magnitudes, or for an elaboration of mysterious hieroglyphics, supposed to represent the bottom of some ring-plain on the moon. No doubt this was all very important and interesting to the initiated; but he made no claim to originality, and would merely give an outline of the colours of some stars and the closeness or faintness of others. The tints of many of the stars were most lovely. β Cygni and δ Cephei he gave as examples; whilst the orange and blue of γ Persei fully entitled it to rank amongst the flowers of the sky.

Mr. T. G. Elger, F.R.A.S., hoped the important paper from Dr. Klein read at the last meeting would direct the attention of selenographers to the dark markings south of Copernicus. Since the publication of Schmidt's work he had carefully scrutinised this region, and on the 3rd November last had glimpsed two very minute black spots. These dusky features seemed to suggest an analogy to Mount Rossa, on the southern flank of Etna, which, according to Scrope, completely covered the surrounding country with a deposit of black sand during an eruption in 1669. Possibly something of this kind might now be occurring on the moon, and, if so, it would be amongst the smaller craters that we should look for changes due to present volcanic activity.

The President said he had lately, at Dr. Spitta's request, tested his new occulting eyepiece. It might briefly be described as a Ramsden eyepiece fitted with two pairs of movable shutters at the focus. Its work on double stars was excellent, especially when the companion happened to be faint and not too close, and he had by its aid discovered a new companion to 27 Hydræ. This was a wide and lovely pair *s. p.* α Hydræ, and was noted by the elder Herschel, though he did not think he had detected its triplicity. The pair was of 6·0 and 7·0 magnitude, but on examining them with this eyepiece a small *comes* of 11 mag. (Struve's scale) was at once seen about 8″ from the 7·0 mag. star, and at about 190°. Altogether, he thought the eyepiece supplied a want long felt, but, from the nature of the eyepiece, there was an unfortunate liability to "ghosts"; hence there was a danger of finding companions which had no existence.

Mr. J. E. Gore, F.R.A.S., contributed a series of observations of the remarkable variable star Mira Ceti. According to Argelander's formula, a maximum was due on January 28, but from his own observations this was not attained until Feb. 4, when he estimated it equal to α Ceti, or about 2·7 mag. The increase of light was at first very rapid, but it became afterwards much slower, and seemed to remain constant from Feb. 4 to Feb. 13. Mr. R. Wilding, hon. curator to Preston Observatory, announced his discovery of Tempel's comet. Its position on the 8th April was R.A. 12 hours and about 19° North dec. The nucleus appeared like a 13th mag. star surrounded by a nebulous disc.

The Secretary gave notice that he would bring forward for discussion at the next meeting a motion to enable members who reside at a distance to vote at the annual general meeting by proxy. Eleven gentlemen were elected members, and Dr. Copeland, of Dun Echt, was elected an associate of the society.

## LIVERPOOL SCIENCE STUDENTS' ASSOCIATION.

THIS Association has lately commenced a new session. At the annual meeting the officers were reappointed—president, Mr. A. Norman Tate, F.I.C.; vice-presidents, Mr. Henry A. Hill and Mr. Wm. Narramore; treasurer, Mr. John Edwards; and hon. secretaries, Mr. H. Leaton Edwards and Miss Helen Fryer. After the election, a paper, illustrated by limelight lantern views, was read by Mr. John Edwards on "A Visit to Rome." On Friday last there was a special meeting to make some alterations in the rules, and after that there was held the first ordinary meeting of the new session, when the president, Mr. Norman Tate, F.I.C., delivered a short introductory address, in which he strongly urged the members to be thoroughly systematic in their studies, not to be too superficial in their reading and observation, or to give attention to too many subjects, but rather to fix upon certain special subjects for inquiry, learn as far as possible all that is already known respecting them, test the facts and well weigh the opinions expressed concerning them, and then endeavour to further elucidate them by careful research. Mr. W. H. Read afterwards read a paper on "Astronomical Studies," in which he gave a comprehensive and interesting account of many astronomical discoveries, with an elaborate description of many of the bodies of the solar system, his remarks being illustrated by an excellent series of models, &c., prepared by himself, and by many diagrams shown by the limelight lantern of Mr. Knott. At the conclusion of the paper a brief discussion ensued, in which Messrs. Osmund, W. Jeffs, D. Clague, and M. Fitzpatrick took part, and the meeting concluded with a vote of thanks to Mr. Read for his paper.

## WESTERN MICROSCOPICAL CLUB.

ON Monday week this club met at the house of Mr. H. V. Tebbs, St. John's-gardens, Notting-hill, attracted by the subject of "Crystals under Polarised Light." The tables were loaded with apparatus for exhibiting the various phenomena connected with the "polarisation" of light, Mr. F. Crisp, LL.B., the hon. sec. of the Royal Microscopical Society, having kindly sent some exhibits from his ample stores. At the desire of the host, the Rev. Nicholas Brady, M.A., described the theory and method of polarisation, while Mr. Tebbs acted as demonstrator. The properties of crystals were described, especial reference being made to those in which the incident ray of light is split up. The methods of polarising by light incident at particular angles by bundles of plates, by Iceland spar, by tourmalines and herapathite, were all noticed. The changes produced in non-polarising substances by heat, strain, and electric currents, rendering them polar, were exhibited. Some of these were exceedingly beautiful. Large crystals of Iceland spar, cut at right angles to the different axes, showed the course of the ordinary and extraordinary rays. A very fine set of models, constructed by Mr. Brady, at the suggestion of Mr. Tebbs, exemplified the relation of the rays of light to the axes and surfaces of numerous crystalline forms. A cordial vote of thanks was presented to Mr. Brady for his valuable exposition, which was ordered to be printed.

Amongst the microscopical exhibits was a simple and inexpensive form of polariscope by Mr. Tebbs, in which the microscope was fitted with a plate of tourmaline below the eyepiece, the object being viewed on the stage without the objective; and some peculiar crystals deposited upon slips of glass from the smoke of coke, shown by Mr. E. Bartlett, L.D.S. Messrs. W. Gwinnell and B. B. Woodward exhibited a selection of the beautiful crystalline forms found in igneous and volcanic rocks. Mr. G. Karop brought out some beautiful effects in crystals by the use of Abbe's condenser and eyepiece analyser. Under the microscope of Mr. S. P. Moore, B.Sc., the diffraction bands were capitally shown in some polarised crystals of milk-sugar. Mr. E. M. Nelson contributed the exhibit of the evening—a polarised Podura scale magnified 2,500 diameters. But few exhibitors have managed to achieve this feat. Some crystals of erythrite (the colouring matter of lichens) glowed as perfect gems of colour under the microscope of the hon. sec., Mr. A. W. Stokes, F.C.S. Dr. Hart Vinen showed how beautiful the deadly crystals of nitrate of strychnia looked under polarised light.

At the next meeting of the club, on May 4, it is probable that Dr. Foulerton will demonstrate to the members a method of photographing microscopical objects. Mr. Tebbs announced that Mr. F. Crisp, LL.B., had invited the club to view at his house at a future meeting the effects produced by the electric polariscope.

According to a paper read before the Philosophical Society of Glasgow, by Mr. A. Williamson, the total area of the coalfields of China proper is about 400,000 square miles. Both the Shansi and Heenan coalfields are greater than that of the aggregate of the principal coal-producing countries of Europe, and in other districts of North China the coalfields are said to be seven times larger than all those of Great Britain. The coal is of various descriptions, and it is said that iron ores are found in all parts in close proximity to the coal.

Experiments are being made by the Government with a new locomotive torpedo steered by electricity from the shore. Very good results are said to have been obtained.

# SCIENTIFIC NEWS.

FROM Rear-Admiral Franklin, superintendent of the Naval Observatory, Washington, we have the official note of the observations of March last. First contact is given by Prof. A. Hall, using the great equatoreal, with aperture reduced to 4in., and a power of 383, as W. M. T., March 15, 23h. 57m. 6·9s. (probably one or two seconds late). Prof. Frisby, using the 9·6in. equatorial reduced to 4in., and a power of 90, made it 23h. 57m. 4·7s.; and Assistant-Astronomer Paul gives it as 23h. 57m. 7·5s., using an aperture of 5in., and power of 90; but does not think he could have observed it a second earlier on account of the state of the atmosphere. No observations of last contact could be made. The difference of R. A. of the second limbs of the moon and sun was observed by Lieut. Bowman on 11 wires of the east transit, and by Assistant-Astronomer Winlock on 9 wires of the transit circle, with the following results: B., Diff. 1m. 56·49s. ± ·028s.; W., 1m. 56·25 ± ·031s. Ninty-nine photographs of various stages of the eclipse were taken with the photo-heliographic apparatus.

Prof. Theodor von Oppolzer, in a note published in the *Monthly Notices* of March last says: "The words midnight and noon have a purely local character, like the words evening and morning. At a given instant it can be 0h. on the whole earth, if we have agreed to designate this given instant everywhere with this number; but there can be midnight only under one meridian at the same absolute instant; so the words midnight and noon are to be avoided when speaking of universal time." Prof. Von Oppolzer thinks that astronomers are more inclined to over than to under-estimate the trouble of a transition period; and that the uniformity of astronomical and civil reckoning is surely worth a little trouble at the beginning of the change.

Mr. Clement L. Wragge, in the course of his Mount Lofty meteorological observations, has discovered some extraordinary hygrometric conditions accompanying the northerly winds of an advancing barometric depression. Six observations from 9 a.m. to noon of Dec. 29 last, with the dry bulb giving a mean temperature of 78·8°, and the wet bulb a mean of 59·5°, disclosed the fact that the relative humidity of the atmosphere on Mount Lofty was 26. Similar observations made at the same time at Torrens Observatory gave means of 89° dry bulb, 63·5° wet bulb, and a relative humidity of only 18. It is only in such regions as the Soudan that similar hygrometric results would be obtained at such temperatures. Heavy rainfalls are sometimes registered in Australia. Mr. Wragge records for 24 hours ending Feb. 28 ·615in. at Torrens Observatory, and 1·1in., or 111 tons to the acre at Mount Lofty.

The Gresham lectures on Astronomy will be delivered on Tuesday, Wednesday, Thursday, and Friday next, by the Rev. E. Ledger. The lectures are given at Gresham College at six p.m.

The desirability of forming a British Textile Institute, somewhat on the model of the Iron and Steel Institute, has been mooted for some time, and in January last a preliminary meeting was held at which a committee was appointed to consider the various arguments *pro* and *con*. That committee has now reported in favour of the scheme, and has drawn up a constitution and rules as a basis upon which to found the institute. Forms of application for fellowship can be obtained from Mr. T. R. Ashenhurst, Technical College, Bradford, Yorkshire.

The Board of Trade return of railway accidents in 1884 is so far satisfactory that the numbers of persons killed and injured show a decrease on the previous year; but the number of persons who were killed from causes beyond their own control was 55 as compared with 22 of the previous year. Of these 31 were passengers, and 24 of them were killed in the Penistone disaster—singularly, the only passengers who were killed by the breaking of the 385 axles which failed during the year. Of these 223 were engine-axles and 24 tender-axles; the average mileage of 135 iron axles being 216,333, and of 59 steel axles 173,287 miles. There were 111 fractures of couplings, and the number of tires which gave way was 1,060, of which 1,005 were waggon tires, and 24 engine tires. Of the total number, 974 were made of iron and 86 of steel, 42 being fastened by Gibson's patent, 14 by Mansell's, and 5 by Beattie's. No life was lost through failure of a tire. There were 306 cases of broken rails.

Mr. Stretton's paper on the "Breaking of Locomotive Driving-Axles" is still being debated by the Leicester Branch of the Amalgamated Society of Railway Servants, the discussion having been adjourned to May 6.

Mr. Gugel, of the Central and South-Western Railroad of Georgia, is taking the reservoir of the Westinghouse-brake from under the footboard and placing it on the top of the boiler just behind the smoke-stack.

Dr. Dohrn's report on the zoological station at Naples states that it has been determined to add a physiological laboratory, and that the Italian Government has promised a grant of £4,000, £1,200 of which is to be paid this year.

The Royal Medals of the Royal Geographical Society will this year be awarded to Mr. Joseph Thomson and Mr. H. E. O'Neill—to the former for his well-known work in Africa, and to the latter for his thirteen journeys of exploration along the coast and in the interior of Mozambique. The Murchison Grant for 1885 will be awarded to the Pandit Kreshna for his four explorations made while attached to the Survey of India, and especially for his extensive and important journey in the interior of Tibet. The Back Grant goes to Mr. W. O. Hodkinson for his Australian explorations, and the Cuthbert Peek Grant to Mr. J. T. Last for his surveys and ethnological researches in the Southern Masai, Nguru, and other neighbouring countries.

The Institution of Mechanical Engineers will hold an ordinary general meeting on Thursday and Friday next, when amongst the papers to be read may be noted a description of the Maxim automatic machine gun, by Mr. Hiram S. Maxim, and a description of the Tripier Spherical Eccentric by M. Louis Poillon.

Thirty thousand "landlocked" salmon have been sent by the United States Government to the National Fish Culture Association.

The French Society for the Encouragement of National Industry have awarded the prize of £40, for the discovery of a useful new alloy, to M. Manhès. The alloy is prepared by mixing three parts of copper with one of manganese, and adding it in small quantities to the molten copper, after refining and just before casting. Copper so treated is said to be but slowly acted upon by sea-water.

# USEFUL AND SCIENTIFIC NOTES.

**Air-Tight Packages.**—According to the *American Druggist*, a German firm supplies chloride of lime packed in the following manner:—Quantities of quarter, half, and one kilo. are wrapped first in strong paper and sealed. The packet is then dipped for a moment in melted resin, which is as nearly cool as it can be to be fluid. This forms a perfectly air-tight varnish, and the parcel is lastly wrapped in a good paper and labelled. The idea is a good one, and may be adopted with advantage in packing photographic chemicals.

**Rugby Station.**—The work of building the new "island" railway station at Rugby, which is to cost some £70,000, and to be the biggest thing of its kind in Europe, continues to be rapidly pushed forward. Although it is expected that quite another year must elapse before the alterations are completed, yet it is hoped that the down side will be ready for use by about June next. The line has been widened 150ft. southwards, so as to give room for nine sets altogether of through metals, instead of four as now. For the greater safety at the junctions of the new Northampton line of the Stamford branch important works, presenting considerable engineering difficulties, have been effected. The traffic will be regulated by large signal boxes at each end of the platform, that at the south end having 180 levers.—*Engineer*.

**Grammatical Terminology.**—The Geneva Société pour le Progrès des Etudes offers a prize of 400 francs for the best memoir on a uniform system of grammatical terminology, applicable in the first place to the methodical study of the French language, and incidentally to the other languages studied in the cantonal schools of Geneva. The essays are to comprise a critical examination of the grammatical terms now in use, with the reasons in each case for retaining or rejecting them, and a complete list of the terms recommended for adoption, with their definitions and the words to which they correspond in the received system.

# LETTERS TO THE EDITOR.

*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

*All Cheques and Post-office Orders to be made payable to* J. PASSMORE EDWARDS.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

> "I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original."
> —*Montaigne's Essays.*

## ERRATUM — THE SEASONS — LUNAR GLACIATION — CURIOUS OPTICAL EFFECT — ORRERY OR PLANETARIUM — THE "MONTHLY NOTICES" OF THE ROYAL ASTRONOMICAL SOCIETY—THE NEW TIME—"MAZZAROTH" AND THE MAGI—LENGTH OF FOCUS OF AN ACHROMATIC OBJECT GLASS — COLONEL DRAYSON'S "GLACIAL EPOCH."

[24136.]—I NOTICE a slight misprint in letter 24061, on p. 121, where, in paragraph two, "a whole wall" appears where I wrote a *white* wall.

There is a very obvious astronomical reason for the arrangement of the seasons in the form assailed by "Devoniensis" in letter 24070 (p. 124)—viz., that on March 20th the sun was on the Equator in his passage towards the Summer Solstice, or highest point above it, which he will attain on June 21st. After this his path tends downwards again, and on September 22nd he recrosses the Equator *en route* for the Winter Solstice, which he reaches on December 21st. Hence it will be seen that at the dates specified he occupies four perfectly well-defined points in his orbit. As for Midsummer and Christmas being "the middle or height of their respective seasons," I can scarcely imagine that many Englishmen will be found to endorse the views of your correspondent. Notoriously the greatest heat—or middle of summer—never occurs in June in this country. We get the very greatest heat towards the end of July or the beginning of August. So again with the greatest cold. I cannot recall an instance of Christmas day being the coldest day in the year. In this matter the mediæval couplet is scientifically accurate:

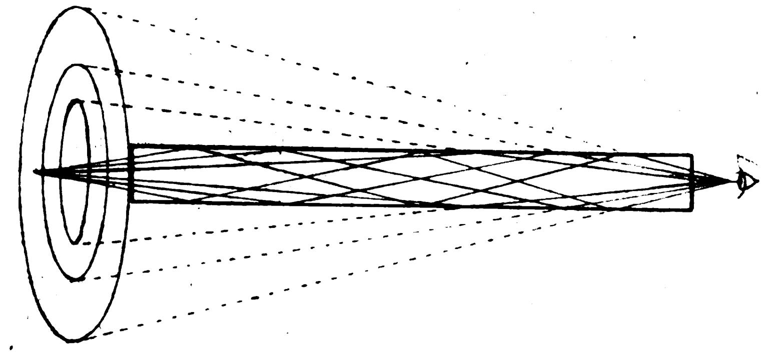
As the days lengthen,
So does the cold strengthen.

As for the etymology of the words used to describe the seasons, Spring comes from the old Saxon word meaning to sprout, or shoot forth: Summer is also Saxon; Autumn is the Latin *Autumnus*; Winter is Saxon. Our forefathers used to call December "Winter-monat," i.e., winter cometh."

May I ask Mr. Peal, in connection with letter 24082 (p. 126), if we are to understand that the "slow decline of . . . . atmosphere" took place unequally over the moon's surface; in other words, that it remained over the region of his equatorial seas, after it had disappeared from other parts of the lunar world? Because, if not, I do not see how his explanation quite meets my difficulty; for I quite fail to understand how an atmosphere could exist, so to speak, in patches round a globe? I ask purely for information. Mr. Peal must not imagine that I have discarded his theory as an absolutely untenable one, because, after due consideration, I do not feel justified in proceeding to that length. It does, undoubtedly, explain some of the visible lunar phenomena very neatly; but I still see considerable difficulties with regard to others.

What Mr. Culley (letter 24087, p. 127) saw in his gun-barrel was, I suspect, not a diffraction phenomenon at all, but one having its origin in multiplied reflections from the polished cylindrical interior. The rough sketch on next page will show what I mean. In it the course of the rays is traced from the source of light, assumed to be pretty near the muzzle, to the eye at the breech end.

I think that "Planetarium" (query 56353), p. 136), will find what he wants in Ferguson's books; but I have none of them at the place whence I write. If he lives in London, he should go to one of the second-hand scientific booksellers. Or he will find the numbers of the wheels for giving the relative motions of the various members of the Solar System in the article "Orrery," in the *Penny Cyclopædia*.



The letter (24105) of "Amateur Astronomer" on p. 146 comes particularly *apropos* of a discussion which (according to your report on p. 143) took place at the meeting of the Royal Astronomical Society on the 10th inst. As I am in entire ignorance as to the identity of your correspondent, I have no means of knowing whether he receives the *Monthly Notices* as a Fellow of the R. A. S., or as a purchaser of them. If in the latter capacity, he certainly has especially good grounds for his complaint. The cause, however, is not far to seek. Just so long as an almost purely Professional Council is allowed, year after year, to re-elect itself, just so long will its members and their friends be permitted to empty the contents of their observatory notebooks bodily into the columns of the *Notices*. It is not pretended for an instant that anybody will ever read—or, in fact, look at — such mere heaps of figures as those of which the "Amateur Astronomer" righteously complains. Whatever Professor Adams may say, I cannot but regard it as discreditable to the editing of our *Monthly Notices* that they should have been detained for such a paper as that which concludes the current number. It is simply ridiculous that the Country Fellows of the society should have been deprived of their right to receive them prior to the meeting, in order that this huge mass of figures should be read for the press: for the simple reason that they are of no *immediate* interest whatever, and would have been in ample time had they appeared in the supplementary number at the close of the session. The paper containing them certainly has the merit of being, in the legitimate sense of the word, an original communication; but I never remember one that would have kept better. Not that purely numerical tabular matter is necessarily devoid of either immediate or perennial interest, as is well illustrated by a communication by Mr. Stone on pp. 102 *et seq.* of Vol. XLIII. of the *Monthly Notices*. In fact, speaking impartially, I have little hesitation in saying that the papers of Mr. Stone, Professor Pritchard, and Mr. Downing in our *Proceedings* are worth the whole of the rest of those of their professional colleagues put together. A firm editorial hand would cure some of the evils complained of. The ruthless excision of such details as those of the runs of screws of particular micrometers, and an intimation to authors that if they were such very important people that they could not condescend to correct the proofs of their communications in time, they would be postponed until some future number, would introduce an immediate and manifest change for the better.

I am certainly in agreement with Mr. Hopkins (letter 24134, p. 151) as to the expediency of the adoption of the new time. Its initial inconvenience would be the veriest "nine days' wonder," and when once people got into the way of reckoning straight through the 24 hours (as they would in the course of a week or two), they would assuredly never dream of returning to the present unphilosophical mode of dividing the day. To the astronomer who has always adopted this notation in his own observatory, its adaptation to civil life would, of course, come as naturally as possible. I must admit that I am one of those people who are confused by railway timetables, as now arranged. Calculating as I do, every day of my life, and familiar with logarithms and mathematical tables generally as I am with the morning newspapers, I candidly confess that "Bradshaw" is too much for me. Stress has been laid on the chronological confusion which the commencement of the astronomical, equally with the civil, day at midnight would involve. But anyone who will study what was written in 1752, when 11 whole days were dropped out by Statute after September 2nd, will see what vaticinations were then uttered as to the utter derangement of all chronology whatever which must inevitably supervene on the change; and, in the light of subsequent events, be able to estimate the outcry at its true value.

If Mr. Arkwright wants to peruse a mass of wild and fanatical guesswork, destitute of any *scientific* value whatever, by all means let him get Miss Rolleston's "Testimony of the Stars," or "Mazzaroth," or whatever the stuff is called, as recommended by Mr. Mee in reply 56309, on p. 154.

In reply to "Perciverance" (sic) (query 56369, p. 156), I would never myself have the focal length of an achromatic cut down to less than one-fourteenth of the effective aperture of the object-glass. Obviously my querist is right in his proportions between the angular subtenses of the field of the same eyepiece when employed with objectives of varying foci. For example: suppose that the diameter of the diaphragm of our eyepiece were exactly 0·5in., then with a 60in. object-glass it would subtend an angle of 28′ 39″, and with an objective of 90in. in focal length an angle of 19′ 6″.

Mr. Richards (query 56380, p. 156) may well say, "But that 'if' is the difficulty." Mathematicians pay exactly the same amount of deference to Colonel Draysen's vagaries anent the centre of the earth's precessional motion, that they do the allegations of the late Mister "Parallax," concerning our world being a plane; or to the assertion of "Zadkiel Tao Tze," that the distance between the centres of the Earth and Sun is exactly 365,006 miles, neither more nor less!

**A Fellow of the Royal Astronomical Society.**

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## DOUBLE STARS—θ AURIGÆ (O. Σ. 545).

[24137.]—In compliance with a request from Mr. H. Sadler, I have examined this star on five nights with my 10¼in. With (refigured by Calver), and send a few particulars which may interest our correspondents. I can most fully corroborate Mr. Hunt (letter 24103) as to the difficulty of seeing Mr. Sadler's *comes* at 170° 50″, it has only been seen on one night, and was then noted as "excessively faint." The small star at 340° is held pretty steadily, and the star marked C by Burnham in his 1878 measures 292° 45″ is very plain. With regard to the close pair I rated the small star as 8·5 or 9 mag. (certainly not more), and it looks still smaller from its colour (to me very blue). A rough measure without clockwork on the 17th inst. gave P.A. 3° ± dist. 1·7″ ±. Will some of our observers using larger apertures look up τ Boötis (O. Σ. 270) and report thereon? I think O. Σ.'s *comes* must be considerably below 11·7 now. Two years ago it was easily visible with an 8¼in. With. This year I have not as yet been able to see it; but on the 18th a very small star was suspected at about 260° 45″, possibly an illusion.

Letchford House, Pinner. **K. J. Tarrant.**

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## TRANSIT OF JUPITER'S IV. SATELLITE.

[24138.]—On the 18th I watched the transit of the IV. Satellite from the time it had been on the disc about 35 minutes to its egress. It appeared as a black dot, and quite as dark to all appearances as that of the shadow of Sat. III., which was also on the disc of the planet at the same time. Inst. 3¼ Wray, pr. 120. **T. R. Clapham.**

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[24139.]—On the 18th inst. I had the good fortune to observe this curious phenomenon. On first turning my 6½in. reflector on Jupiter, I saw what I thought was the shadow of a satellite in transit. On referring to the ephemeris I found it was the IV. Satellite. It was on the northern equatorial belt, about half-way across the ball; its shadow was about 8″ s. f. Both satellite and shadow were intensely black. Buildings interfering with view of reflector, the satellite was watched to egress with a 3in. achro., power 100.

When the satellite had got about 4″ from the limb it began to get fainter, and I soon lost sight of it until egress. For some time after egress the satellite was very faint, and could only be seen with close attention. **C. L. Tweedale.**

Crawshawbooth, Lancashire.

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[24140.]—This evening, at 7.20, on turning telescope on Jupiter, I saw the shadow of Satellite III., and on looking for IV. saw in its place a very dark brown dot (almost black). I saw a similar occurrence March 26, 1873, when observing with the late G. W. Roberts, F.R.A.S. There has been a considerable break in my astronomical studies, and I am thus not competent to express any opinion as to the frequency of dark transits of IV. Sat. in the interval between 1873 and 1885. As this is just about equal to the period of Jupiter, can this have anything to do with the question?

In 1873 I was using an 8in. Wray, power 325, and under exceptionally favourable atmospherical steadiness. This evening I have been using a 6½in. Calver mirror, power 135, 144, and 250; but my position is very unfavourable, as a high hill to the south cuts off fully 15° of my view, and as the hillside becomes very hot in sunshine, radiation goes on for a very considerable time after sunset, and spoils definition. Thus, on returning to the observatory at 10 o'clock, the definition was very bad; but in moments of approximate steadiness I felt sure the satellite did not show as a perfectly circular dot. It was a little elongated. Shall be glad to hear if any other reader of "E. M." saw this somewhat rare phenomenon.

I should like to ask any telescopists who have used Brashear's silvering process for specula how they vary the quantity of reducing solution for varying temperature? Also if a paraffin-coated vessel will give a thicker film on speculum than if the silvering vessel were of ordinary glazed crockeryware, as I have found a heavy deposit of silver in the latter?

C. L. Tweedale (56368) had better be careful, as the model ventilator he saw is undoubtedly a patent. If he refers to the *Building News* he will probably find the ventilator advertised.

Ilkley, April 18. **Allan E. Kershaw.**

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## THE DIAMETER OF MARS—AND CONCERNING ITS SATELLITES.

[24141.]—What is the real diameter of the planet Mars? I ask for information, because the textbooks are at loggerheads upon this interesting point. Taking down a few books at random from the shelves, here are some of the values assigned to it by various authors:—

| Miles | | Page |
|---|---|---|
| 3976 | Arago's "Popular Astronomy," Vol. II. | 472 |
| 4000 ± | Chambers' "Descriptive Astronomy," | 97 |
| 4070 | Proctor's "Saturn," .......................... | 219 |
| 4100 | Mitchel's "Stellar Worlds,".................. | 129 |
| 4184 | Beckett's "Astronomy Without Mathematics," .......................................... | 213 |
| 4200 ± | Lynn's "Celestial Motions,"................ | 14 |
| 4210 | Webb's "Celestial Objects," ............ | 140 |
| 4300 | Dunkin's "Heavens and the Earth,"... | 168 |
| 4363 | Guillemin's "Heavens," .................... | 178 |
| 4500 | Loomis' "Treatise on Astronomy," ... | 222 |
| 4546 | Herschel's "Outlines of Astronomy," | 730 |
| 4920 | Plummer's "Astronomy," ............... | 115 |
| 5000 ± | Proctor's "Other Worlds than Ours," | 87 |

Showing a difference between the extremes of more than 1,000 miles in the diameter of this small planet, and a very large fraction indeed of its total diameter. And yet several of the authorities quoted profess to give the value to a single mile! Surely such large discrepancies ought not to exist in works dealing with an exact science like astronomy.

Turning now to the satellites. In that remarkably veracious book "Gulliver's Travels" (Voyage to Laputa), occurs the following passage: "They have likewise discovered two lesser stars, or satellites, which revolve about Mars; whereof the innermost is distant from the centre of the primary planet exactly three of his diameters, and the outermost, five; the former revolves in the space of ten hours, and the latter in twenty-one and a half, so that the squares of their periodical times are very nearly in the same proportion as the cubes of their distance from the centre of Mars." Assuming the diameter of Mars as 4,200 miles, Dean Swift's hypothetical satellites would stand—

| | Distance. | Period. |
|---|---|---|
| Inner........ | 12,600 miles | 10 hours. |
| Outer........ | 21,000 ,, | ·21·5 ,, |

whilst the real ones are—

| | | | |
|---|---|---|---|
| Inner.... | 6,000 miles | 7h.39m. | (Phobos). |
| Outer.... | 15,000 ,, | 30h.18m. | (Deimos). |

Both sets satisfying Kepler's third law — the former giving the ratio 4·6, and the latter 15·6, between the respective cubed distances and squared periods. Looking at the state of astronomy in those days, it seems a pretty shrewd guess by the witty dean in 1727 of what was not discovered until 1877—150 years afterwards. **W. S. Franks.**

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## ALARUM CLOCKS ADAPTED TO THE USE OF EXPERIMENTERS AND OTHERS.

[24142.]—In reply to "Abacus" (let. 24099), respecting the use of alarum clocks for giving one stroke upon a bell at given interval of time, the idea is a very old one.

Clocks with the verge escapement were used in connection with the work of astronomers in their observatories upwards of 60 years now passed and gone. The plan was a very simple one. A pin was fixed on the contrate-wheel, a slot being cut in the pillar-plate, from which another pin, made of an angular shape, protruded, planted at such a distance that the pin in the contrate-wheel began to lift a lever at the 45th second, which immediately discharged itself at the 60th second, and struck a good smart blow upon a bell, thus giving warning to the astronomer at the expiration of every minute.

Many years since I made a chronometer for a celebrated astronomer with a more elaborate attachment, which consisted of a pallet something after the shape of a pallet, to a duplex escapement. This was nicely fitted on to the fourth wheel or seconds pivot, the pallet lifting a nicely-balanced gold lever, which was brought back to its place by a delicate spring, not much stronger than the locking-spring of the chronometer; this lever lifting the tail of a hammer, which fell at the 60th second upon a very beautiful spring, or gong, fixed under the dial of the chronometer, which gave a very distinct blow at every revolution of the fourth wheel or at every minute.

An appliance, something similar to this, could be attached to the third wheel, which revolves twice in fifteen minutes; but then it would not always give a blow at the exact minute; the first blow would be at the 7½ minutes, or 7min. 30sec., and the second blow at the fifteenth minute. These applications can be made to any ordinary portable clock, without an additional train or winding up, similar to an alarum; but there would be some difficulty in constructing a train to denote a blow at egg-boiling time, or 3½ minutes, or any other irregular interval; but for the photographer or the astronomer, or for any observation consisting of any equal number of minutes, his attention is called exactly at the completion of every minute. My object in stating this to "Abacus" is to inform him that this method of denoting the exact expiration of every minute has been in operation for upwards of 60 years, and it is called the "journeyman clock" by astronomers and observers.

**W. B. Crisp,**
Author of the Prize Essay on "The Compensation Balance and its Adjustments."

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## MICROSCOPE CONSTRUCTION.

[24143.]—It was with pleasure that I saw the promise of "Os" to supply the necessary instruction for making a micro. stand, for I have found much pleasure myself in similar work, and should have been glad to show how it was done without one *special* casting or piece of material; but then I am *insane*, for I ground all my own lenses, and *bought* none. I am also short of time, and should not do justice to a large task; but I will gladly supplement "Os's" papers on the brasswork by others on the glasswork. If "Os" will show how to make a stand as solid as his own mental condition, I will show also how to produce lenses as *free* from all aberrations as my mind may be judged full of them. **Rob. Crus.**

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## "ENGINE-MAKING AT HOME."

[24144.]—As an old engineer myself, I have seen a great number of designs for the improvement of steam-engines, and if you think it of value to your readers I will briefly mention one or two of these as bearing on the subject in question. Now, from my experience of fixed steam-engines, whether large or small, if they were not fitted with either link motion or slip eccentrics, I should most decidedly use the form of guide for the piston-rod outlined at p. 533 of last volume, Fig. 4. The plan there shown is not exactly a practicable one, or one that could be used in practice on one point. But then the sketch in question is only intended to convey an idea, not a working detail. Now, I am not going to say anything on the question of appearance as regards the guide bars and motion work, as shown at Figs. 1 and 2, because if well made and properly proportioned the appearance is good, even showy. But how many amateur engineers can get such a job properly put together so that every part is true and square? Now, in my humble opinion, the fitting of parallel bar-guides is a very difficult matter, unless the maker is a practical engineer, and has efficient tools to do the work with. The number of the parts is much more than with a guide-shoe, whilst the bearing surfaces are rarely anything like the area that the guide-shoe plan gives.

If I was again making an engine for my own use, I should, in the first place, as we are on that point, use a guide-shoe, and I would undertake to get up the whole (for a small engine) without the use of a planing-machine. To make this easy, I should arrange the path of the guide-shoe, say, ½in. above the surface of the engine-bed; or make the guide itself to bolt on to the bed, thus allowing for lining up easier. Then I should most certainly have an overhanging cylinder—another advantage in finishing and use. I would desire to make it clear to "J. H.," or the writer of the articles in question, that I am not finding fault, or in any way attacking him or them, but that I state what my own views are on points of detail.

"X.," on page 128, reopens a question that I have many times had in mind—viz., that of heating a boiler by gas. I have not the early Vols. of the "E. M.," but I distinctly recollect a plan set out therein. It was to make the boiler of two half spheres of wrought iron, so that no stays were wanted, and the whole done on the anvil block. The edges were flanged out so that bolts held the two halves together. The sphere then was stood on a light casing with rings of gas underneath it. One peculiarity of it struck me at the time as not being so practical. It was the plan of partly shutting off the gas by a valve contracted by the steam. In other words, the pressure of the steam was made to force down or up a piston against a spring or resistance, and by a connection closing the gas supply partly. This is far better accomplished in the "Fontain" engine, where a corrugated tube is used for the same purpose. That the steam should regulate the source of heat is well enough; but there are practical difficulties with it, as when using a steam contracted gas cock. However, that is a problem we may yet solve.

"X." also mentions an oscillating cylinder for such small powers. Now perhaps I may, without trespassing on valuable space, just say that the class of model he mentions has no lead to the steam admission; hence the port is not wide open until mid-stroke, neither is the steam cut off until the very end of the stroke. Now such a thing with an engine of even ¼ h.p. would be very undesirable. To remedy this I have seen many plans, one successful one being a dodge to move the valve-face slightly either way, so that lead was given and an earlier cut-off. An ex-engineer in the Royal Navy, who subsequently started business as an engineer, brought to my notice a very good modification by placing the slide-valve in the bottom cover, the requisite lead and any cut-off being obtained by the oscillation of the cylinder and the action of a fixed link and block. This gave a very good result indeed. Still more recently in an engine I was invited to see in London the cylinder oscillated, but the slide-valve did not, being driven by an eccentric direct. The form in question was simple, and ran well. Contrary to my expectation, the flat surfaces did not leak steam or give trouble, as I should have supposed. Now I quite agree with "X." on the simplicity of an oscillating cylinder, and would willingly help him or others to practically solve this problem. That is to design a simple oscillator, but the valve to give a proper distribution of the steam. In my opinion it can be done with stationary valve-faces.

Having had experience with small high-speed motors, may I be allowed to say that I think there is not a question but that 1,000 revs. a minute could be got out of an engine with a cylinder 1¼in. by 3in. stroke. But the entire force of the steam would be wanted, or nearly so, to drive the engine. It must also be a special engine made for the speed, and with ports of unusual area. Then, again, if the engine be small, the boiler must be large, because a cylinder of that size and at that speed would want a great volume of steam, and the pressure kept up as well. So that I should be very strongly in favour of a moderate speed, say 200 revolutions a minute, with of course a larger cylinder than 1¼in., and longer proportional stroke, but the engine might be an oscillator, and of the simplest design possible.

A well-designed and made steam-engine in the shop of an amateur should be a thing of beauty and a joy for ever. I have had many engines, but few could ever come up to the horizontal of 2in. bore and 3in. stroke, made regardless of cost, and supplied with ample boiler power; the work it would do was wonderful, and nothing seemed (in reason) to be too much for it. On one point only it was originally troublesome, and that was the feed-pump from the speed was troublesome to start. But when it came into my hands I used a by-pass for the water and never had cause to grumble; the water was going into the boiler in a fine steady stream, thus not killing the steam, whilst at a moment's notice the full power of the pump was available if the steam began to blow off at the safety-valve. I trust more will be elicited on this subject. **Invicta.**

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[24145.]—In a paper by Mr. Thornycroft, on "Torpedo Boats and Light Yachts," read before the Institution of Civil Engineers, in May, 1881, mention was made of a blowing-engine, which had "been worked at a speed of 1,700 revolutions per minute, or 56 strokes per second, without damage."

This was a reciprocating engine, with piston and connecting-rods, every part being properly balanced.

I forget the speed of the Tower spherical engine, but it is pretty high.

Can "J. H." give a sketch, illustrating Brotherhood's method of "moving his pistons by an eccentric," or refer me to one? (See letter on page 147.)

In all the drawings I have of these engines, the pistons have directly reciprocating connecting-rods and a crank.

The steam is admitted to all the three pistons on one side, the outer side of each being alternately connected to steam and exhaust.

The connecting-rods may, perhaps, be said to move the pistons, as, being single-acting, the steam only moves them outwards, and the inward stroke is made by the connecting-rod pulling the piston in again. **Glatton.**

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## MINERAL-OIL LAMPS.

[24146.]—I should not again trespass on the courtesy of the Editor, or the patience of the readers of the English Mechanic, had not direct reference been made to me by two correspondents in this week's issue.

To Mr. P. Ward, I will only observe that in all my letters I carefully refrained from particularising any special lamp, as I desired to shun even the appearance of using the correspondence pages of this journal as an inexpensive advertisement medium. However, since Mr. Ward has mentioned the "Silber lamp," I cannot honestly permit his damaging statement, in reference to one lamp, to pass without recording my experience of many. I use (amongst others) six of these lamps, and though they have been in constant use for some years, and are lighted for sixteen consecutive hours in mid-winter, no explosion has ever taken place, nor has the carrying part of the opals ever, during those hours, been raised one degree in temperature, though they are freely carried about in a large house. Though far from being the best lamp, they are good, useful, and safely constructed, and in their cheap form have quite revolutionised the lamp trade, being at present the most popular lamp sold.

Colonel Shakespear says that I "ought to know that over-heating is caused by the metal wick-tube being in the oil," &c. I only reply that when he writes on a subject he ought to know more about it. Such long sheaths were only used in the old vegetable-oil lamps, but no well-made mineral oil lamp, raising oil by capillary attraction, has any such fitting, as it would simply prevent the lamp burning.

In initiating this correspondence, I had hoped some expert might have taken the subject up, and that I and other readers might have benefited by information thus imparted, as there is no subject more useful to the general public, and none so imperfectly understood. Perhaps my hopes may yet be realised; as it is, however, I will not further pursue it, as I may be informed, by some "well-instructed correspondent," of the demise of Her late lamented Majesty Queen Anne, and be expected to enter on a controversy on the subject.

**J. Hughes.**

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## THE MUSICAL SCALE.

[24147.]—On p. 129, No. 1046, Mr. S. E. Hunt objects to my "method of arriving at the measures (of the scale) by a succession of perfect fifths as inaccurate, as no number of perfect fifths can exactly equal the number of octaves." Like Mr. Elphick's proof of the correctness of the harmonic scale, this objection applies equally to the scale advocated and to that objected to. The scale of equal temperament is the only one which will stand this test. When Mr. Hunt says that a comparison of the values given by me with those of the equal-tempered scale shows that in the former the errors (of the latter) are exaggerated, he simply begs the question and asumes as admitted what he desires to establish. But when he says "tune to his measures, and hear how they sound," he appeals to the only true test, the one which, having applied, I find conclusively supports my case. In its application, however, as in every testing experiment, proper precautions and conditions must be observed. The monochord is, perhaps, the best instrument to use; but care must be taken that in shortening the string to produce the different notes, its tension be not at the same time increased. Another condition is (and this is essential because the scale to be tested is simply melodic) that only one note at a time be sounded. Of course, one cannot do otherwise on a monochord; but still there is such a prejudice in some minds in favour of the idea that the pitch of a note must be regulated to form perfect harmony with some other note or notes sounded along with it, that this test is apt to be applied in substitution for that of simply listening to the single notes sounded in succession. If these conditions are fulfilled, it wil lbe found that upon a monochord, divided in accordance with the perfect-fifth plan througout, the natural scale may be played or a simple melody performed with the most correct intonation; while, if the harmonic divisions are used, the third, sixth, and seventh notes of the scale become decidedly flat. This flattening is especially noticeable in the third and seventh, because it makes the semitone intervals above these notes disagreeably wide. No doubt, when a tune is accompanied with chords of other notes than those of its own melody, it is best to employ notes having the harmonic values, because more pleasing harmony is thus obtained; and in this case the departure from correct intonation in the air is not noticed.

The violin, next to the human voice, has been considered to be the most perfect of musical instruments; in fact, that these two are alone capable of giving perfect intonation. But the four unstopped strings of the violin, when properly tuned, give at least four fixed notes at intervals of a perfect fifth apart. Now this tuning is inconsistent with the harmonic scale (or, rather, that scale is inconsistent with itself). The vibration ratio of the perfect fifth is $\frac{3}{2}$ (and in this the harmonic and melodic scale agree), therefore calling the vibration *rate* of the lowest or G string 12, that of the D string is 18, of the A string 27, and of the E string 40½. But according to the harmonic theory, E must also have a vibration rate, which is $\frac{5}{3}$ of that of the G immediately below it. This G (being the octave above the note of the open G string) has a relative rate of 24; $\frac{5}{3}$ of this only 40. Now will Mr. Hunt say to which of these two pitches, 40½ or 40, the E string ought to be tuned? They seem both to be required by the harmonic system. Shall we say that, as ordinarily tuned (E string 40½), the violin is not fitted for playing in the key of G?

The scale of equal temperament, as Mr. Hunt indicates, is nearer to the harmonic scale than is the melodic or natural one, and it allows of harmonic combinations which, if not perfect, are sufficiently near exactitude to satisfy ordinary musical ears, and not seriously to offend those of finer sensibility. This, no doubt, is one reason of its general adoption; but its chief advantages are that it simplifies the system of notes required for concerted music by restricting the number to 12 in the octave, and also gives the same limit to the number of digitals or claviers required in the organ, pianoforte, &c.

Joppa, April 13. **W. Hardie.**

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## MUSICAL SCALE.

[24148.]—The question in dispute appears to hinge on the following: Is a major third to be made or not by taking $\frac{5}{4}$ or $\frac{81}{64}$ of a monochord to make it? I am quite alive to the fact that various series of fractions or ratios might be taken. Mr. H. has taken one, and with an appearance to differ from Nature's love to coincide with harmonics.

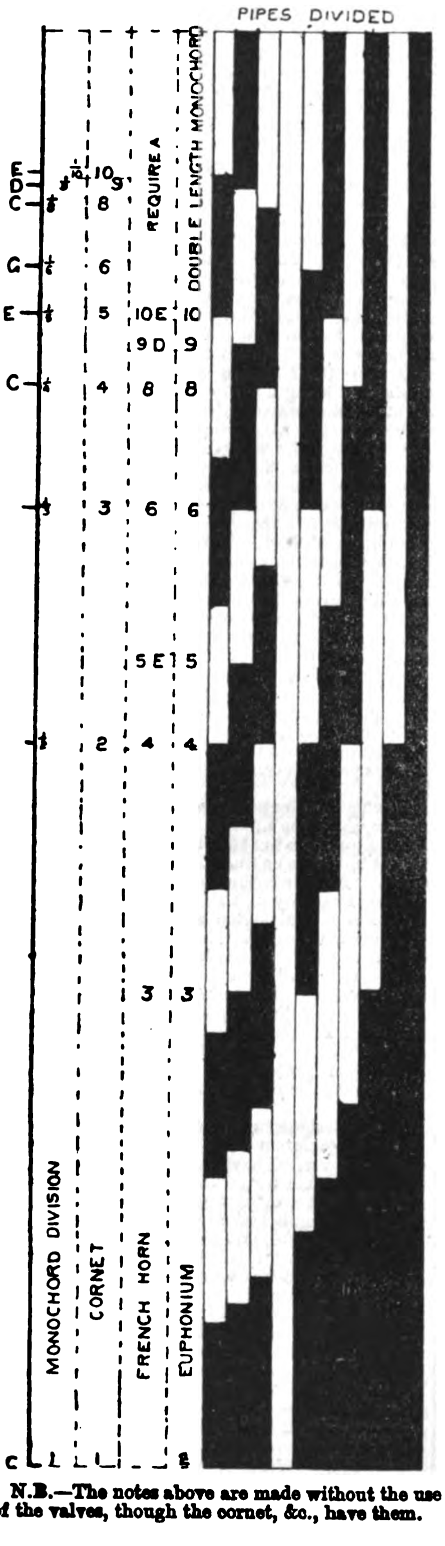
I will first take the over-blown pipes. Thus, a pipe having a certain size in *cross section* to a certain length, voiced properly, gives a full note (a one-wave tone); the same length pipe reduced in cross section by a little more pressure of wind would give the octave (a two-wave tone) most freely: still smaller, as a cornet, &c., you have great trouble to get the *one-wave tone*, if you do get it, that would depend on how much the tube had been reduced in the cross section, as all are not reduced alike; but it is rarely you can get what might really be called a note. In the French horn of the old kind, no valves, when long crooks are put on, the *two-wave note* is hard to get, even with very tender lipping; but the *three-wave tone* may be called its first division, then a four-wave, five, six, eight, nine, and ten waves follow.

In open pipes, at the end of every wave, we have what are called swells, in the centre of each wave what are called nodes; every open pipe or horn must have the swell at each end, if either divided by one or more waves; stop pipes divide in another manner, though in whole waves in them.

I herewith give a table as the best means to show what I mean; if W. H. will not accept it I cannot help that; but the thousands of readers of the "E. M." must judge—some may accept, others may not.

The fractions at the side give position to stop or bridge for certain pitches on the monochord to be tuned to C, the tenor C, and all the horns to be in C, though they are made in other keys; the pipes also tuned to C; the French horn and euphonium in their position, though they divide the same. I might hint at the wonderful number 7: it gives a sound, but not of use in harmony of music; in mathematics it is a most wonderful divisor.

Many writers on acoustics have given us divisions as I give, and as the question rests on the $\frac{5}{4}$ third or not in the table, we have four and five waves—C and E, and that divided by eight, nine and ten, C, D, and E. The table also shows how simple numbers in proportion can be used as fractions, and simply divides the monochord, pipes, or horns, and agrees with harmonics. Do we want to make them disagree? What for? Now if we take "W. H.'s" monochord, he also takes two numbers, or fractions, one for flats, the other for sharps (I do not agree with him how he has placed them), and to arrange for any key, like myself and others have taken the equal temperament, some might say, How does this affect the question? Let us test for a proof in another way, by the help of equal temperament. "W. H." puts his fifths all perfect ones; we will leave out his first fifth, the F to C; it won't affect the question, and start, as some pianoforte or organ tuners would do, what is called tenor C, tuned to a fork, then tune C to G above, now its octave G below, from this G to D above, from D to A, this A to its octave below, from this A to E, all in perfect fifths. Here we come to a test; by having a C E G on the perfect fifth principal, strike the chord. Does a tuner like this? I think not. He will say the *third is too sharp*—hardly bearable. This is the $\frac{9}{8} \times \frac{9}{8} = \frac{81}{64}$ third. To make the thirds more pleasant he makes the fifth slightly flatter. If done well, it will be the equal temperament. This third amounts to $\frac{51000}{40478}$, whereas the $\frac{5}{4}$, with the true fifth, which belongs to the harmonics, if struck as a chord, what ear can be offended at it? Its simple numbers, four, five, and six waves, repeat and repeat, whereas in the others would repeat but seldom, and only produce beats instead of a third tone, which would not mix pleasantly. A C of 128 and E of 160 waves would give a sub-harmonic 32 beats to the second, and with a fine ear can be heard as a sub-harmonic; a C and E, two or three octaves above, would give out a higher and stronger harmonic; if C and E a $\frac{81}{64}$ third we should have to chose those having 2048 and 2592 waves per second to give even the first recognised sub-harmonic, therefore beats or a shaking noise would be heard if lower thirds were used of $\frac{81}{64}$ kind.



N.B.—The notes above are made without the use of the valves, though the cornet, &c., have them.

"W. H." also says it's not a *fifth*, the B to F. Will he undertake to correct all those who write on "Thorough Bass," or show where our good composers of the past were wrong? They have shown us how to use this fifth, and call it a diminished, or an imperfect fifth. I know it is a discord, but it is used and resolved to a concord. I will not undertake to correct them.

I take this step to answer on account of the readers of the "E. M." Those who already know will excuse if I tell the "Old, old story." Those who live to learn, like myself—should I have given them any hints worth note, I shall feel thankful I have at least written for some one's good. I would ask every cornet or horn player of the "E. M." readers to test the table without the use of the valves. I have kept to the key, that no twisting or elastic arguments could call forward enlargement or side thrusts, as both readers and Editor might tire.

Before I close I will touch on the semitone, which makes up the fourth. Is not a $\frac{16}{15}$ more simple than the semitone fraction $\frac{256}{243}$? also $\frac{5}{4}$ for the third than $\frac{81}{64}$. In the table I have not the $\frac{16}{15}$; but that could have been shown if I had enlarged the table and divided the monochord, for 12 to 15 is as 4 is to 5, and 12 to 16 as 3 to 4; therefore the difference of a third and fourth.

I will now conclude. I think I have not cut up and disagreed with harmonics, and what true lover of music would not feast on chords struck by them to his inmost soul's delight, and even now and again admire a diminished or imperfect fifth, that by contrast the harmony might be enriched, and thus gain rather than lose by there being more than one fifth, as well as more than one third, as the $\frac{5}{4}$ third, which is used.

New Cross, S.E. **W. H. Elphick.**

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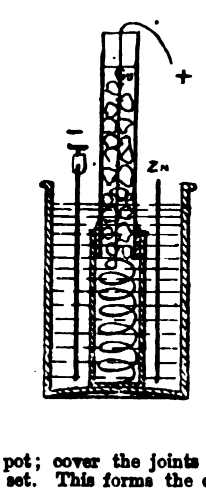
## IMPROVED DANIELL CELL.

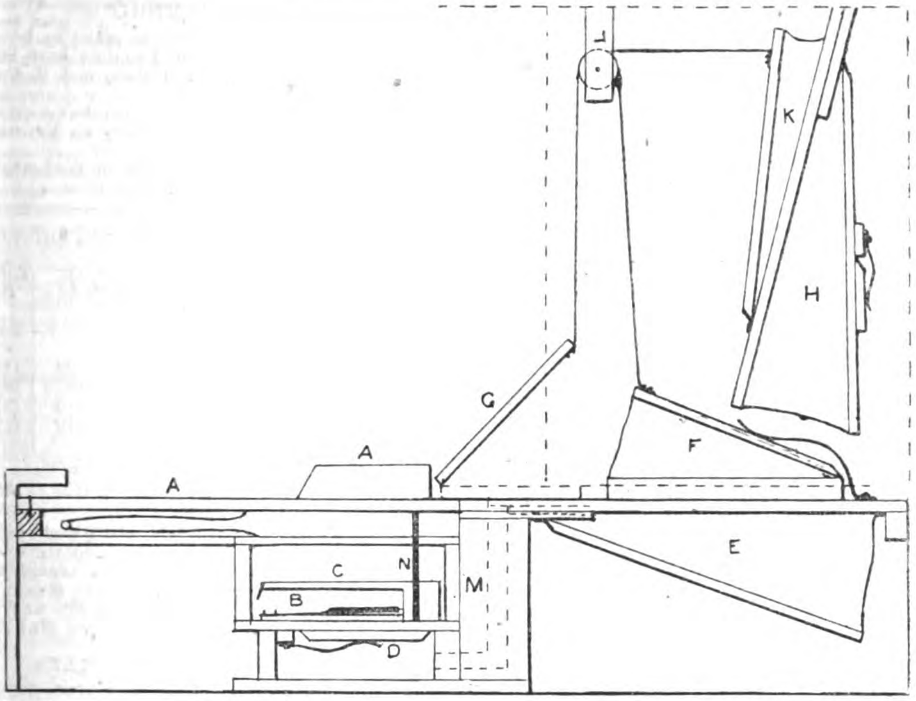
[24149.]—Hoping it will be interesting to some of your readers, I herewith send you a description of my new cell. All who have used the Daniell cell know what trouble there is to keep the copper solution out of the zinc division, because it always has a tendency to creep over the porous partition or pot, and so into the zinc sulphate. This arrangement which I am about to describe completely stops this action, and so adds to the life of the cell. The solutions still mix, but only by diffusion through the porous pot; this cannot be stopped by any means which we know of. In making up this cell, I take a porous pot 1in. shorter than the jar which forms the outside containing vessel, then take a piece of glass tube 4in. or 5in. long, and of a diameter slightly smaller than the inside of the porous pot, wind round one end of this a length of ¾in. tape until it fits the pot tightly; soak this end in melted wax and place it in



the porous pot; cover the joints with wax and allow it to set. This forms the cell to hold the copper solution. To form the negative pole, take a few yards of copper wire and wind it into a close spiral which just drops through the glass tube; leave a length of wire to form the outside connection. Bend a zinc plate to fit outer vessel, and the cell is complete. Charge in the usual way, and place a few crystals of sulphate of copper in the glass tube. It improves the cell to cork the glass tube, passing the wire through the centre of the cork. The solutions should be level with each other, and sufficiently high to cover the juncture of the glass tube with the porous pot. You will readily see that this form of cell makes it impossible for the copper sulphate to find its way into the zinc solution except by diffusion. This form of cell is well adapted for electric clockwork, and as I have seen many inquiring for a suitable battery for this purpose, I hope this will meet their wishes.

I inclose a rough sketch of the cell, which explains itself, if you think it worthy of publication.

**Clement H. Wragge.**



## SEPARATE PEDAL ORGANS FOR AMERICAN ORGANS OR HARMONIUMS.

[24150.]—Thinking that this subject may be interesting to the musical portion of your readers, I send rough sketch and brief description of a separate pedal organ, which can easily be attached or connected to an American organ or harmonium not affording the facilities for pedal practice at home. The pedal organ is contained in a frame not less than 6in. deep. The instrument, to which it is required to be connected, is placed over or on the back portion of the frame in which is situated the bellows, consisting of a large reservoir and two feeders. In reference to sketch, A A shows pedal board, B the reed, C the tube, D the pallet, E is the reservoir of pedal organ bellows, F is the feeder of same, H and K show reservoir and feeder of American organ bellows. The feeders of both instruments may be connected to the footboards by webbing attached in the usual way. G is the footboard of American organ. A separate roller, L, should be added, to pass the webbing over; that is connected to feeders of pedal organ bellows. N shows the plunger, which is actuated by the pedal. The dotted lines at M show how the air is conducted from windchamber to reservoir. The other dotted lines show position of side of American organ to which the pedal organ is connected. If the bellows of the latter is required to be worked by a separate blow-lever, with the bellows of the American organ, the mode of connecting the feeders will somewhat differ to that explained in sketch. The feeders of the pedal organ bellows may be connected to both footboards and separate blow-lever if desired. Munroe's pedal bass reeds are most suitable for the described arrangement, as it is constructed on the suction principle, with exhaust bellows. It is more convenient, and less trouble, to place the reeds in a tubeboard, with tubes spaced out to suit the compass of pedal board. The latter method does away with the inconveniences and complication of a radiating action, and is certainly more simple, and quite as effectual, as the other method. **G. Fryer.**

## TESTS FOR A 6½in. MIRROR.

[24151.]—If "Aleph" (letter 24102) would get Webb's "Celestial Objects for Common Telescopes," he would have no difficulty in finding plenty of tests for his mirror. He must not, however, flatter himself that ξ Ursæ Maj. is at all a test for a 4in. o.g.; I divide it easily with my 4in. Wray, power 160. Webb calls 52 Orionis an excellent test (for what aperture he does not say), but I divide it well with 250.

As comparative light tests, perhaps the following may be suggested:—

| | |
|---|---|
| ν Ursæ Maj. | 4, 12, – 7·8″ |
| ι Do. | 3·5, 13, – 12″ |
| θ Boötis | 4, 12, – 60″ |

The two 13th-mag. stars between $\varepsilon^1$ and $\varepsilon^2$ Lyræ.

As a test of separating power

| | |
|---|---|
| ξ Boötis | 3·5, 4·5, – 1″ |

These are all visible to the naked eye, and are now well placed for reflectors; but unless "Aleph" has a star map; I don't see how he is to identify them; and if he has a map, why request naked-eye tests, as almost any star can then be found if care be exercised, either by the finder or a very low power. I, of course, assume the absence of equatorial circles.

I saw ν Ursæ Maj. well, and the two debilissimæ in $\varepsilon^1$ and $\varepsilon^2$ Lyræ with difficulty (being low down) on the 6th inst., powers 160 and 290 respectively, though I am situated in the heart of the City. The others I have not yet examined.

London, April 18. **Beta.**

## A NEW METHOD OF FORMING CRYSTAL MODELS BY PLAITING.

[24152.]—I think it will be hardly necessary to define the models, which can be formed from the diagrams otherwise than by their names.

Fig. 10 gives the *Doubly Oblique Prism*, Fig. 11 the *acute rhombohedron*, Fig. 12 the *obtuse rhombohedron*, Fig. 13 the *Scalenohedron*, and Fig. 14 the *Double hexagonal pyramid*.

FIG. 10.

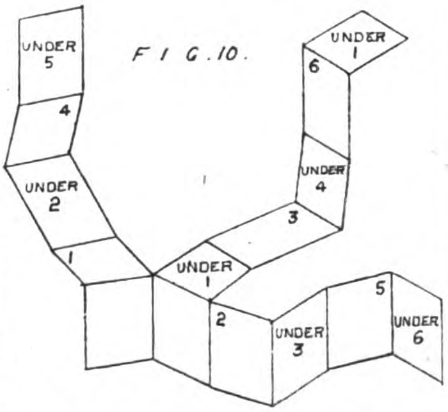
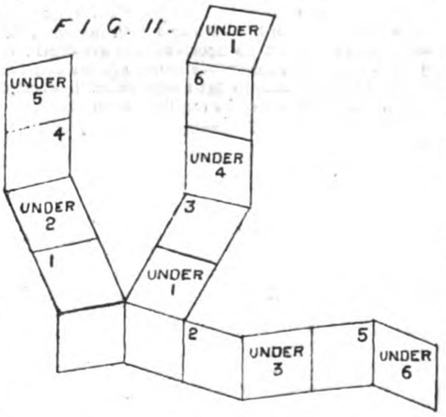
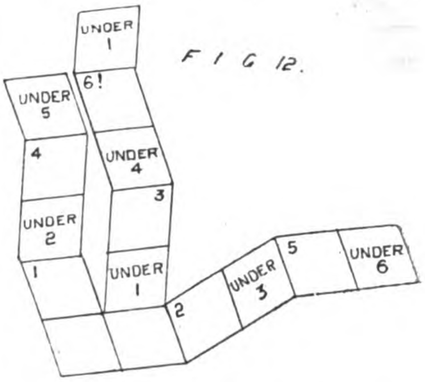


FIG. 11.



Many readers will be previously aware of the forms of these models, others will have little difficulty in plaiting from the figures; and if those who find any difficulty will send me a stamped envelope I shall be very happy to send them an explanation of their difficulties, and perhaps one of the models, from which they will get a better understanding of my meaning.

FIG 12.



Only one remark is, I think, really neeeded on the above-mentioned figures. In Fig. 12 the mark ! will be seen on the face marked 6. I put this there so as to mark the face which should be pulled, after the model is plaited, so as to undo it with the greatest ease.

FIG. 13.

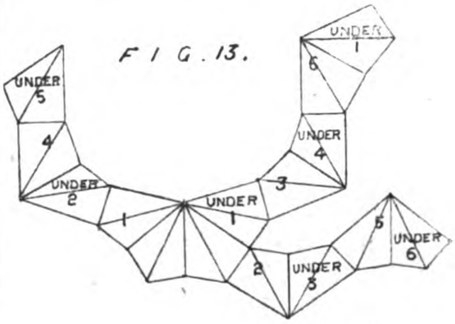
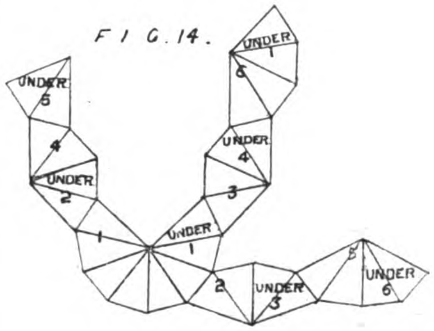


FIG. 14.



Errata.—In the heading of my first letter on this subject "crystals" should be crystal models; in the heading of my second letter "foming' should be forming. In my first letter I should have said that the best material for making the models is "glazed cambric pasted on white paper." In my second letter, in the formula for Fig. 7, "δ" should be S.

In the analytical table sent with my last letter, "scalenshedron" should be "scalenohedron," and "rectangular octohedron" should be "regular octohedron."

I quote from a letter I have just received from Mr. Gorham the following remarks:—"The models require *some* making to bring them home completely. You cannot make a model correctly by drawing it with compasses and ruler, but by making a plane of cardboard, and repeating it by tracing around it, and this in such a way that the proximity of the planes decreases from zero—say, from the two blank planes of a cube, which are to remain inside—to plane 6, which is to come outside, so that the two blanks and plane (1) and plane (under 1) are drawn as close as possible; plane (2) is a shade of a ghost of a line farther apart, but plane (under 2) is kept close; (3) is sensibly at a greater distance and (under 3) close; (4) is wider still, and so on. I find this is the only decent way of making a model after a trial of *some hundreds*."

Park House, Tonbridge. **E. A. Tindall.**

Comparison of Tides at Liverpool and Fleetwood for the Month of March, 1885.

| Date. | Calculation. | | Observation. | | Error. | Barometer | Wind. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | ft. | in. | ft. | in. | | | | |
| March 1 | 28 | 6 | 27 | 11 | − 7 | 30·1 | W.N.W. to E.S.E | Slight. |
| | 28 | 2 | 27 | 11 | − 3 | 30·1 | — | Dominant system anticyclonic |
| 2 | 28 | 11 | 28 | 10 | −11 | 30·1 | E.S.E. slight S.S.W | Fresh outside. |
| | — | | — | | — | — | | — — |
| 3 | 28 | 9 | 28 | 6 | − 3 | 29·6 | S.S.E. | Strong. |
| | 28 | 10 | 28 | 9 | − 1 | 29·5 | S.S.E. | Strong. |
| 4 | 28 | 0 | 28 | 7 | + 7 | 29·3 | S.W. | Fresh to strong. |
| | 27 | 9 | 28 | 4 | + 7 | 29·4 | S.W. | Fresh to strong. |
| 5 | 26 | 8 | 27 | 1 | + 5 | 29·5 | S.S.W. | — — |
| | 26 | 5 | 26 | 6 | + 1 | 29·5 | — | Variable winds. |
| 6 | 25 | 2 | 25 | 5 | + 3 | 29·5 | N. to N.N.E. | Slight. |
| | 24 | 10 | 24 | 11 | + 1 | 29·6 | N. to N.N.E. | Barometer rising. |
| 7 | 23 | 6 | 23 | 7 | + 1 | 29·8 | N.E to W. | Unsettled. |
| | 22 | 11 | 23 | 4 | + 5 | 29·8 | S.S.W. | Fresh. |
| 8 | 21 | 10 | 22 | 3 | + 5 | 29·9 | N. to N.W. | Slight. |
| | 21 | 0 | 21 | 3 | + 3 | 29·9 | N. to N.W. | Slight. |
| 9 | 20 | 4 | 20 | 0 | − 4 | 30·0 | N.W. to N.E. | Fresh; anticyclonic. |
| | 19 | 6 | 19 | 0 | − 6 | 30·1 | N. to N.E. | Fresh; anticyclonic. |
| 10 | 19 | 5 | 19 | 0 | − 5 | 30·3 | N.E. | Slight; anticyclonic. |
| | 18 | 10 | 18 | 6 | − 4 | 30·4 | N.E. | Barometer rising. |
| 11 | 19 | 10 | 18 | 10 | −12 | 30·5 | N.E. | Wind light and variable. |
| | 19 | 7 | 18 | 11 | − 8 | 30·5 | N.E. | Fresh; very high barometer. |
| 12 | 20 | 9 | 20 | 1 | − 8 | 30·6 | N. | Slight; still anticyclonic. |
| | 20 | 10 | 20 | 1 | − 9 | 30·6 | N.E. | Slight; still anticyclonic. |
| 13 | 22 | 5 | 21 | 10 | − 7 | 30·6 | N. to E.N.E. | Fresh; still anticyclonic. |
| | 22 | 3 | 21 | 9 | − 6 | 30·6 | E.N.E. | Fresh. |
| 14 | 24 | 4 | 23 | 8 | − 8 | 30·6 | E.N.E. to S.E. | Slight. |
| | 23 | 11 | 23 | 6 | − 5 | 30·6 | — | Large anticyclone still prevailing. |
| 15 | 25 | 11 | 25 | 0 | −11 | 30·5 | N.N.E. to S.S.E. | Slight. |
| | 25 | 3 | 25 | 1 | − 2 | 30·5 | S. | Slight. |
| 16 | 27 | 0 | 26 | 4 | − 8 | 30·4 | S.S.W. to N.N.W. | Fresh; anticyclone. |
| | 26 | 4 | 26 | 2 | − 2 | 30·2 | N.N.W. | Fresh; gradients steep. |
| 17 | 27 | 11 | 28 | 1 | + 2 | 30·1 | S.W. | Freshening. |
| | 27 | 4 | 27 | 7 | + 3 | 29·8 | S.W. | Fresh. |
| 18 | — | | — | | — | 29·5 | W.S.W. | Fresh to strong. |
| | 28 | 9 | 28 | 2 | − 7 | 29·7 | N. to N.N.W. | Strong; anticyclone. |
| 19 | 27 | 8 | 26 | 8 | −12 | 29·9 | N.N.W. to N.N.E. | Strong. |
| | 28 | 9 | 27 | 8 | − 1 | 29·9 | N.W. | Fresh. |
| 20 | 27 | 1 | 27 | 5 | + 4 | 29·8 | W.S.W. | Strong; steep gradients. |
| | 27 | 9 | 28 | 1 | + 4 | 29·8 | N.W. | Fresh; steep gradients. |
| 21 | 26 | 0 | 26 | 11 | +11 | 29·7 | W.N.W. | Strong; whole gale in Scotld. |
| | 26 | 4 | 26 | 5 | + 1 | 29·8 | N.W. | Fresh. |
| 22 | 24 | 9 | 24 | 6 | − 3 | 29·9 | W. to N. | Slight. |
| | 24 | 7 | 24 | 4 | − 3 | 30·0 | N.E. | Fresh. |
| 23 | 23 | 4 | 22 | 10 | − 6 | 30·2 | N.E. | Slight; large anticyclone. |
| | 22 | 8 | 22 | 8 | 0 | 30·3 | N.E. | Barometer falling. |
| 24 | 21 | 8 | 22 | 0 | + 4 | 30·2 | N.N.W. to S.W. | Slight. |
| | 21 | 1 | 21 | 1 | 0 | 30·2 | S.W. | Slight. |
| 25 | 20 | 10 | 20 | 9 | − 1 | 30·2 | W.S.W. to S.E. | Slight. |
| | 21 | 8 | 21 | 7 | − 1 | 30·1 | — | Wind variable. |
| 26 | 22 | 1 | 22 | 0 | − 1 | 30·0 | S.S.W. | Fresh. |
| | 22 | 10 | 23 | 11 | +13 | 29·8 | S.W. | Strong to gale. |
| 27 | 23 | 9 | 24 | 4 | + 7 | 29·7 | W.S.W. | Strong to gale. |
| | 24 | 5 | 25 | 6 | +13 | 29·9 | N.W. | Very strong. |
| 28 | 25 | 7 | 25 | 0 | − 7 | 30·2 | W.S.W. | Fresh; sudden rise in bar. |
| | 25 | 11 | 25 | 9 | − 2 | 30·1 | W.S.W. | New depression approaching. |
| 29 | 26 | 10 | 27 | 4 | + 6 | 29·9 | N.W. to S.S.W. | Fresh to strong. |
| | 26 | 11 | 26 | 2 | − 9 | 30·0 | N. | Very strong. |
| 30 | 27 | 10 | 26 | 10 | −12 | 30·1 | S.S.E. to N.E. | Fresh. |
| | 27 | 8 | 27 | 8 | 0 | 30·3 | S. | Slight; bar. rising generally. |
| 31 | 28 | 0 | 27 | 7 | − 5 | 30·3 | N.E. to S.S.E. | Slight; anticyclone. |

## COMPARISONS OF TIDES.

[24153.]—The interest which attaches to the oscillations of the ocean as connected with the varying barometric conditions and the direction and steepness of the gradients of the atmosphere can only be appreciated by those who make the subject one of close observation and study, and who have the advantage of residing in localities where the tides are, if superimposed, of equal age and of extensive range. This is the case eminently on the Lancashire coast. During the last month, as is the case in March generally, the weather has been exceedingly unsettled; the fluctuations of the barometer have been very extreme, and the alternations of cyclone and anticyclone extraordinarily rapid. But a reference to the accompanying comparisons, which are drawn from simultaneous observations made at Liverpool and Fleetwood, will show how completely the sea-level is subservient to these changes, and with what amount of exactness their effects may be predicted. The "diurnal inequality" maintains its sway in spite of them all, and the law which regulates it is proved to be inexorable. As surely as the moon or "anti-moon" (i.e., the obverse attraction) is traversing from the southern to the northern hemisphere—from a region, in fact, where ocean predominates to a region in which there are only continents—so surely is the corresponding rise of tide due to the attraction greater than that of the following tide, and *vice versâ*. The month of March opened with strong winds, due to a large anticyclone, which was travelling from north to south. This was succeeded by cyclones of less area. From the 9th to the 23rd anticyclones prevailed almost continuously, and as these rotate in the direction of the hands of a watch, with barometer highest in the centre, they deluge us with cold airs from the north and east, and cause the prevailing low temperature, which is so generally objectionable. But the sea-level is thereby depressed, and each tide shows it; often the depression is in advance of the wind, though sometimes it lags behind it. A sudden shift in the motion of its centre seems to cause an equally sudden change of level, examples of which occur on the 24th and 26th instants. The accordance cannot be accidental or artificial; it is quite certain all such movements are submissively made in obedience to laws by which hydrostatic and pneumatic pressures regulate each other.

**James Pearson, M.A., F.R.A.S.**

Fleetwood, April 8.

## OLD LOCOMOTIVES.

[24154.]—Railway men who remember the opening of lines 55 years ago are few and far between, so it is always pleasing to hear from them. It is quite certain, from what Mr. Stretton and Mr. Read say (letter 24123, p. 150), that in 1830 there was an engine "Invicta" on the Whitstable line; but is it not strange that none of the locomotive books—Woods, Clarke, and others — say a word about either the line or the engine. Will Mr. Edw. P. Read kindly say how long the engine was at work, where she is now, who the line belongs to at the present day, and any other things he can tell us about the old rails and rolling stock?

**Anxious to Know.**

## NEW MIDLAND ENGINES.

[24155.]—Yes, sir, it is true, as asked in letter 24126, p. 150, that the big 1667 engines have less heating surface than the 800 class, and it does account for all lost time.

An engine that is short of steam is never a cheap working engine: she must be heavy on the coal heap.

Below I hand you a few figures about the heating surface of a few engines on the Midland—

| Number. | Date | Cylinder. | Stroke. | Wheels. | | Heating surface. | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Of tubes. | Of firebox. | Total ft. |
| | | | | ft. | in | | | |
| 890 class. | 1871 | 17 | 24 | 6 | 8 | 1020 | 92 | 1112 |
| 800 rebuilt | 1877 | 18 | 26 | 6 | 8 | 1115 | 110 | 1225 |
| 1327 | 1877 | 18 | 26 | 7 | 0 | 1203 | 110 | 1313 |
| 1667 | 1884 | 19 | 26 | 7 | 0 | 1011 | 110 | 1121 |
| London and Brighton engine, Gladstone. | | | | | | | | |
| Gladstone | 1883 | 18½ | 26 | 6 | 6 | 1372 | 112½ | 1585 |

The figures tell their own tale, and I won't take up your room. Just look at the proportion of cylinder to heating surface: that is enough to account for all faults we hear of. There is not an engine on the line like the 800 class for fine work.

**An Old Locomotive Man.**

## LOCOMOTIVE DRIVING AXLES.

[24156.]—I entirely agree with your correspondent "Inquirer," p. 150, that the question of axles breaking should receive the careful attention of the railway contributors to the English Mechanic.

In your issue of 13th March, I gave a table, p. 34, which I hoped would form the subject of discussion, but it appears that it "has been passed over in silence."

The subject is certainly one of considerable difficulty, and further details and knowledge will be required before the subject is finally understood. "Inquirer" asks, "Is iron or steel the best material for crank-axles"? This is a very proper and a very natural question, but one that neither I nor any other engineer can correctly reply to in the present incomplete state of knowledge.

During the year 1883, 347 crank or driving axles failed; 173 were made of iron, and 74 of steel.

The average mileage of

171 iron axles = 213,719 miles;
72 steel axles = 199,471 miles.

The mileage of four axles being exceptional, it is not included in this average.

During the nine months ending 30th September, 1884, 152 crank or driving axles failed; 102 were of iron, and 50 of steel.

The average mileage of

99 iron axles = 216,857 miles;
47 steel axles = 156,115 miles.

From these figures it will be seen that the "iron" axles appear to have an advantage in mileage, yet it is a well-known fact that "steel" is much the stronger, and fewer steel axles failed. It is often stated, and is almost taken for granted, that a crank-axle is, and must be, weaker than a straight axle; but there seems to be no proof that this is the case in practice.

I have carefully worked out the various strains upon a crank-axle due to direct weight, leverage, and force of steam acting on the pistons; but they fall far short of the force which would be sufficient to break a good sound axle. What is it that breaks a crank-axle? This is a question constantly asked, but so far not clearly replied to. If the weight and pressure of steam is not enough to account for the failure, other reasons must be looked for.

When an engine is running at high speed there is a greater or less amount of oscillation; this is kept in check by the flanges of the wheels, and great strain is put on the axles. Points and crossings are generally laid to gauge or even tight, and it frequently happens that the flanges of the wheels are thus pinched, and it will be at once seen that this action must exert an enormous force upon the axle by the tendency to bend it upwards in the middle. This force is greatly increased with the size of the wheel, as the leverage or length of the spoke is greater.

It seems perfectly certain that the strains, which increase growing flaws, and ultimately end in a failure, are in a very great measure due to the force communicated to the axle by the wheels and flanges. This side thrust is therefore a matter for very serious attention, and having expressed the opinion that one of the principal causes of axles breaking is due to it, I have advocated the driving-wheel flanges being turned thinner than the others, in order to avoid the side shocks and pinching action as far as possible.

It may interest your readers to know that the whole subject of "axles-breaking" is engaging the most careful attention of the Leicester branch of the Amalgamated Society of Railway Servants; two evenings have already been devoted to it, and it again stands first on the notice paper. Various valuable details have already been brought to light in the course of the discussion by these practical men, and all possible data have been obtained from every important line in the kingdom. It is well known that axles break "at growing flaws"; now how do these "flaws" begin? Are they in the metal at first, or do they begin *after* the engine has been running? If the latter, what cause is it that starts the flaw? Should an axle, after running a certain number of miles, be taken out and disused? These are some of the points upon which, as I have already said, more information is required before a sound opinion can be expressed.

**Clement E. Stretton, C.E.,**
Hon. Mem. A.S. Ry. Servants.
Leicester, April 18.

### LATHE MATTERS.

[24157.]—I do not, myself, regard anything but an edge tool as legitimate to act on soft surfaces; but my experience is, as is that of others, really limited as yet, in many ways, and so I do not venture to express any opinion on the matter of diamond-set laps; they seem to have given satisfaction to Mr. Hines and others to a considerable extent, however.

Diamond, from its splinter-like nature, I should have been especially doubtful of, and, following my natural bent, should have first, on going to use it on soft metal, have tried to firmly imbed the sparks with a hard steel roller, afterwards going over a try-surface to test their hold and remove loose ones. The difficulty or impossibility of burnishing off the edges of any bits accidentally left in the surface acted on, would have made me additionally chary of using it. I have no present intention of either advocating its use, nor of trying it. It is my present opinion that a cutting tool would best give the amount of accuracy and finish necessary for a soft-nosed mandrel, with a hardened and accurate cylinder centring. If the outer end or tip of nose is preferred hardened, to prevent wear or bruising, without weakening the hold-fast strength of nose, I may have to change my plans.

I have had experience of getting soft bearings to great accuracy; I have no wish to add to it. You can hardly touch a soft surface with anything that will not set in it, more or less, and when you have got it up, by dint of carefully setting up your centres, straining spring out, or to a minimum, getting up high speed without vibration, extra hardening your tools, shaping them with a lens, and then polishing them up, then finishing, at much expense of time, with a soft bit and rouge; you have only to look at it to scratch it. When this latter feat is accomplished, you must either begin again, or be satisfied with unfaithful work, for the alternatives are either to true it up again, and re-polish all over, or to polish out the scratches, in the first case reducing the size, and in the second, producing little depressions where the scratches were. No measuring tests can, perhaps, detect the error; but it is there, and in the course of time would have its due influence and effect.

I am glad to note that "J. K. P." is satisfied with the accuracy obtained by "touches in a screwing lathe," and is not like some foolish workmen of whom we read, that they found their work but seldom to their liking. I have hopes that I may attain to about the same pitch of perfection in the tools and instruments I am designing and making. Dr. Edmunds, also, who is anxious to raise the particular branch of mechanical work he affects to such perfection as art and science may admit of, and industry accomplish, will be cheered greatly. I do not wish to "poke fun," but to hint that there is work to be done of a somewhat higher class than a screwing-lathe and edge-tools can accomplish; and that there is one section of the English Mechanic readers and correspondents who are aiming in this direction.

"What I know that I know," is impressive; but in a recent discussion on friction did not appear quite the case.

So (24115) I should, though tempted by the "cui bono" not to do so, like to point out that "a cutter with a distorted periphery" is not the tool in question; it is a lap-wheel to be set with diamond sparks, and of a true periphery. Has a Morse drill a distorted form because, though ground out by an angled circular cutter, it has a straight tip?

If it were a cutter, "in order to be an efficient workshop tool," the teeth would be cut out roughly by files, cutters, or sliding tools with ease and speed, and the edge would have to be given by grinding and sharpening after hardening. There would be no great difficulty in making one by hand, if the axial line to cut the teeth to were marked in place as turned; the lines would be straight, and of the true thread angle, though the edge of cutter would be axial to screw, and inclined to its own axis. After hardening, if distorted much—and it ought not to be if properly treated—there would be some trouble with it, perhaps; but in a workshop, amongst workmen, there would be no real trouble at all. If in demand, they could be had as cheaply as any other simple form.

If it is desirable to reverse chucks, how will the cone-nose advocates do, or how have they missed the point? In a cylindered mandrel the prevention of reversing would be a safeguard to centring.

I grow more and more astonished at the amount of discussion and quasi-relevant recriminations that can arise from trifles, more or less. I hope it will continue to be the case: otherwise we shall actually begin to make progress. **Vulcan.**

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[24158.]—I had some doubt, after letter No. 24114 was written, whether I might not have blundered, by failing to make a distinction between the action of square or rounded-edged cutters (or grinders) as applied to cylinders, and those which have angular edges, whether symmetrical or not.

I have since made an experiment on a large scale, and am convinced thereby, as well as by the opinion of a very experienced practitioner in that direction, that I may let that letter go down to "die Ewigkeit" by only correcting a word or two.

In p. 149, first column, line 17, the fitting in question is a female mandrel, broad-flanged, commencing with a cylindrical hole, and the internal screw a good way inside from the front. This fitting, I learnt from Mr. Clements's lathes, for which I once had more reverence than I now have; but I like it for this purpose, as, in a drill spindle used in the slide-rest, the less the drill projects the better, and the drill-chuck and all the fitting portion of the drill-stem are in this construction contained within the body of the spindle.

Line 39 down, "referring" should read "refers," and about 31 lines lower, "mean depths" should be "mean depth." Four lines lower, for "in outline, is," read "is, in outline." Three lines from bottom, for "that purpose is," read "for that purpose mine is." I wish to repeat, that any knowledge I possess I will give freely to any ordinarily civil inquirer; but I will not argue. If I make a statement, I do so confidently, as knowing that what I say is right; if I have a doubt, I will admit the same. **J. K. P.**

### TRUEING MANDRELS.

[24159.]—It appears to me that the method of "trueing up" maudrels, described by Mr. Wenham, (in 28882, page 560), is not strictly or critically speaking, a method of "trueing up" at all; for though errors might be reduced by continued working, they could not, in the nature of the process, be eliminated; in fact, cutting tools, unless bent into rigidity, and set in mechanisms also rendered sufficiently rigid, and acting upon rigid or already true and homogeneous substances, cannot turn out true work—work that will stand critical tests.

Paper rolls of chilled iron are turned very approximately true by diamonds, but they are of comparatively large diameters, and rigid in themselves, and spring at point of tool is of less effect than for smaller diametered lathe mandrels. With the very light cuts, and a "stout rod," which, however, has its liability to spring, recognised in the directions "below the centre," &c., very approximate results might be got; but unless the mandrel was homogeneous and true to begin with, the tool and work would spring apart, more or less, at the hard portions and protruding portions, continually reducing inaccuracies, if kept constantly traversing to and fro, but never eliminating them. As "F. A. M." said, regarding his centre cone, the which he scraped into truth, "we cannot turn true,"—we cannot, that is, by the methods in vogue.

The attainable set-offs against uneven hardness or contours, to be made true, are high speeds and rigid tools; in the former case, the inertia of the work comes in as an equivalent of rigidity, and also, while there is no vibration, as a cause of true running, small disturbing causes have their actions equalised, or have not the time to produce the effects they would at slower speeds.

For "trueing," high-speeded revolving laps, such as are generally in vogue (I have seen some very large surfaces treated in this way), are certainly more capable than cutting tools at slow speeds; in the soft state, very good results can be got by very hard tools, light cuts, and high speeds; but for hard material, it appears to myself that a high speed on the object, a stretched or otherwise made rigid tool or apparatus, and fine multiple cutters—an abradant, in fact, first with one facet, to produce, as near as possible, circular contour, and then cylindrical form, and finally with multiple facets, and properly ordered motions—following in the wake of the opticians—and fine rouge, to produce the highest attained accuracy and polish,—would be the way to go to work on a really fine mandrel.

I think, also, there is room for tests, to detect lack of homogeneity in soft state, with a view to its correction in the hardening. It is more needed after hardening than before it. **Vulcan.**

### DIAMOND TOOLS.

[24160.]—Since writing my last letter I have paid a visit to my father, who, though no longer in business, still keeps on an amateur workshop. The business I now carry on was founded by Cawdron, my great uncle, who was a compeer in ornamental lathe-making with the original Holtzapffel. Cawdron used diamond tools for trueing up hardened steel mandrels. Three of these tools came into the possession of my father, all of which I recollect when a boy, and, though the largest of these has disappeared, my father has hunted up two of them, and they are now in my possession. These can be examined by any one who will give me a call. No. 1, which appears to have been most used, is a long triangular-shaped splinter, the greater part of which is buried in a copper rod, showing an angular point or edge, which is somewhat injured. No. 2 has evidently been fractured somewhat in use; but has still an edge or point which will cut.

No one doubts that the diamond is capable of paring down hard steel; the only question is, whether its use, now that we have modern methods of emery and other grinders, will ever become of workshop use except in very special cases? These tools will be found to be very expensive, difficult to set so as to stand their work without breaking off or getting loosened, and very uncertain in their work. They cannot be ground down to an effective edge upon a diamond lap, as Mr. Wenham thinks.

The only kind of diamond that will not break away is the carbonado. This is so hard that the skyfe will not touch it; or only with so much injury to itself that the professional diamond-cutters will have nothing to do with it, and, if they would, only at great expense. Then, again, Mr. Wenham is entirely wrong in this idea of sharpening up the above, like grinding up a lathe tool, for when once the natural angle with its outer skin is gone, that portion of the stone is useless, and the only way is to reset it so as to bring out another natural angle.

The work done by the diamond upon hard steel is not the most satisfactory, and such work can not, in this manner, be finally finished up suitable for such sliding work as the traversing mandrel; but in all cases must afterwards be laboriously lapped up true; consequently, the tool is really of but little practical use.

Mr. Wenham writes as if Dr. Edmunds had suggested to cut the screw-threads with diamond grinders. All he has suggested is, that in certain cases where hard steel hobs or screw-noses are required of extreme accuracy, they may be trued up to the extent of reducing the surface a fiftieth of an inch.

In fact, there is little need to take any such trouble with the Edmunds mandrel-thread, insomuch as it is left rather an easy fit, and the set of the chuck is secured by the true face-zone and the true cylinder-base. What Mr. Wenham says, is that "a revolving V-cutter (50°) does not cut the same groove as a fixed-point tool of the same angle and equally tilted for the rake of the thread."

That is a point upon which I say that Mr. Wenham is in error.

Griffin Works, Norwich. **Edward Hines.**

### MILD-CENTRE STEEL.

[24161.]—In reply to Mr. Wenham's remarks about mild-centre steel, I beg to inform you that it is made by all Sheffield steel makers nearly, and I believe is made thus:—A round bar of iron, heated to a certain point, is placed in the centre of the mould, and the steel poured round it.

**H. Gilbert.**

### MERCURY AS BALLAST.

[24162.]—Fill a quill with quicksilver, cork the ends tightly, place it in the middle of a loaf when being put into the oven; and the loaf is sure to jump out of the oven in the progress of baking. This is a statement of a curious experiment which I heard when a boy. I am now an old man, and I have never heard it contradicted; but, not being a baker, I have not been able to try it. However, it may go a great way to explain the value of mercury as ballast. **Rho.**

### POWERFUL OPERA-GLASSES.

[24163.]—Since my last (p. 522) of 6th February, some delay has occurred through maker No. 2 having proposed to raise his prices. Maker No. 1, however, undertook to replace his work for lower, instead of higher prices, and has now sent over excellent specimens of the three sizes of instruments, already fully described on page 285, Nov. 28, 1884. An advertisement showing how they may now be obtained has been inserted on the front page in this issue, to save correspondence with so many of our readers who have written about them.

For the benefit of tricycle riders, I should mention that, as the result of his visit to the above maker in Paris, "Faber" returned with a glass 1¾in. diameter of barrel, 3in. in length, with ½in. focal play, so as to be always ready at focus in his pocket, with a power of 4 diameters; being probably the maximum example of instantaneous utility, high power, and portability yet achieved, its weight in aluminium being only 2¼oz.

**Montmartre.**

23, Park-crescent, Portland-place, W.,
April 20.

### LECLANCHE CELLS.

[24164.]—I notice the reply of "Rho," letter 24108, on this subject, with which I concur, with the exception of the prices assigned for manganese, 6d., and carbon 4d. per pound.

Those are very much too high. Manganese of the best quality can be bought at 4d. per lb., and carbon 2d.

This, of course, will very materially reduce the cost of each cell. **Geo. G. Blackwell.**

26, Chapel-street, Liverpool.

## REPLIES TO QUERIES.

⁂ *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[54825.]—**Salt, &c.**—It appears to me that "F. W. H." overlooks the real point altogether in the questions he puts to "Marienberg," as well as merely word playing on the terms natural and non-natural. It's either true or not true that the cereals will perish if not cultivated by man; evidence has been asked for either way, and it has been given so far as to show that they will perish if left to themselves, for even "Backwoodsman" admits that by the fifth season the wheat was choked off, and I know in this climate it will not survive one if left to itself. I would also remind "F. W. H." that the existence of primitive man is ouly a supposition, which has never been proved. The remains of the earliest men found in Europe, who lived up to the ice border, show plainly enough that whether they lived 3,000 or 300,000 years ago, they were certainly not primitive, and although, so far as I know, a ploughshare has not been found, grains of corn and cakes of baked bread have been, and that fact will serve as well, I think, and perhaps better, than finding the "fossilised ploughshare."—Dens

[55484.] — **Water - Pressure (U.Q.)** — Your sketch shows sides of indefinite thickness, as in a reservoir. This looks as if you wished to know the pressure against sides per unit of area. If H = depth of water in feet, the mean pressure on sides is 31·2 H pounds per square foot. The pressure per square foot at any depth, H = 62·4 pounds. If the reservoir have sides, *t* inches thick at the point H, the stress per square inch on the material of which the tank is made is $2{\cdot}6\,\frac{HD}{t}$, where D = diameter of tank in feet. The shape of middle of tank has no influence on the pressure against the sides. The same rule, 62·4 H, gives the pressure per square foot on any part of the bottom.—Glatton.

[55700.] — **Strength of Shafting.** — "One Ignorant" must excuse my delay, as my "E. M." has been at the binder's, and I could not refer to his query. If he works out the power again, he will find that he has made a mistake: the 6in. shaft comes out exactly nine times as strong as the 2in. one. I inclose a demonstration of the fact that the strength of a shaft varies as the cube of its diameter. Let a shaft (Fig. 1) be broken by twisting. Just before twisting off, the fibres are distorted and stretched as shown in Fig. 5, and two marks, *a* and *b*, which coincided before applying force, are separated by a small angle. The distance of *a* from *b*, measured on the circumference of the shaft, shows how much the fibres are stretched, and is a measure of the stress, or pull per square inch, on each of the outer fibres. When this stress exceeds a certain limit the outer fibres break, the next ring of fibres have an undue load, and break also, and the whole shaft gives way. Let Fig. 2 represent one end of the broken shaft, and let it be divided into four rings, of which the width = W = ¼ the radius of the shaft. At a radius of half the outer one, the fibres are stretched only half so much as at *a b*; (*c d* = ½ *a b*) at ¾ the radius this stretch, and therefore this stress, or power of resisting torsion, is three-quarters that at the outside, and so on. At the outside of a shaft of half the diameter (see Fig. 3), the stress when breaking is again equal to the shearing stress of the material, and is thus the same for the outer layer of any shaft of the same material. Dividing this section into the same number of rings as Fig. 2, we again find that the nearer we get to the centre the less the strain becomes, and at a radius *r*, which is of course half the radius R, the fibres are stretched to the same amount. The width of the ring (1) in Fig. 2 is twice that in Fig. 3. The circumference is also twice that in Fig. 3. There are, therefore, 2 × 2 = 4 times the number of fibres acting. They are acting at a leverage R, which is twice that in Fig. 3, which is *r*. Four times the number of fibres, each set with the same average pull, means four times the total pull. This at twice the leverage = 4 × 2 = 8 times the total force acting at the centre of shaft. This may be proved to be the case for any number of similar rings in Figs. 2 and 3, and we therefore find that the resistance due to all the rings in Fig. 2 is four times that due to all the rings in Fig. 3. That is, a shaft which is double the diameter of another is four times as strong. In the same way, it may be shown that a shaft three times the diameter is nine times as strong, and so on.—Glatton.

FIG. 1.

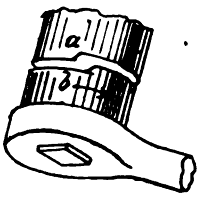


FIG. 2.

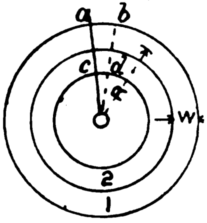


FIG. 5.

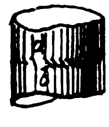
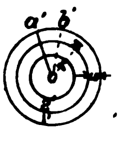


FIG. 3



[55930.] — **Self-Winding Watch.**—I gather from the following that something superior to the self-winding movement depicted by "Annie," on p. 108, is in the market. Perhaps some of our American friends can give more particulars. The movement on p. 108 is Loehr's "Perpetual," but it appears that a watch has recently come into the market, which may justly claim every qualification called for by the term "self-winding," without possessing any of the drawbacks or imperfections hitherto encountered in all works of that description. In quality similar to the A. M. N. Waltham movement, as are also the whole train, escapement, balance, mainspring, &c., everything is correctly proportioned with due appreciation of the popular demand, and in strict obedience to the laws governing the manufacture of any first-class, well-regulated, and thoroughly reliable watch. The mechanism of the movement, by its very simplicity precludes possibilities of disarrangement, while the process of winding is as positive and thorough, whether the watch be carried by a person of sedentary habits or by one given to more or less violent exercise, such as riding, dancing, running, &c. No matter how severe or continuous the motion of the person carrying this watch, the mainspring can never be wound up beyond its last quarter, as the pendulum will then cease its motion. This peculiarity deserves special mention, for, in addition to its simplicity, its action is absolute. In former specimens of self-winding watches the process of winding was made more or less unpleasant to the sense of hearing, on account of a peculiar clattering movement of the pendulum. This defect, nor anything approaching it, does not exist in this movement. If required, the mainspring, when wound up, can be unwound at once, without removing any part of the mechanism; or, if so desired, the whole case containing the mainspring can be taken out singly without disturbing the rest of the movement. The patentee is Mr. H. von der Heydt, of Chicago, Ill., and if his winding movement will do what is asserted, it is certainly an improvement.—W. M.

[56025.] — **Trueing Grindstone. — Patent Law.**—One of the objects of the reply on p. 66 was to enforce and emphasise what I had before stated in connection with patent law, &c.—that it is morally wrong, and also illegal, to make and use a patented invention, unless, indeed, one is prepared to dispute the validity of the patent. On p. 277, Vol. XXXIX., I explained that the prohibition clause in the "Letters" had been altered, and now reads "make use of." It was also pointed out that it is legitimate to make a patented invention for the purposes of experiment; but not to use the invention in the ordinary meaning of the term. On p. 108 "Z. Y. X." wrote: "I agree with 'Nun. Dor.' that, notwithstanding the words of the prohibitory clause in a patent, a man may make a patented machine for the purpose of seeing whether it can be improved"; but previously (p. 40) he reminded your readers that the prohibition clause is against making, using, mending, or exercising the invention. Having already shown that the prohibition clause does not say that one shall not make, I do not see what purpose would be served by following "Z. Y. X." in his appeal to the granting clause. Does he contend that the granting clause is more potent than the prohibition clause? Does he hold that we must not make a patented invention for experiment, or what does he contend? I confess I cannot see his point. I do not know of a single judgment which refers to the granting clause, and I do not remember an advocate using its phrases as the foundation for an argument. If I were inclined to split hairs, I might point out that there is a considerable difference between "and" and "or"; but I am not. I would, therefore, ask "Z. Y. X." to kindly correct anything that may be wrong in what I have stated, and so help to convince some of your readers that they must not use patented inventions, even privately. Perhaps, without appearing egotistical, I might say that I quite appreciate the difference between the "granting" and the "prohibition" clauses, and yet I fail utterly to understand what "Z. Y. X." means in his latest reply (p. 152) when he says I have failed to see the true import of the words in the patent. Will he kindly explain what is their "true import"?—Nun. Dor.

[56041.]—**Gun-Metal.**—"Nun. Dor.," with all deference to him, confuses gun-metal with metal for guns. Metal for guns may be gun-metal (copper, tin, and zinc), or it may be bronze (copper, tin, zinc, and lead), or it may be cast iron chilled in its core, or it may be cast steel (very soft) or it may be steel (in strips like the Armstrong), or it may be Delta metal (which does, so they say, contain iron), or it may be any other material (whether ordinarily called a metal or not); but I venture to think, notwithstanding "Nun. Dor.'s" remarks (p. 152), that gun-metal is a well-known article of commerce used for many other purposes than for guns, and I again venture to ask whether gun-metal, as ordinarily spoken of, contains any iron at all. Now, oddly enough, the letter of "J. C." preceding "Nun. Dor.'s" (p. 152) gives, as I think, the true description of gun-metal—and for this information I thank him,—Copper, tin, and zinc, or copper and tin; and he quotes Tredgold and Smeaton as to the qualities, &c., of gun-metal. I well recollect Uchatius's great advent and subsequent disappearance; but I thought that was steel, and not bronze. Now for an answer to "Nun. Dor.'s" not unreasonable question "what he (I) meant by asking on p. 66 in the words 'Is it really the fact that these four metals can be melted together'?" Now, what I meant was this. Gun-metal, a well-known article composed of copper, zinc, and tin, or copper and tin only, is made in tons in almost every brass foundry. By the way, brass is first cousin to gun-metal, and is composed of copper and zinc, and tin being added to the copper, with or without zinc, forms gun-metal. This compound called gun-metal is generally supposed to be difficult to get of a uniform quality at different meltings (same with brass), in consequence of the difficulty of keeping the zinc from volatilising at the heat, which is necessary to keep the copper liquid, and all sorts of contrivances are resorted to to keep the zinc from flying off and being lost. Not so much difficulty when copper and tin are melted together. Now, I thought that the introduction of iron would add greatly to the difficulty, and I still think so, and, further, I believe still that gun-metal as a commercial article, and well known in the trade, never contains iron in large or even small quantities.—A. P. Bower.

[56082.]—**Telephone Transmitter.**—Suppose this querist refers to the back numbers containing diagrams of different transmitters—Nos. 695, 747, 865, for instance.—Lex.

[56093.] — **Pitch Grease.**—I don't know "pitch grease" by that name; but if the querist will melt his tallow and add one-seventh of its weight of sugar of lead, and when that is dissolved, about one-fifth of black antimony, stirring well together until cold, I think he will have something which should be very like what I imagine is meant by pitch grease.—Essar.

[56099.]—**Faulty Leclanche.**—This fault cannot well be detected without examination. I suppose the blocks are not exhausted.—C. J. M.

[56110.]—**Mill Bills.**—There are a variety of recipes for tempering mill bills given in back numbers, but there is no royal road to success. The querist must study the nature of the steel, and learn when he has it at the right heat. Then quench in water—plain water, for chemicals can certainly have little to do with the matter. Here is one recipe: To three gallons of water add 2oz. oil of vitriol, 2oz. of soda, and ½oz. of saltpetre. Here is another: 1oz. each of white arsenic, spirits of salts, and sal-ammoniac, dissolved in four gallons of spring (!) water. Will any of your readers tell me what possible effect any of these mixtures can have on the temper of steel? "P. M.'s" best plan will be to have a clear fire, and judge of the colour of the heat in the dark; for most cast steels it should be a bright red.—Essar.

[56112.]—**Testing for Arsenic in Wall Paper.**—Mr. R. Forrest, in his critique on my reply to the above, says: "The simplest and readiest way to distinguish arsenic from antimony is, &c." The query is not how to distinguish arsenic from antimony, neither does antimony, as far as I am aware, find a place as colouring matter in wall paper.—J. Kean, Northampton.

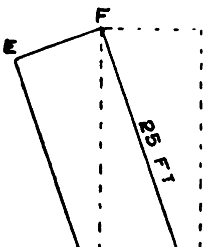
[56117.]—**Pacinotti Ring.**—"Electra" has evidently seen neither a Pacinotti ring, nor a Brush. In the Brush, every alternate coil is connected, in the Pacinotti, *not*. What Mr. Bottone illustrated are not "collecting strips, or collectors"; but the brass strips of the commutator. The collectors or brushes were not figured at all.—S. Bottone.

[56125.]—**Staining Buckskin.**—If "D. G." wants to stain or dye his gloves "mouse colour" why does he want to use pipeclay as the staining vehicle? I think the best plan will be to mordant with a weak solution of phosphate of soda, 1 to 100 water, brushing that over three or four times; then brush elderberry juice over twice, and finish with a weak solution of nigrosine—a one per cent. solution.—Dyer.

[56132.]—**Cutting Pipes.**—Mr. Geo. A. (F.) Walton and I are showing pretty clearly that—

> "'Tis with our judgments as our watches, none
> Go just alike, yet each believes his own."

Mr. Walton (p. 67) replied to this query, and I undertook to point out that he had got rather mixed in his calculations. As "M. B. M." asked for his required information in such very definite terms (viz., "B to E is the length I want"), I did not care (like Mr. Hardie) to tell him that that length alone would be of little or no use to him. I preferred (p. 109) to answer his question as it stood, and to suggest to him, in a gentle sort of way, what I thought would be a necessary change in his proposed mode of carrying out his ideas. As the matter stands now, Mr. Walton says that I am in error, and I think that he is in error. I would like to meet him half-way by pointing out where I think he was, and still is, in error; and I hope that, in return, he will point out where "my answer, as well as my method, is in error." It will put the matter before "M. B. M." in rather a clearer light. We will take "M. B. M.'s" sketch as it stands. (I may be allowed to reproduce part of it here.) Angle F B C is a right angle, so is F E B, and length of F C is 25ft. Find length of E B. Mr. Walton is in error in supposing E B to be equal to F B, and that error vitiates his whole work. I see now the slip to which Mr. W. alludes—he put 225 for 625—but taking it as corrected, the reply is still wrong, as it gives the length of F B, not of E B. The latter I have shown to be 23·56ft. in length. I hope that Mr. Walton will now show where my answer or method is in error; also, if he can suggest any fairer and more candid way of getting rid of the discrepancy between our replies, I will be glad to adopt it.—Jno. M. Adams.

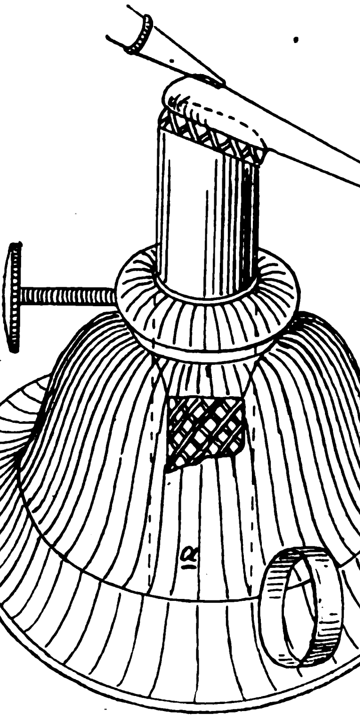


[56137.]—**Tracing Paper.**—After a number of experimental trials made years ago, and with a variety of ingredients, I found the following succeed so well that I adopted it for mechanical tracing. Melt by heat 1 part of fine rosin in 1 part of boiled nut oil, and, whilst still warm, add 6 parts of spirits of turpentine; all by weight. Apply the mixture when cold with a small bunch of calico. As each sheet of tissue-paper is done, hang it on a line to dry. It is very transparent, and takes on ink or colour well, and it does not turn brown by age.—Draughtsman.

[56142.]—**Wheatstone Bridge.**—The carbons, ⅜in. diameter and 2ft. long, are about 10 ohms resistance; some the same size are only 8 ohms, so must be tested to know accurately. If the querist has a 5-ohm coil, and wants to make another like it, the simplest way of going about it is to connect the 5-ohm in circuit with a constant battery and galvanometer—say, it gives 20°—remove the 5-ohm coil, and insert sufficient length of wire until a deflection of 20° is again given; then the wire inserted will be equal to the 5-ohm coil. If you use the bridge for this, you must have resistances in the two left-hand openings, A and C, or the galvanometer will be short-circuited. Make this the rule: let the two left-hand openings be fixed resistances—say, 10 ohms each; the bottom right-hand, D, the resistance to be measured, and the top right-hand, B, the adjustable coils. To give you the key to the whole affair (free from algebra or mathematics), I quote from "Culley," p. 216:—"To measure a resistance *greater* than that of the coils at B, the resistance of A is made less than that of C, and the reading at B is multiplied by the ratio between them. Let A be made 1 and C 1,000, or let them be in the proportion of 1 to 1,000, and let the reading at B be 2,000, then A : C : : B : D or 1 : 1,000 : : 2,000 is to 2,000,000, the resistance measured. When the resistance to be tested is *less* than can be measured by the coils at B, A is made greater than C; thus let A be 100 and C 10, or in the proportion of 10 to 1, and let the reading at B be 1, then A : C : : B : D or 100 : 10 : : 1 : ·1. Thus, the resistances of A and C can be varied at pleasure, until they bear such a ratio one to the other as will enable the coils at B to balance the resistance in D, when the resistance is found by direct rule-of-three."—M. S. E.

[56242.]—**Relation between Size of Dynamo and E.M.F.**—To Wm. Grey, F.C.S.—This is very little understood. Many suppose that the E.M.F. depends on the number of coils and the speed of rotation of armature. So it does to a certain extent; but if you have no iron in the fields you get very little or no current. According to my own experiments, which I will publish in full shortly, each 1lb. of best soft Swedish iron in the field and armature together, driven at the best speed, is capable of furnishing two volts of E.M.F. The current in ampères of course is decided by the sized wire employed. For instance, a dynamo, which weighs 10lb., wound with 7lb. of No. 16, R = 1·34 ohms on the fields, and with 6oz. No. 20, R = 0·5, total R = 1·84, has an E.M.F. of about 18·5 at 3,000 revs., and gives a current on short circuit of about 10 ampères.—S. Bottone.

[56250.]—**Engine Making at Home.**—Make the bedplate of solid stuff by all means. Respecting the dimensions, we agreed that lengths of rods and centres of motions should be halved exactly, but that dimensions for strength would have to be greater than half, which dimensions should be taken in detail. Go on with the cylinder to the new dimensions given; and for the bedplate prepare a block of mahogany not less than 2in. thick, more if you choose, and measuring roughly 2ft. in length by 5in. wide. Plane it to a parallel thickness, and square one edge. Draw a centre line down its face with a gauge laid against the squared edge. Draw the centre line of the cylinder across at a distance of about 4½in. from one rough end, and from thence mark the centres of guide-bar bosses and crank bearings. When the cylinder is made, screw it down with small wood screws. I should attach all the work before finishing the edges, since if the moulding were worked before the engine was fitted up, it would get dirty, and the screws would be more likely to split the grain.—J. H.



[56303.]—**Blowpipe Petroleum Lamp.**—I am glad to see one of your correspondents taking up this interesting subject to which I have referred in my last work in the following words, "I believe a good deal could be done with a petroleum lamp; but having never tried one, I shall, as Berzelius says, pass it by here ("The Blowpipe in Chemistry, &c."). The field is, therefore, entirely before your correspondent "$H_2$ S." ("E.M.," No. 1,045, page 113), for no one has yet described such a lamp, and I, for one, shall be very pleased to hear what results he obtains from this lamp, especially in using boric acid as a reagent. According to the custom which makes the "E.M." such a universal favourite in Britain, Germany, and America, I send the sketch of a petroleum lamp sent me some years ago for trial by my friend Mr. Frank P. Williams, the manager of some large metallurgical works in Llanelly, Wales, and, I believe designed and made by himself. He is an old Freiberg student, and a man of first-rate ability. A brief description of the Fig. will, no doubt, suffice for "$H_2$ S.'s" comprehension. The dotted lines show the section of a tinplate tube, which is carried through the centre of the lamp to its bottom. This tube is perforated by five large large vertical slits reaching nearly to the bottom, giving it the appearance of a series of railway arches. Through those slits cotton-wool is stuffed with a knitting needle, or similar instrument, until the lamp is loosely filled with it, except the lower part of the centre tube (at *a* in the Fig.), which is left vacant for the bottom of the plaited wick to hang, and suck up the fluid paraffin there. The lamp is thus rendered portable without fear of extensive leakage.—W. A. Ross.

[56271.]—**Portable Engines.**—To "Invicta."—Many thanks for reply to query. I can see by drawing the way to make barrel part of boiler, but do not quite understand how firebox is made. I want it suitable for a coal fire. Would this be large enough to work a sewing-machine?—A New Subscriber.

[56272.]—**Lifting Water.**—300 tons in 24 hours $= \frac{300 \times 2240}{24 \times 60} = 467$lb. per minute; $\frac{467 \times 90}{33000} \times 1·5 = 1·27$ horse-power. This allows for a loss of one-third of the power through friction. Allowing actual pump barrel to be 25 per cent. larger than the theoretical, the buckets will sweep at each stroke, if single acting, a volume $= 27·73 \times 467 \times 1·25 \times \frac{2}{12}$ cubic inches, supposing the twelve strokes to be six up and six down. If twelve up and twelve down, multiply by $\frac{1}{12}$ instead of $\frac{2}{12}$. If double-acting, the volume swept by bucket will be half that swept by a single-acting pump. Of course the diameter will depend on the length of stroke. The area of bucket multiplied by length of stroke will equal the volume swept by bucket per stroke.—Glatton.

[56273.]—**To Mr. E. Eaves, Coventry.**—I shall require the motor for about two hours one day a week. It is made from instructions given in the "E. M." by Mr. Chaster. Will you kindly give me instructions to make an accumulator to light three 10 c.p. lamps for about three hours, to be charged from a dynamo half the size given in No. 1007? Also, how long it will take to charge it, and how

I shall know when it is fully charged.—J. J. HAMMOND.

[56288.]—**Crankshaft.**—Depends a good deal on facility of construction, and on appearance in so small a model. I should say from $\frac{3}{16}$in. to $\frac{1}{4}$in. Balancing not worth while.—GLATTON.

[56289.]—**Exhaust-pipe.**—I will answer this query by asking another. On page 12 of this volume, "Exhaust" mentions an alteration in position of blast-pipe, with improved results. As presumably your blast is strong enough, it would appear that by lowering your blast nozzle you could enlarge its diameter without impairing its efficiency. Will "Exhaust" tell us if the noise of puffing was diminished in his case?—GLATTON.

[56296.]—**Sand-blast.**—Particulars and illustrations of three forms on p. 235, Vol. XVI. Another design, which I have not tried, on p. 314, Vol. XXVII.—GLATTON.

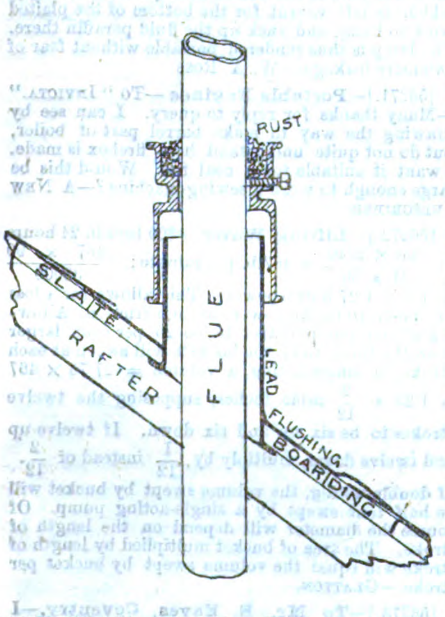
[56320.]—**Dynamo.**—If a good strong man were set to work at about 6 a.m. and ground away till about 6 p.m., he might (?) possibly charge the accumulator sufficiently to light the said lamps for a couple of hours or so. But I should advise the said man to invest in a cinglet beforehand, or he would most likely take a violent cold from the profuse perspiration into which he would be thrown.—S. BOTTONE.

[56321.]—**Indicator Diagram Paper.**—The paper for this, as for the indelible notebooks, is, in the making, loaded with China clay; the better sorts with fine bone dust from burnt bones. I find whiting, rubbed on with a bit of clean waste, answers nearly as well. A stroke with the blunt point of a brass pin makes an indelible mark. Writing paper too highly glazed, or if handled too much, will take ink perfectly if rubbed with a little whiting.—DRAUGHTSMAN.

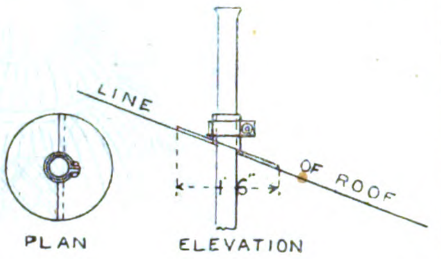
[56326.]—**Sketching.**—In sketching from nature, where accuracy is aimed at, great aid may be found by tying a card at the end of a thread, the other end knotted and held between the teeth. If the card is a strip nearly as long as your drawing, all the better; the thread to be of such length that the card will touch the drawing. Shut one eye, and holding the card in the direction of the object, measure by marks on the card any dimension you require, and transfer it in its proper position to your sketch. Those who have not tried this plan, which was shown me first by an artist relative, will be surprised at the accuracy in detail that a very little practice will achieve. I have sometimes used a scale for the purpose, but a card is handier. With a steady hand, the proper inclination of lines may be obtained as well as their apparent length.—DRAUGHTSMAN.

[56331.]—**Chimney Pipe.**—Fix a thin iron sheet on with set screws tapped into the cast iron. Make a tight joint with asbestos, if you are not a good enough workman to make a fit without. Joint the sheet with the slates as if it were a large slate.—GLATTON.

[56331.]—**Chimney Pipe.**—The annexed sketch will show "H." the method I adopt to keep the roof weathertight; but if my meaning is not clear to "H.," I will reply again. The hole in the roof is cut 2in. larger in diameter than the flue, and a lead or zinc pipe is fixed into it. This pipe should project at least 6in. from the roof at its lowest part, and must be flushed all round with lead or zinc. On to the flue is fixed a cast-iron cap which covers the lead pipe, but does not touch it, there being a space of 1in. all round. The cap is prevented from slipping by three set screws, which also serve to set it concentric with the flue. In the upper part of the cap a recess is cast, into which is packed rust or asbestos putty.—AREFES.

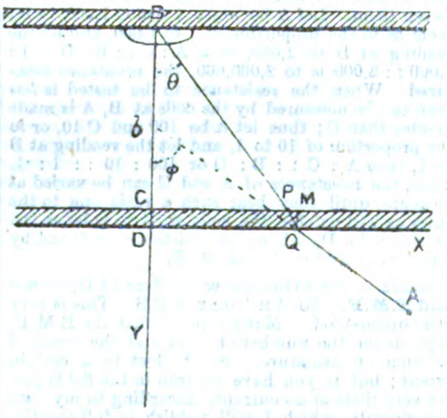


[56331.]—**Chimney Pipe.**—A rigid joint in roof would not do, because expansion must be allowed for. I have had the same difficulty with a pipe taking exhaust steam through slated roof, and have cured it by attaching to the pipe a circular disc of galvanised iron made in halves and overlapping at the joint. The disc is bent to the pitch of the roof and is placed over the slates, but not attached to the roof in any way. A semicircular collar is formed on each plate, the two, when brought together, forming a complete collar round the pipe. A wrought iron clip round the collar keeps the whole in position, and a lining of red sheet indiarubber (such as is used for steam joints) prevents water coursing down between collar and pipe. The sketch herewith will, I trust, serve to make the matter plain.—SILEX SEADRIFT.



[56331.]—**Chimney Pipe.**—Surely, if your pipe gets hot enough to melt solder, the rain that runs inside won't cause much trouble! It would vanish in the shape of steam. Try equal parts of red lead and white lead mixed for cement. That will take to the iron and slate; the heat won't affect it.—GWENT.

[56332.]—**Optical.**—Let B P Q A be the course of a ray of light proceeding from B to the eye at A. Let Q M be perpendicular to P C. Let A Q cut B C D at $b$. Let the angle C B P = $\theta$, and the angle C $b$ Q = $\phi$, $\mu_1$ and $\mu_2$ the indices of refraction from water into glass, and from air into glass. Then, $\sin.\,\theta = \mu_1 \sin.\,PQM = \frac{\mu_1}{\mu_2}\sin.\,\phi$. $DQ = PC + PM = BC\tan.\,\theta + CD\tan.\,PQM = BC$



$$\frac{\mu_1 \sin.\,\phi}{\sqrt{(\mu_2^2 - \mu_1^2 \sin.^2\phi)}} + CD\,\frac{\sin.\,\phi}{\sqrt{(\mu_2^2 - \sin.^2\phi)}}$$

Hence, taking D Q as axis of $x$, and B D produced downwards as axis of $y$, the equation to Q A is $(x - DQ) = y \tan.\,\phi$, and therefore, putting $x = 0$, $y = Db = -\frac{DQ}{\tan.\,\phi}$. Also, if $\alpha\,\beta$ be co-ordinates of A $(\alpha - DQ) = \beta\tan.\,\phi$. ∴ $Db = \beta - \frac{\alpha}{\tan.\,\phi}$ where $\phi$ is found from the equation. $\alpha\,\beta\tan.\,\phi$

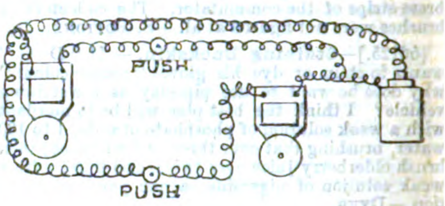
$$= BC\,\frac{\mu_1 \sin.\,\phi}{\sqrt{\mu_2^2 - \mu_1^2 \sin.^2\phi}} + CD\,\frac{\sin.\,\phi}{\sqrt{(\mu_2^2 - \sin.^2\phi)}}$$

$$= \left\{\frac{BC\,\mu_1}{\sqrt{(\mu_2^2 - (\mu_1^2 - \mu_2^2)\tan.^2\phi)}} + \frac{CD}{\sqrt{(\mu_2^2 - (\mu_1 - \mu_2^2)\tan.^2\phi)}}\right\}\tan.\,\phi.$$

If the thickness of the glass C D is neglected, it is seen by a geometrical construction (see Parkinson's "Optics," Third Edition, Art. 73) that the direction A Q is found by drawing from A a normal to an ellipse, centre D, focus B, and axis major, $2\,BD \div \frac{\mu_1}{\mu_2}$. It is clear that the position of $b$ will vary with that of A.—T. H. L.

[56336.]—**Glucose.**—Add to a solution of the substance a few drops of sulphate of copper, and enough solution of potash to form an intensely blue liquid. The oxide of copper is not precipitated in the presence of either of the sugars; but if the blue liquid be very gently heated, a red suboxide of copper will separate if glucose be present; whilst with pure cane-sugar the precipitation does not take place unless the solution is boiled.—A. R., King's Coll.

[56337.]—**Electrical.**—The sketch represents a method of ringing two bells on one circuit with two pushes, and battery at one end. If the circuit is a long one, you may require to increase the battery power.—BOBADIL.

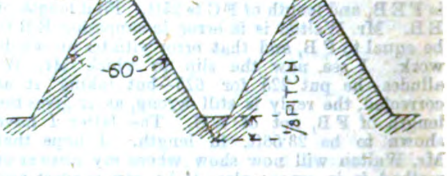


[56340.]—**To Mr. Bottone or Others.**—You would require about 6lb. of No. 16 on the fields, so connected that when a current from a battery is passed through, one pole piece becomes a N. pole and the other an S. The armature is wound in one length: about 6oz. of No. 20 will do very well; the two ends must not be connected together, but each end to its own commutator cheek. One brush must connect to one end of field magnet wire, while the other brush and the other field magnet wire must be attached to binding screws which form the poles of the machine. (See "The Dynamo: How Made and How Used.") You might be able to light seven or eight $2\frac{1}{2}$-candle lamps by driving the machine at 3,000 revs.; but at the end of twenty minutes the machine would become very warm indeed.—S. BOTTONE.

[56342.]—**Public Lighting.**—The town of Enniskillen, co. Fermanagh, is lighted with petroleum lamps placed in the old gas street lamps of the usual shape. This has been the case for the last three or four years, owing to a dispute with the gas company. If I remember rightly, it is the case also in the town of Cavan.—J. R.

[56342.]—**Public Lighting.**—About five or six years ago the Kensington High-street was lit in this way for some months. Perhaps the Kensington or Knightsbridge Vestry would give their experience, on application.—GLATTON.

[56346.]—**Seller's Screw Thread.**—In the American standard screw-thread the sides of the thread are inclined to each other at an angle of sixty degrees, and a part equal to one-eighth of the pitch is cut off the top of the thread, and off the bottom of the space, as shown in the annexed sketch. The following formula gives the pitch of the thread and the diameter at its base, when $p$ = pitch, $d$ = diameter of screw, and $d_1$ = diameter at bottom of thread



$$P = \cdot 1d + \cdot 025$$
$$d_1 = \cdot 87d - \cdot 03.$$

—AREFES.

[56356.]—**Telephone Battery.**—In some telephonic exchanges Leclanché cells are used, being connected zinc with carbon till the required strength is produced. The Leclanché battery consists of a rod of amalgamated zinc immersed in a solution of ammonic chloride, in the outer cell, and a porous cell containing a rod of carbon and a mixture of peroxide of manganese and powdered carbon. This form of battery is very weak, yielding only an E.M.F. of ·31 volt, therefore many cells must be used for heavy work. Daniell's battery is sometimes used, but it is too well known to need description.—J. KEAN, Northampton.

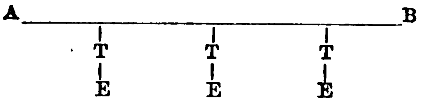
[56356.]—**Telephone Battery.**—When magneto-bells are in connection with telephone, one or two No. 2 Leclanché cells are used for the transmitter. If you do not use magneto-bells, a six-cell Leclanché battery at each station in circuit will meet your requirements, arranging it so as to use the whole battery for outward ringing and two cells for the transmitter.—R. F. S.

[56356.]—**Telephone Battery.**—The battery used is the Leclanché.—Accumulator.

[56356.]—**Telephone.**—The Leclanché battery is commonly used for telephone circuits which are not too constantly used; but where much work is required the Fuller is often substituted. I think that a saturated solution of salt might be used with the zinc in place of sulphuric acid; but should like the opinions of others on the subject; if so, it would not be so "expensive or troublesome."—F. Broadbent.

[56358.]—**Chronic Cold in Head.**—I have seen many cases, having "walked" all the great Continental hospitals for many years, but cannot offer great hopes of a permanent cure. I have seen it cured, however, by the use of cold water injections twice or thrice a day. The advice "Ora et Labora" received—viz., cod-liver oil, iron tonic, and water injections is the best he could have got.—B. Sc., Plymouth.

[56361.]—**Telephone System.**—I find the following arrangement works admirably, and have tried it successfully with as many as twelve stations in circuit:



A B is the line wire, T the telephones, and E earth. In this arrangement only one leading-in wire is required. You must be careful to obtain a good earth at each station.—R. F. S.

[56370.]—**Repairing Boilers.**—There is no great difficulty in repairing a shot hole in a boiler; in fact, the cause for admiration in the case the querist mentions, in my opinion, arises not from the way the repair was made, but from the fact that it was done in the face of an enemy, and under a heavy fire from the Arabs. Repairing shot holes in a boiler is a very simple matter, especially with a boiler for a paddle boat, which always uses steam of low pressure. Now, to put the matter clearer, no doubt the plan adopted was as follows:—The passage of the shot through the boiler plates would mean two jagged holes; through these the steam would rush out pretty quick, so that there would be no need to blow off the steam. Two pieces of wrought iron plate, a little larger than each hole, would then be procured—possibly such odd pieces were carried on board for such use. One piece being held up inside and the other one outside, bolts passing through the two plates would draw them together, and with the aid of cement or red lead and hemp, or any other material handy, a joint could be made—the manhole giving egress to the man holding up inside. I have repaired shot holes in even a ruder way—viz., with thick pieces of timber bolted together; but not in the face of an enemy actually firing on us. Where the point came in, was the coolness of undertaking such a work with most likely few tools and appliances and under a heavy fire. During river fighting, boilers carrying low pressures were repaired in many instances, and the steamer again ready to take her place in the fighting again in a few hours, in the war between the North and South.—Invicta.

[56371.]—**Spoiled Negative.**—Soak the plate for a long time in very strong solution of hyposulphite of soda, which will most likely remove it. I have cured very bad cases in this way; but it is never so good as if the accident had never happened, so take care not to let it happen again. The best way to make sure that a negative is dry is to pass the fingers lightly over it: if it feels shiny all will be right: but if there is the slightest sticky feeling about it, you will print it at your peril. If the hypo. does not remove it, try strong solution of potassium cyanide.—R. A. R. Bennett, Oxford.

[56374.]—**Microscopical—Mounting Sputa.**—Lift the sputa with a glass rod on to the glass slide and put on cover glass by the usual method, then take a clean glass rod and put a drop or two of your staining liquid (Beale's carmine or gentian violet) at the edge of the cover glass, and by capillary attraction the sputa will be stained in a few minutes; it can be ringed with asphalte and will keep for a few days. To make it permanent is more difficult. Frey recommends the addition of camphor water, chromic acid, or Pacini's solution in the same manner as the stain, and later xylol balsam has been used.—B. Sc., Plymouth.

[56378.]—**Launch Boiler.**—The reason why is that the heat from the fire, when first lit, is absorbed by the tubes and the cold water, consequently there is no warm air to cause an ascending current in the funnel. A partial remedy consists in opening the smoke-box door, and by burning shavings, &c., in the box, warm the funnel, and thus set up a primary current. On the smoke-box door being closed, the pull of the funnel will help matters. Another remedy is to start the fire nearer the bridge, allowing a space near the door where the bars are left uncovered. A current of air is quickly set up in some boilers, which, although lengthening the time of getting up steam, prevents the smoke coming out of the fire-door. A friend who has a small launch, and who was troubled in the same way, by my recommendation, got over it as follows: He uses a pair of bellows fitted with a non-return valve in the delivery; this is coupled by a piece of stout rubber pipe to a stop-cock in the steam space. By working the bellows, air is pumped in, and passes out by the ordinary blower-jet in the chimney. The steam space acts as a reservoir of air, and a very little jet at the blower sets up enough draft to keep the smoke passing through the tubes instead of out at the fire-door. Steam is got up much quicker too. Of course, long before there is any steam the funnel and tubes are hot, and the bellows are not needed to force the draught. In the case of a launch in which originally the exhaust was in the funnel, but which was subsequently fitted with a condenser to maintain the draught, an arrangement equivalent to a bellows was worked off the engine to supply air to a large low-pressure jet in the chimney. This also has answered well—Invicta.

[56379.]—**Bichromate Battery for Lighting.**—"In the Dark" must not expect to get the E.M.F. required for his lamp if the cells leak into each other (which reduces the E.M.F. to that of one cell, but gives more current); and I should advise him to buy flat earthenware ones (in place of the old one), or else he can make each cell as follows. Two boxes, one to go inside the other, so as to leave ¼in. at the sides and bottom, which is to be filled up with melted pitch. Two good coats of Brunswick black should now be given inside and outside. The cells should be screwed together and white leaded at the joints.—Accumulator.

[56379.]—**Bichromate Battery for Lighting.**—This battery, besides being wrongly coupled up, has no chance of giving out its best results. In the bichromate battery there should always be more of the negative element than of the positive, and consequently each of your cells will require two carbon plates with the zinc between. This will be 20 carbons for your 10 zincs. In coupling up, begin with, say, the cell on your left, connecting its zinc to the two carbons in the next cell, the two carbons in each cell being joined to each other by a short loop of wire between the terminals. Connect all the cells in this way, the zinc of each to the carbons of the next. This, if correctly done, will leave the two carbons vacant in the cell you begin with, and the zinc vacant in the cell you leave off at. From these you lead the wires to your lamp. Even if properly coupled up, the 10 cells may not light your 10-candle lamp; but the chances of success are increased by using two carbons for each zinc, and the lighting power will then depend on the freshness of the solution and the size of the plates. The cells leaking into each other will not much matter, so long as they do not leak out.—Bobadil.

[56383.]—**The New Station at Birmingham.**—The above station covers an area of 12 acres. There are seven through lines, and several bay sidings. The total length of platforms exceed a mile and a quarter. There are, likewise, five signal cabins, the largest of which requires seven men to attend to.—H. W. Hudson.

[56386.] — **Shuttles, Compressed Teak.**—Answer to queries 1 and 2—best Persian boxwood. Requisites: Colour, toughness, weight. Teak compressed will, no doubt, receive weight and closeness of grain. In a few cases only are shuttles now shod with iron. A few foreign woods are used besides boxwood for the purpose; but we are not quite out of boxwood yet, as there are 2,000 or 3,000 tons in Liverpool at this time which could be bought at a much lower price than in former years. Acout compressed teak taking the place, it—well, we shall see what we see.—Shuttle Maker.

[56388.]—**Motor.**—What battery are you using? If the motor starts all right and slackens afterwards, it is the battery, and not the motor, that is at fault. What *do* you mean when you say, "When the battery-current is divided between the armature and field-magnet, the machine will hardly go at all"? Unless the current does divide itself thus, the motor will certainly not work at all.—S. Bottone.

[56389.]—**Incandescent Lamp.** — Terminology wrong. There is no such thing as a 50-volt lamp. A lamp can have 50 ohms resistance, and require a current of 1 ampere to light it, which will require an electro-motive force of 50 volts to produce, since the current is equal to the electromotive force divided by the resistance. Hence it is impossible to light a single lamp having a resistance of 50 ohms with an E.M.F. of less than 50 volts, just in the same way that you could not expect to melt lead (which requires a temperature of nearly 600° Fahr. to melt it) by holding it in a ladle over a boiler full of boiling water (temperature 212° no matter how big that boiler were).—S. Bottone.

[56389.]—**Incandescent Lamp.**—In the first place, electrical power is measured in volts, the product of the current in ampères by the difference of potentials in volts. The heating in incandescent lamps is proportional to the current squared, as the resistance of incandescent lamps is high; if low difference of potentials is used, the current will be small; hence the heating will be much smaller in proportion, and the lamp will not be incandescent. Evidently, in order to get incandescence, the current must be increased—that is, the difference of potentials must be greater. It is, therefore, evident that the difference of potentials must be great enough to send a current of sufficient strength through the lamps to cause incandescence, and as the resistance of lamps is high numerically, the difference of potentials is much greater than the current.—J. Rance.

[56390.]—**Reamer.**—Our friend "Beginner" is ruthlessly trying, I am afraid, to do an impossibility. Supposing he could get the cutting edge to clean out the hole, it would not be even approximately round or true; and the plan he has tried is useless. It would be far better for him to get the steel blade of the reamer made out to the proper width at once by a smith, and do the job properly. "What is worth doing at all is worth doing well."—Invicta.

[56391.]—**Haydon's Cutter Bar.**—To "Bellicose."—I think I know about Haydon's cutter bar as much as anybody, except himself. I was grieved to hear from a friend some time ago that "D. H. G." (that is, D. Haydon, of Guildford) had been struck down by illness, and was unequal to doing any work. I use his bar constantly for the heaviest cuts, both in the lathe and in the planing machine, and would not be without it on any account. It is, in my opinion, the best cutter bar that I ever saw, and I have seen most, and have made many varieties. The whole thing lies—that is to say, if you have a real Haydon bar (and there have been many spurious ones of improper angle and unsuitable height), in the means applied for grinding. I was the first to suggest this to "D. H. G.," and he condemned my plan utterly at first; but subsequently wrote to say that my method was the only thing wanting to make his arrangement of stock and cutter a complete success. I do not go to the extent that he did of using all kinds of cutters in the bar. I restrict myself to one, or, at most, two—viz., a gouge for wood, with a chisel very seldom, and for metal, say, cast iron or wrought iron, the tool with front angle 120° for roughing out. There is nothing like it that I have ever met with, and with my method of grinding you can go to work in the dark. The last sentence of your query shows that you are in want of more light, which I shall be happy to show you. I explained the grinding years ago, Vol. XIV. p. 434.—J. K. P.

[56391.]—**Haydon's Cutter Bar.**—"Bellicose" should, at any rate, be prepared to conquer the difficulties he meets with in the use of the Haydon cutter bar. Every reader of the English Mechanic will regret, as I do myself, that the well-known initials of "D. H. G." are no longer seen, owing to an illness of the severest character, which, it is to be feared, will permanently incapacitate that clever and practical mechanic, to whom I myself, like many others, owe so much. Hence, as the foster-parent of the cutter bar in question, I feel in duty bound to reply to the above query. At the same time, I am fain to confess that I never succeeded in using the bar to the same extent as the inventor, in whose skilful hands it appeared capable of anything and everything except inside work. It was, however, never intended to be a mere amateur's tool, but to go into the regular workshop, and to bear all the rough-and-tumble of an ordinary tool. It should, therefore, be capable of as deep a cut as a solid tool; and as the principle of the cutting action of the little steel tools is absolutely correct, if they are rightly ground and the bar is rightly made, they should even be capable of a deeper cut than the solid tool shaped and ground by rule of thumb. Were the bars less capable than a solid tool of equal size, "D. H. G." would have chucked it into the rubbish-heap. In order, therefore, to qualify this bar for workshop use, it was necessary to devise a mode of accurate grinding of the cutters at the shop grindstone, with some readily adjustable contrivance which any ordinary workman could make and use. All that is necessary for the purpose is a block of wood to rest across the water trough, or top bars, of the frame, such block being exactly thick enough to give the proper clearance angle to the two lower faces of the cutters; but during this process of grinding the cutter is to be pushed up in the sling, so as to stand above the shank of the bar. Hence it is generally necessary to cut down a little the edges of the water-trough, or bearers, on which the grinding-block is to rest, the height of the latter being found by trial, and the height to which the little tool is to be pushed up in the sling being tested by a steel, or sheet metal, gauge. Once determined, these two measurements are constant for 3° of clearance (the standard), and to get more, or less, clearance, all that is necessary is to push the cutter up a little higher, or to use a thicker block. I may observe here that a common error is to test, not the face angle, but the front edge formed by the meeting of the two lower faces. The latter are to make 3° with the vertical line, not the front edge. Again, the *following* edge is to be so placed as to be nearly parallel with the surface of the work—*i.e.*, as nearly so as will enable it to escape a "hitch in," to which it is liable. If either edge is sharper than the other, it is to be the leading one, not the follower. But as a rule both are of equal sharpness. Observe that the tool is not to be placed "end on," except for a rough cut; and even then it will do far better if the following edge is placed a little towards parallelism with the work. For general sliding a front angle of 120° will be found the best—*i.e.*, a plane angle of that size. I must remind "Bellicose" that if he has merely bought a Haydon bar as he would buy an ordinary tool, without reading up the subject of double edges, so as to understand the principle of the thing, he is sure to get in a fog, and to fail in using the tool to the best advantage. Other bars, such as Tangye's, are excellent in their way, and are now very widely known and used, and with these there is far less trouble in grinding the tools. But Haydon's beats them all when once the principle is grasped, because you can shape the little tools to do any sort of work, and keep the angles of cutting edges, which are both theoretically and practically correct.—O. J. L.

[56393.]—**Cubic Feet of Air per Min.**—9·79815lb. weight of water. Accepting it that 15lb. pressure results from a 32ft. column or head, and, therefore, it requires 166·6ft. column or head to give 50lb. pressure.—G. Pinnington.

[56394.]—**Medical Battery.**—Are they chloride of silver cells? If so, perhaps the chloride requires revivifying, which is done by immersing it in aqua regia. Then charge either with sal-ammoniac or chloride of zinc.—F. Broadbent.

[56400.]—**Harmonium.**—From the wording of this query it seems tolerably clear that the querist is not well acquainted with harmoniums. An instrument 3ft. long might just as well have the regulation 5 octaves, or 61 keys, as 30. To make the reeds would be as profitable as making screws. "Working Man" should buy them, and the pan on which they are to be screwed. He must reflect that to make an instrument with 30 reeds only will mean almost as much work as a full-size 5 octave; and he will always find it more convenient to buy the keyboard, reeds, and pan. He can get a keyboard for, say, 20s., a set of reeds (5 octs.) for 10s., and a pan for 6s. If he will say whether or not he is handy with tools, I will see what I can do to help him; but if it is a question of money, I would advise him to wait until he can afford the full size, for, so far as 30 notes are concerned, he would do better to make it into an organ accordion. The pan for 5 octaves will be about 34in., and he can get that into a case 38in. long: it is not worth while to put 30 reeds only into a case 3ft. long, for 30 reeds will not make what is commonly called a harmonium, and will certainly not give satisfaction as a musical instrument. Directions for making pans have been given many times; but unless the "maker" is a good hand, it is more than likely he will make a mess of it, for 126 thoroughly sound glue joints have to be made in a single-row pan, besides sundry other special points to attend to. By all means buy the pan, the reeds, and the keys; you may try your hand at the bellows and the case. Four octaves, or 49 reeds, is the smallest size that it is worth while to make, and that only for a "portable."—Fliegen.

[56401.]—**Faulty Induction Coil.**—I do not see that steeping the coil in paraffin wax would restore the insulation. I have always found the best way was to rewind at once and thus save both time, temper, and expense, in trying to effect the object by an indirect method. With a new coil the simmering in melted paraffin I believe to be an excellent plan, because it converts the whole into one mass of solid paraffin practically.—Invicta.

[56403.]—**Skrivanoff Battery.**—To "Bobadil."—On referring to my reply you will observe that oxide of mercury is given, not chloride. The red oxide is used. 2. The precipitate formed after boiling is of a light grey colour. The boiling must be continued till the red of the oxide has disappeared, and this cannot be successfully done in much less than the time specified, if you wish to make as much paste with the precipitate as will be of any use. 3. The E.M.F. of the battery per cell is about 1·5 volt.—Bobadil.

The arrangements for electrically lighting the general offices and hotel at Paddington Terminus and the Royal Oak and Westbourne Park stations of the Great Western Railway with incandescent lamps, are nearly completed. The most improved machinery, an enormous mileage of wires, and myriads of lamps, will be employed in the installation, which will probably be the largest of its kind in this country.

# UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

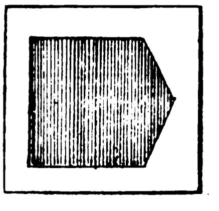
Since our last, "Glatton" has replied to 55484.

55871. American Organ.—To Mr. Fryer, p. 527.
55875. Cupola Blast.—To "Invicta," 527.
55878. Brass Gratings, 528.
55879. Cutting Iron, 528.
55886. Artificial Manures, 528.
55893. Brake Failure, 528.
55897. Internal Resistance of Battery, 528.
55898. Phosphates in Guano, 528.
55908. Small Farms, 528.
55912. Steam Launch. To "Vortex," 528.
55916. Tramway Engines, 528.
55918. L. and S.W. Engines, 528.
55920. Electric Bells. To "Centre Seconds," 528.

56079. Lathe, p. 42.
56083. Telescope, 42.
56084. Canvas Canoe Building, 42.
56087. Dynamo, 42.
56088. Knife-Cleaning Machine, 42.
56090. Self-Lubricating Bearings, 42.
56092. Altering Dynamo for Plating Purposes, 42.
56094. Iron Brake Pipes, 42.
56101. Spinning Wheel, 42.
56107. L. and N.W. Locos, 42.
56113. Clock, 42.
56116. Brick Clays, 42.
56121. Canine, 42.
56128. Engine and Boiler, 42.
56130. Pan, 42.
56133. Milling, 42.

# QUERIES.

[56407.]—**Facing Stop Valve.**—I have an eight-h.p. Robey engine to see to, which does not stop when steam is cut off. I have faced valve to the best of my ability; but still, when steam is cut off, the engine continues in motion. Some engine drivers say there is a joint broke on steam pipe in boiler. Would some kind reader of this useful journal, more experienced than I, give me his opinion as to same, and oblige? I inclose sketch of valve face.—Robey.



[56408.]—**Preparing China for Oil Painting.**—Would some reader tell me how to prepare china for oil painting, so as to look very rough or honey-combed when done?—Constant Reader.

[56409.]—**Sulphur in Coal and Coke.**—Will some one oblige me with a ready mode of estimating percentage of sulphur in coal, coke, and other fuels? I have exhausted every other available source of information in vain.—Innes.

[56410.]—**Finance.**—It is proposed to renew a work at a cost of £700, and it is calculated it would then last twelve years, when it would require renewing again. On the other hand, I calculate, that by patching, at a cost of £316, the work will last six years, when it would require renewal at a cost of £700, and would then last twelve years, as in the first case. What should I save per annum by patching now, and renewing in six years' time, reckoning interest at 5 per cent.?—Sefton Park.

[56411.]—**Power of Electro-Motor.**—I have fitted up an electro-motor, but am not sure my calculation as to its power is correct. Perhaps some of your obliging correspondents will assist me in the matter, the conditions as follows:—The rotating drum is 1ft. in diameter; the magnets are arranged on the periphery; the weight of drum and magnets, 50lb.; the velocity, 220 revolutions per minute. Required, the amount of work done? also the formula by which it is worked out?—R. G.

[56412.]—**Fire for Brazing.**—Would any reader give, with the Editor's permission, a sketch of fire for brazing tricycle frames, also for tempering bicycle springs?—B. M.

[56413.]—**Green's Economiser.**—Will "Engineer, Dewsbury," or other of our correspondents, tell me how to take out a burst pipe, and to put in a new one in Green's Economiser? Please give as full details as possible.—Soho.

[56414.]—**Exhaust Pipe.**—I should be greatly obliged if "Invicta" will tell me of the two remedies he mentioned in last number but one, as I could create a draught as a substitute?—J. T. D.

[56415.]—**Electro-Motors.**—To Mr. Chaster.—Will Mr. Chaster give us a few more particulars of the winding of the F.M.'s of his motor? He says the N. poles of one F.M. must bed against the similar pole of other F.M.; as the whole is fitted up, we must make the poles similar in the winding, as we cannot reverse after fitting up. In winding, I suppose the F.M.'s on the bench in the position they would be when fit up, but resting on the commutator end, then with armature chamber farthest from me, wind on wire same way round as hands of clock, ditto with other F.M., but with armature chamber nearest me, then join end of wire, where I leave off winding in No. 1 F.M., to where I commence on No. 2 F.M.—is this right? Also would he say what position the slit of commutator takes on the spindle?—is it in a line with poles of armature, or with the wire on armature?—J. K.

[56416.]—**To "Invicta."**—Many thanks to "Invicta" for his reply to my query (No. 56040) and shall be very much obliged for any information he can give me concerning the construction of my machinery, also the distance the paddles should be placed from the bow. Would two boilers (the same as on p. 110) be better than one? Would vertical trunk engines do, as they would not take up so much room?—F. C. S.

[56417.]—**Dynamo.**—To Mr. Bottone.—I have wound the dynamo according to your instructions in query No. 55934; when connected, I can only get the current of about one Bunsen cell. I have wound F.M.'s with 9 cores on each leg of No. 18 d.c.c. wire, the weight of which is 5lb. in all, armature with ¼lb. No. 20 wire. I have connected the two upper ends of F.M. wire and soldered them, the lower ends to the brushes. Can you tell whether this is the right way?—P. G., Tooting, S.W.

[56418.]—**Gramme Dynamo.**—Can some of our readers help me out of the following difficulty? I was running my dyname with eight lamps in parallel arc, all working perfectly, suddenly they went dim, and no further efforts would raise them above a red heat. I have carefully examined and tested the dynamo and found it sound, and when a short wire is put between the binding screws, the machine works well, and will rapidly heat it, thus showing that all is right there. It will not, however, light up the lamps when coupled parallel, as it would before, but if a thin wire is put between the terminals and four lamps in parallel arc, coupled up to the bushes, it will keep them burning well. Where is the fault, and why, when all the conditions are the same, will not the machine light up the lamps?—D'Elgo.

[56419.]—**Veterinary.**—Will some pharmaceutical reader elucidate the annexed formula, viz:—

| | |
|---|---|
| Quinquinia, sic: | 16grs. |
| Tinc. nuc. vomicæ | 2drs. |
| Liq. ferri. dialysat conc. ad. | 1oz. |

This is a composition in use by the veterinarians. It is alleged by the druggist preparers to be a mixture of "quinine and solution of iron, which being prepared by a dialysed process, is a neutral and miscible preparation, and will keep any length of time." This clever laboratory rendering is accomplished, and to imitate it I have tried unsuccessfully the several cinchona alkaloids in the tinct. nuc. vom., and liq. ferri. dialy. Would the mother liquor of the quinine manufacturer allow the iron to dialyse, or how is it done?—Army Compounder.

[56420.]—**Waste Oil.**—I have a quantity of waste oil that has been used for an Otto gas engine. Can any of your readers tell me if it is possible to purify it, and use again for the same purpose, if so, by what means?—F. Edge.

[56421.]—**Bichromate Cells with Hydrochloric Acid instead of Sulphuric Acid.**—Will "Sigma," or some other gentleman well acquainted with this matter, inform me whether it is safe to use platinum foil instead of carbon plates in the solution, formed by mixing hydrochloric acid with the solution of potassic bichromate, and if there would be any advantage in the proposed substitution? An early and full answer will be much appreciated by—Bichromate Cell.

[56422.]—**Enamelling.**—To Mr. Lancaster.—I have followed your instructions (54648) page 433, Vol. XL., on the above, but have not been successful in obtaining an even gloss all over the photo., as this must be due to the enamel collodion not being put, which is the best method of coating the glass; also when mounted and trimmed on card with starch, they have a great tendency to curl at the corners? Which is the best mounting medium to use for them?—An Amateur.

[56423.]—**Electro Brazing.**—Could any fellow readers inform me of a good solution for deposition of brass on zinc; also mode and battery power required for working of the same?—Cathode.

[56424.]—**Sheepskin Rug.**—I have bought a white sheepskin hearthrug, and sent it to a professional dyer to be dyed. The wool has been dyed splendidly, but the skin has become as stiff as sheet iron. What can I use to soften it as before it was dyed? It is useless for my purpose in its present state.—Gwent.

[56425.]—**Brass Plate.**—Could any one give me any information how to hammer up a brass plate from a flat piece, and what tools I shall require? The centre has a worked pattern, and I want to dish it and form a flat rim, and wire it round the edge.—Repousse.

[56426.]—**Old Locomotive Engines.**—I have just seen a list, giving particulars of the size, weight, &c., of the following engines: Rocket, Meteor, Comet, Arrow, Dart, Phœnix, North Star, Northumberan (sic), Planet Migestic (sic), Mercury, Mars, Sampson, Jupiter, Goliath, Saturn, Venus, Vutern, Sun, Etna, Fury, Victory, Atlas, Vesta, Milo, Liver, Pluto, Caledonian, Ajax, Leeds, Fire Fly, Torch, Halk, Hecla, Diomed, Shark, Medea. Can any of your readers say to which railway they belonged? I may add that the list shows neither the line, the date, nor the maker, and, but for the fact that the engines are numbered from 1 to 37, I should be inclined to think that they belonged to various lines.—Mac Loco.

[56427.]—**Armature.**—Could some of our electrical readers tell me how to construct a small Gramme ring and commutator, and how to connect the sections for lighting incandescent lamps? A sketch would oblige.—Kernoozer.

[56428.]—**Hot-Air Valve.**—I have a hot-air chamber in which the air must not exceed 103deg. Fahr. I wish to have a valve on top of chamber to relieve the air when it reaches 103deg. Fahr. My plan to lift the valve is to have a lever outside on top of chamber, parallel with the top, working on fulcrum, the valve to be attached to one end, and to the other end of lever a small rod to go down through top of chamber, and connect to a flat rod of metal lying parallel to top of chamber, the lever to be lengthy with bend on the other end, the bend to be fast to the top of chamber. After all have been carefully balanced, I think the heat on rising would draw the inside lever down at one end, at the same time drawing the outside lever down at one end, the other end lifting the valve and relieving the hot air. Would any correspondent kindly tell me if this plan would do?—if so, what kind of metal would be best for the inside lever for the heat to act upon?—G. H. B.

[56429.]—**Mosses.**—Can any fellow reader recommend me a moderately cheap hand-book on mosses, and give me some hints for a formation of a collection of the same?—H. P. Hitchcock.

[56430.]—**Leaky Air-Cushions.**—I have a number of indiarubber air-cushions, but they all leak somewhat. I have tried elastic glue for stopping the leakage, but of no avail. Can any kind reader of the "E. M." assist?—Nimnim.

[56431.]—**Pickle for German Silver.**—Can any of "ours" give me the particulars how to make the above pickle? I thoroughly clean my German silver with oil and brick dust, and then stamp out small shapes in different sizes. I put these away until wanted, and then I find them tarnished, they are too small to clean again I have used weak acid (nit.), which has turned them very bright but they go green after. How can I prevent this, as I experience great disappointment at the dulness of the work?—Max Tour.

[56432.]—**New Midland Engines.**—Will "More Expansion" or "Helvellyn," kindly say why, if these engines were doing so much better through being worked more expansively, they have been taken off the Scotch expresses for the present?—A. Fireman, Lincoln.

[56433.]—**Object Glass.**—Will Mr. Wenham or any other reader give me the radius of curves for flint and crown lens of a ¼in. object-glass for a microscope? I think I have succeeded with the eyepiece, and would like to try my hand at an o.g. I quite indorse the remarks of "Nemo" (No. 24084) in last week's "E.M." I feel sure many amateurs, like myself, would be delighted if such a subject was clearly and simply explained by some of your able correspondents.—Micro.

[56434.]—**Pure Woollen Material.**—What are the tests for distinguishing this from adulterated stuff? Of what is the ordinary blanket composed?—A. C. G.

[56435.]—**Cutting Clock Wheels.**—Will some reader inform me what kind of machine is used for cutting small wheels for clocks? Can they be managed in a hand-turning lathe?—J. Dun.

[56436.]—**Chemical.**—What amount of sulphuric acid 1840 gravity is required to convert 1lb. crystallised Glauber's salts into sodium hydrogen sulphate?—Na$_2$ So$_4$.

[56437.]—**Chemical.**—I wish to start the manufacture of nitric acid, and I shall be obliged if someone will give me a few hints as to the setting of the cylinders with diagram. Are there any books published giving practical details of its manufacture in cylinders? The only books I have seen describe its manufacture in the old-fashioned retorts.—X. Y. Z.

[56438.]—**Fastening Fish Forks in their Handles.**—Will some one kindly inform me how to reset electro-plated fish forks with electro-plated handles, which have become loose in consequence of having been left too long in hot water?—Electro.

[56439.]—**Separating Potash and Magnesia.**—Will "Chemical Subscriber" inform me how to separate a solution of potash and magnesia? I have a large quantity of both, mixed by accident, in a barrel containing some water.—George Richmond, Peckham.

[56440.]—**Warnerising.**—Would someone kindly inform in what this process consists? It is a mode of waterproofing woollen and cotton cloths and lace without altering their appearance or texture.—R. M.

[56441.]—**Sensitive Flames.**—What form of jet is necessary to produce a flame that will respond to certain sounds by suddenly dipping?—W. Hobbs.

[56442.]—**Laminated Armature.**—Will Mr. Bottone kindly send outline sketch, full size, showing proper form of laminated armature 3in. in diameter? What thickness should sheet iron be for this size? How best fastened on shaft? What should be the space between each lamination, and how are they kept apart—by metal washers or non-conductors? I propose to make one of above size for motor. How would discs of malleable iron answer, ⅛in. thick? A thin boss could be cast on each piece to keep them apart, providing the separation may be metallic. Your special opinion on this point will oblige, as well as all the foregoing. Living out of England, I have not access to your book.—Electric Motor.

[56443.]—**Lathe Flywheel.**—Will a cord or gut for a three-speed cone pulley run well enough on an old-fashioned flat-surfaced belt flywheel? I wish to get a new mandrel with all the later improvements, but do not wish to be at the further expense of a new flywheel.—B. Sc., Plymouth.

[56444.]—**Dynamo.**—Could one of our electrical readers tell me how to wind a Victoria dynamo (together with a sketch of the same), and also how is the armature constructed?—Accumulator.

[56445.]—**Driving Sewing Machine.**—I have a No. 1 Wheeler and Wilson sewing machine. I took off all working parts and put on a 3in. circular saw on shaft. I have been using it for a year for grooving, but I find it is sore work to drive it if the cut is deep. I was thinking of putting on two teeth and pinion wheels on it and a handle. Will any of our practical readers give me a rough sketch of how to supply the power?—Joiner.

[56446.]—**Cement for Rain Water Pipe.**—Could any of the readers of the English Mechanic tell me of a cement that would do for an outside iron rain pipe from the roof, where two sections of the pipe are about ¾in. apart? The waste pipe from a bath runs into the rain pipe, so that every time the bath is used it causes the garden to be half-flooded with soapy, steaming water. As it would take a good deal of trouble as well as money to move the pipe, I should be very glad if any one could give me a recipe. Owing to a leakage of the taps there is a continual dropping of water down the pipe.—T. E. Ashworth.

[56447.]—**Pattern Making.**—Many thanks to "J. H." for his kind information. I have only been a subscriber this year and have not got the numbers you speak of; but I have written to the Editor for them. About the back gear spindle, I know how to make it slide out and in by eccentric; but I don't know how to put in the spindle, the holes being oblong, 2 by ¾, and the wheels being bored out to 1¼. If I turn a spindle to fit the wheels, and smaller at each end to receive bushes that go into the holes, then I cannot get it in. What size of driving wheel should I have? My cone on mandrel has three speeds, the largest are 6¾ and 5¼ and 4¼. What should be the size of the steps of driving wheel, so that strap would fit alike on each step?—Busby.

[56448.]—**Double Electric Bells.**—Under this heading, Mr. R. T. Lewis replied to J. James some weeks ago. Would he kindly instruct me how to adjust ordinary trembling bells, so as to make both ring in multiple arc as advised? Those I have are both good bells, coils of silk covered wire, one is a 3½in. bell, the other 4in. They are 250ft. apart, that is the line wire, No. 20 copper, is that length. I have three Leclanché cells connected to them; the porous pots are 7in. deep. Would more battery power be advisable? Why I ask is this; I noticed on some other bells an excess of battery power, caused the platinum contacts to go black—so often wanted scraping. Is the battery power likely to do so in this case? Each bell connected by itself to the cells and line wire rings perfectly, so it is evidently a question of adjustment when they are arranged in multiple arc.—M.M.I.Sc.S.

[56449.]—**Filling Sand Holes in Brass Rollers.**—Will any subscriber be kind enough to inform me how to solder up sand holes or any uneven places which show up after turning large rollers, covered with brass shell, for rolling leather?—Thos. Grey.

[56450.]—**Regenerative Gas Burners.**—Can any of your readers give me some practical information as to the relative advantages of the Wenham, Bowers, and (?) Clark regenerative burners? Do these burners give off excessive heat? Are they fit for a room in a private house? Do they blacken the ceiling, or can they be placed in direct communication with a ventilating tube which goes into a disused chimney? The Bower burner has an arrangement at the under part which will obstruct the light in its passage directly downwards which the Wenham has not, but from what I have seen the Bower gives a whiter light. Any other information about regenerative burners from those who have had practical experience will greatly oblige—Steatite.

[56451.]—**Preparation of Sodium.**—I have lately been trying to make some sodium. I heated strongly sodium carbonate, charcoal, and chalk, in a cast-iron tube, 2ft. long and 2½in. diameter, plugging up the ends with clay, and through one plug passing a piece of iron gas tubing 1ft. long. First a little water came off and then white fumes (CO) which burnt. I then passed the fumes into naphtha for a long time, keeping it cool, but I could collect no sodium. Would any reader tell me why I failed, and how I could do it with the above apparatus?—Perplexed.

[56452.]—**Tennis Lawn.**—Would any fellow reader tell me how to treat my lawn? The soil is very clayey, and it does not seem to come on very well.—Perplexed.

[56453.]—**Paper for Copying Process.**—There is a process of copying in black any number of copies, by means of minute perforations in a prepared paper. Can any reader tell me if ordinary tissue paper will do, and which is the best method to prepare it?—Rustic.

[56454.]—**Violoncello.**—To T. Lisle.—In reply 56300, you described the violoncello by Otto. As I am making a violin as near as possible on the Strad. model, I would like to know the exact thickness of back and belly, as left by Stradivarius while at his best. You will confer a favour by giving the sizes of the two plates all over.—J. Towns.

[56455.]—**Hancock's Inspirator.**—In description of a new American loco. (p. 58, March 20th) it is stated that instead of pumps, the boiler is supplied by a pair of Hancock's Inspirators. Will any reader conversant with the matter, kindly describe this plan, and say how long it is in use, and if satisfactory?—Inspirator.

[56456.]—**To Electrical Advisers.**—I have a battery of six pairs of copper and zinc plates, about 5in. by 5in., in square earthenware jars; using dilute sulphuric acid, the current lasts about a minute and a half only, owing, I suppose, to deposition of hydrogen on the copper plates; amalgamating the zincs has not greatly improved matters. What can I do to utilise the battery with least expense? I have tried to get porous cells, but cannot get any to fit the jars as they are rather narrow. How would bichromate of potash agree with the copper plates?—Friar Bacon.

[56457.]—**Employers' Liability Act.**—Apropos to Mr. Weatherfield's useful information in article 24088 (Employers' Liability Act), and perhaps I may be anticipating his last paragraph in putting the following questions:—Myself and some twenty fellow workmen as millwrights, are principally employed at a distance from our employers' works, in fixing or repairing machinery in corn mills and similar works, for our employers' various customers. With the late improvements, especially in flour mills, of fast-running and complicated machinery, we are invariably working in exceedingly dangerous positions, and in most cases the work is done under the immediate superintendence and order of the mill owner or his manager. Our employers merely send us to our destinations with instructions that we shall find out what is required when we arrive. My further reason for asking this question, is, that during the past week, one of my mates had a most miraculous escape from a serious accident which I witnessed; the work was ordered to proceed with the machinery in motion, though the foreman had been asked to stop for a short time, which he refused. Had an accident actually occurred, who would have been liable?—the owner of the mill, or our employer? or would the owner of mill shield himself by the fact that he did not pay us wages, consequently we are not his servants, and our employers on the grounds that we were not actually working under their instructions?—Bona Fide.

[56458.]—**Crank Bending.**—Will some of "ours" who have had some experience in bending cranks by blocks or other devices, such as are used in looms (they run about 6in. in crank and have rounded corners, and are made from 1½in. round iron) give a fellow-reader a few hints as to the construction of blocks used, and also the kind of lathe for turning inside of crank up? The method described in letter 56127, No 1046, is not practicable in this case, as we have to leave them 3ft. 6in. long over all, and the crank about the middle. It would be impossible to true the crank up without some support in the middle or near the crank.—Young Smith.

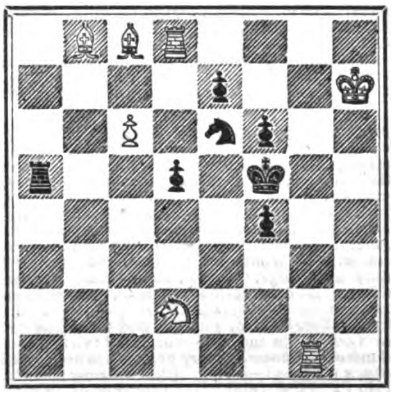
[56459.]—**Burning Oxygen in Hydrogen.**—Would some reader favour me with a description of an experiment, and a sketch of apparatus, showing how a jet of oxygen gas may be burnt in an atmosphere of hydrogen?—Charles Godfrey.

## CHESS.

All Communications for this department must be addressed to J. Pierce, Langley House, Dorking.

### PROBLEM DCCCCXXXVI.—By "Chess Struck."

*Black.*



*White.* [7+7

White to play and mate in three moves.

### Solution to 934.

| *White.* | *Black.* |
|---|---|
| 1. B-Q B 2 | 1. Q takes B (*a*) |
| 2. B-K B 4 (*d.* ch) | 2. K moves |
| 3. Kt mates | |
| | (*a*) 1. Q takes Q B (*b*) |
| 2. Kt Q B 4, &c. | |
| | (*b*) 1. B takes Q (*c*) |
| 2. B K B 4, &c. | |
| | (*c*) 1. Kt takes Kt (Q 6) (*d*) |
| 2. B-Q B 4, &c. | |
| | (*d*) 1. Kt takes Kt (Q B 7) (*e*) |
| 2. Kt-Q B 4, &c. | |
| | (*e*) 1. Q-K Kt 8 (ch) |
| 2. B-Kt 5 (ch) &c. | |

### NOTICES TO CORRESPONDENTS.

Correct Solutions to 931 by H. Culmer; to 932, by C. Meiklejohn; to 933, by "Birmingham" (no name); J. A. M. (very good problem, but easy); Bronti, Jacobus (though not elaborate, well constructed; several near tries for second solution, but Black neatly escapes); L. S. Chivers (variations must be given in full; not too late for Tourney. The best way to become a composer is to study the problems of the best masters; get Miles's "Chess Gems" and "English Chess Problems," and begin with two-movers); G. J. S. (neat but rather commonplace); J. M. Brown (very good, has some points and is pleasing); J. Sunn, H. Culmer, W. Hewson, E. S., and C. Meiklejohn; to 934, by H. Culmer (but all variations not given); R. A. Bennett (first move difficult, but unfortunately marred by the duals); V. S. Pochin (very cleverly planned); Rev. W. Anderson, Old Romney (but only first move correct, except in one variation).

R. A. B.—Your are wrong as to second solution to 934. If $1\ \frac{\qquad}{\text{Q takes Kt,}}\ 2\ \frac{\text{B-K B 4}}{\text{K-Q 4}}$ and there is no mate.

E. S.—In reference to your attempt, see above notice to "R. A. B."

Double Pawns.—Corrected form substituted.

J. F. P.—Look again at 933.

Correspondents are requested to notice change in address.

The production of coal in Belgium, in 1884, is provisionally put at 18,300,000 tons, against an ascertained production of 18,177,754 tons in 1883.

## ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

### HINTS TO CORRESPONDENTS.

**1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.**

***** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.**

**The following are the initials, &c., of letters to hand up to Wednesday evening, April 22, and unacknowledged elsewhere:—**

Heaton and Co.—Selig, Sonnenthal, and Co.—Clement E. Stretton.—W. C. Hughes.—Cotton.—An E. M.—Beta.—S. Austel.—W. A. G.—S. S.—Aryas.—J. F.—R. W. J.—J. Broadbent.—Montmartre.—Phillip Vallance.—J. E. Chaster.—Micro.—Electrician.—T. Westlake.—Poser.—B. Boothroyd.—F. E. H.—A. Price.—X. N. X.—D. Booth.—Tubal Kain.—Quantum Libet.—Subscriber.—J. Kean.—J. R. Postlethwaite.

**F. Howard.** (For directions how to make a galvanometer see p. 544, No. 960.)—**Amateur.** (No book that we know of; but many articles in back volumes. See the indices from, say, Vol. XXVII. to the present.)—**One Anxious to Know.** (Certainly, provided it is properly signed and attested. 2. Because the valves were on the dead point, and steam could not get into either cylinder in forward gear. Backward gear allows steam to enter.)—**A Would-be Blacksmith.** (Get "The Smithy and Forge," 2s. 6d., from Crosby Lockwood and Co., Stationers' Hall-court, E.C., and ask them to send you their catalogue.)—**H. D.** (You mean silver, not quicksilver? If so, you will find directions in No. 794. Look in the index to Vol. XXXIV. for a dozen and more references. Every process has been given in the back volumes.)—**W. M.** (Boil a strong solution of soda in it, with the addition of a lump of quicklime. It is much more difficult to get it out of pipes. The easiest way is, perhaps, to take the pipes down and heat them, when the lining will sometimes drop out.)—**Somerset Lad.** (Yes, it is due to galvanic action; the remedy is to make burned joints instead of using solder. 2. See some recent replies. It is not economical, unless it is wanted occasionally only for short intervals.)—**W. H. Searle.** (We know nothing at all of the Cycle Company you mention, and much fear you have lost your money. We should write to the chief constable of the town in which they carried on business.)—**St. Aldates.** (Best thanks, but it is almost impossible to satisfactorily reproduce pencil drawings of astronomical phenomena.)—**X. Y. Z.** (We can hardly insert such queries. You should advertise for tenders for your proposed cottage in the *Building News.*)—**T. H.** (A mere sum, of no value or interest to any one.)—**W. C.** (If you make it in the ordinary way with white flour, it will be as white as you can well get it. You seem to have burnt yours.)—**W. Hobbs.** (See the rules given in the guide books of the game. The opponent must take or be huffed.)—**Tyro.** (See some calculations in last volume, or the formula in the pocket-books. 2. From the Secretary at the office, Gt. George-street, S.W., we suppose. 3. Not suited to the Query columns, because of no interest to any other reader. Must advertise for the loan of the drawings in the usual way.)—**Enquirer.** (They are "cold drawn," or solid drawn as it is called.)—**Anti-Friction.** (See p. 201, Vol. XXXVIII. A good grease is made with tallow 19lb., palm oil 12lb., soda 1lb., water 3 gallons. The proportions vary slightly for summer and winter use. Those for summer are given above.)—**Lewis Carter.** (See Mackrow's "Naval Architects' and Shipbuilders' Pocket-Book," Lockwood and Co., Stationers' Hall-court, E.C. For the designing of yachts, see Dixon Kemp's work, published at the *Field* office, Strand, W.C.)—**Chimes.** (You will find the information in Sir E. Beckett's work, "Clocks, and Watches, and Bells," Lockwood and Co.)—**A. B. C.** (On the principle of the gas-holders, or gasometers as they are called. The quantity can be regulated by a tap; the pressure by weight.)—**Frank.** (Brush it well, and, if necessary, clean with paraffin oil and a brush. Then apply a little linseed oil.)—**D.** (We are not aware that it is usual to enamel them; but no doubt any firm who do bicycle enamelling, nickelling, &c., will undertake the work.)—**G. R. K.** (Query inadmissible. See Hints No. 4. Pictures of the kind are sold by philosophical instrument dealers, such as Horne and Thornthwaite, Strand.)—**Sportsman.** (The usual plan is to run the molten metal through a sieve kept on the shake, and allow it to drop from a considerable height into water. See the cyclopædias.)—**Mso. Jno.** (The usual plan is to rub it over with hearthstone and water.)—**James Barclay.** (A holosteric barometer is practically one which dispenses with fluids, such as the aneroid, the Bourdon or bent tube, and the balance barometer, consisting of a short metallic and a long wooden arm. 2. We do not know where ground malt can be obtained, but imagine it could be had of corn-chandlers or millers, where there is a demand for it.)—**Cyanide.** (Read up back volumes and look in textbooks of chemistry and electricity. A Leclanché battery is quite unsuited for plating.)—**Young Beginner.** (Directions for making cameras have been given many times. See pp. 224, 287, Vol. XXXV.; p. 567, Vol. XXXIII. The common box forms consists simply of two square tubes sliding one within the other. For a portable tripod see pp. 130, 155, Vol. XXXVII. For articles on amateur photography see pp. 212, 381, 474, Vol. XXXVII.)—**Amateur.** (There is a paper on domestic brewing in No. 505, a series of articles in Vols. XVIII. and XIX. on the chemistry of the art, and many replies and letters in back volumes. Black's work on "Brewing," published by Longmans, is about the best, and Lockwood and Co., publish a useful handbook for young brewers by H. E. Wright. You can also have the "Art of Brewing," price 2s., from Mr. Calvert, Great Jackson-street, Manchester, which will perhaps suit you best of all.)

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"The 'Household Journal' is admirably edited, clearly printed, and well illustrated, so that it contains all the elements of success, even with the large number of prizes offered to subscribers. The tales, anecdotes, &c., are capital, and suited to all classes of readers."—Taunton Courier.

TESTIMONIALS.

"Dear Sir,—I received the paper, the 'Household Journal' all right, and was very much pleased with it, and I have got ten subscribers to join me.—Yours truly, THOMAS ARSCOTT, 27, Concrete Buildings, Haverigg Walton, Cumberland."

"Mrs. G. Howlett received the 'Household Journal' yesterday, and is very much pleased with it. She has succeeded in getting five more subscribers, whose addresses she encloses, also P.O. for 10s.—Albert Terrace, Oxford Road, High Wycombe."

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Splendid Hot Rolling **Press**, equal to new, 30s.; worth £5.—H. Wheatley, 17, Manchester-road, Heywood.

Splendid ½-plate mahogany **Camera**, complete, with tripod stand; also quarter-plate Stereoscopic Camera, complete, 30s. lot; worth double.—Wheatley, 17, Manchester-road, Heywood.

**Induction Coil**, 1in. spark, discharging pillars, commutator and condenser, on mahogany stand, ebonite reel ends, price 47s.—Williamson, 61, Derby-street, Bolton.

A New Varnish.—**Spirit Copal**, clear as water. Never before been produced. Sample bottle, 6 stamps.—S., 5, Coventry-street, W., London.

Pumphrey's **Pocket Tripod**, for cyclists, professional and amateur photographers. Perfectly rigid. May be had on approval. Illustrations and testimonials free.—Pumphrey, Stanhope-street, Birmingham.

The **Camera and Lantern**, with three instantaneous photographs; gives full instructions in their production; 6d. post.

**Camera and Lantern Apparatus**, dispenses with multiplicity of slides, 36 plates, camera changed anywhere.—Pumphrey, Birmingham.

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"**American Brand.**"—Prices: quarter, 2s.; half, 4s 6d.; whole, 8s.; 4 by 5, 3s.; 5 by 8, 6s.; 8 by 10, 12s. dozen.

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**Standard Ohms.**—S. Bottone has a few of these on hand, price 2s. 6d.—Stanley-road, Carshalton.

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**Water Motors.**—Complete one horse-power, £9. Half, £6. Quarter, £4. Eighth, £3.—Thomas Wheeler, Preston.

Steel **Name Stamps**, 3d. per letter. Figures (set), 2s. 4d. Letters, 6s. 4d., per post.—E. F. Baldwin, Robinswood-hill, Gloucester.

Powerful Rhumkorff **Induction Coil**, ½in. spark, with condenser and commutator, on mahogany stand, quite new, first-class condition, complete, 23s. Large Bunsen's Battery, 5s.—A. B. Cowley, 41, Chapel-street, Hyde, Manchester.

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**Planing Machine**, £15. Anvils, &c., 15s. Stamp reply.—Mrs. A. Davis, London House, Cefn-Meur, Ruabon, North Wales.

New pair **Smith's Bellows**, 23in. by 21in., 50 shillings.—J. Olive, Middle Wall, Whitstable.

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**Launch Engine**, 4 by 4½, new, £12 10s. Screw Propeller for same. Boilers, various sizes.—Chenhall, Eastville, Bristol.

**Engine**, horizontal slide-valve, 1in. bore, 2in. stroke, price £1.—Particulars on application to Wm. H. Jackson, No. 5, Summerland-row, Butts, Coventry.

Quarter-plate bellows body tourist **Camera**, by Fallowfield, three double dark slides, cost £4 10s.; hardly been used; price £2 10s.—P. Y. Capper, Hamlet-road, Chelmsford.

**Devonshire Cream**, delicious, by improved centrifugal process. Parcels Post, lb., 1s. 6d.—G. Bull, Manor Farm, Martock, Somerset

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4½in. by 9in. **Cylinder**, about 1½-horse, piston rings, valve-faced couplets, £3.—A. W., 16, West-street, Stratford New Town, Essex.

**Launch Engine and Boiler**, 3in. bore, 4in. stroke, Vertical Tubular Boiler (19 tubes), 3ft. high, 1ft. 9in. diam. Price £35.—S. Smith.

**Screw Propellers** from 6in. to 30in. in stock. Improved pattern.—S. Smith, 11, West-street, Soho, W.

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**Microscopes**, several unfinished, very cheap. Also Objectives, Condensers, Polariscopes, Microtomes, and other Apparatus.—99, City-road.

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Large Chemical **Spectroscope**. Pocket ditto, 18s. 6d. Tisley's Harmonigraph, 63s. 10 by 8 Camera and Lens, 40s.—99, City-road.

**Electro-plating Machine** to work by hand or power, cost £18 18s.; price £8 8s.—S., 20, Montpelier-road, N.W.

**Telescope**, 4in. reflector, by Watkins, London, 4 powers tripod, &c., cost £18 18s.; price 5 guineas.—S., 20, Montpelier-road, N.W.

2in. by 3½in. Model Horizontal **Engine**, nearly new, price £4, a bargain.—H. C., 18, Poole's Park, Finsbury Park.

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Half horse-power Horizontal **Engine Castings**, ports in cylinders, 12s. 6d. Drawing, 1s. 6d. Litho, 2 stamps.—A. Dorrington, West Gorton, Manchester.

**Engine Castings.**—1 H.-P., 28s.; 2 H.-P., 50s. 3 H.-A., 70s. Litho, 2 stamps.—A. Dorrington, West Gorton Manchester.

Launch **Engine Castings**, 2in. cylinder, 12s. 6d.; 3in., 26s.; 4in., 50s.; 5in., 70s. Litho, 3 stamps.—A. Dorrington, West Gorton, Manchester.

Amateur's **Drilling Machine.** Castings, 3s. 9d. Forgings, 3s. Drawing, 8 stamps.—A. Dorrington, West Gorton, Manchester.

Double or single Oscillating **Paddle Engine Castings** for Boats from 15ft. to 25ft. Litho and particulars, 3 stamps.—A. Dorrington, West Gorton, Manchester.

The Amateur's **Gas Engine.** Complete Castings, 42s. Drawing, 5s. Litho, 3 stamps.—A. Dorrington, West Gorton, Manchester.

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**Dynamo Castings**, Jones's patent H: 8 c.-p., 5s.; 16, 5s. 6d.; 20, 6s. 6d.; 30, 7s.; 70, 16s. a set.—H. Jones.

**Dynamos**, finished: 8 c.-p., 30s.; 16, 36s.; 20, 40s.; 30, 50s.; 70, 100s. each.—H. Jones.

**Dynamo Armatures** of above wired after fitted up 1s. each, own make, warranted.—H. Jones.

**Dynamos** for house lighting. — Jones's Patent Laminated Felds and Armatures, 5, 6, and 7 lights, £6, £7, and £8 each.—H. Jones.

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**Battery**, bichromate, highest electrical efficiency. Contains 10 per cent. more chromic acid than potash bichromate. Lee's new double Bichrome. Soluble in own weight water. No crystals formed. Recommended in "E.M." No. 1044 (Reply 56016). 7d. 1lb., 7lb. sample parcels. 6½d. lb. in 56lb. lots.—R. A. Lee.

Chaster's **Electro-Motor Castings**, 3s. 6d. set As described in "E.M.," 1036, 1037, and 1039.—R. A. Lee.

Lee's Patent Primary **Battery** for above, or lighting 5 incandescent lamps. £3 10s.—R. A. Lee, 76, High Holborn London, W.C.

**Hand Dynamos**, £2 10s. each, sent free on receipt of cash.—Sledge, Wyatt, and Co., Clapham.

**Single Needle Instruments** (pedals), with battery, 30s. each.—Sledge, Wyatt, and Co., 95, Wirtemburg-street, Clapham.

**Sounder and Key**, with Battery (P. O. pattern). Complete set, 30s.—Sledge, Wyatt, and Co., Clapham.

Astronomical **Telescopes** of all kinds and Apparatus or Fittings made by A. Clarkson, 28, Bartlett's-buildings.

**Eyepieces.**—Huyghenian of any power to fit any telescope, 15s. each. Sun Diagonals, £1. Star Diagonals, 30s.

Astronomical **Telescopes**, second-hand, by best makers.—Clarkson, 28, Bartlett's-buildings, Holborn, E.C.

**Lathe Heads**, Slide-rests, Beds, Cranks, Rests, Chucks, Appliances, rough or finished. Send for list.—W. R. Smelt.

**Models** for Patentees and Manufacturers accurately made to scale. High-class workmanship. Moderate prices.—W. R. Smelt.

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**Price List** of Lathes, Parts, and Castings, 1 stamp.—W. R. Smelt, Engineer and Tool Maker, 7, Goldsmith's-row, Gough-square, E.C.

For sale, a fine **Model Locomotive**, 3ft. 6 inches long by 13½ inches wide, stands 1ft. 6 inches high to top of boiler, all motions from foot plate; it is a powerful and beautifully made engine. Price £70. Photo.—Geo. F. North, 2, Marlborough-place, Brighton.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
*FRIDAY, MAY* 1, 1885.

## EARTHY AND OTHER MINERALS.*

If it is true that the wealth of a nation is indicated by the magnitude of its commerce, it is certain that the prosperity of a country depends mainly on the variety and extent of its natural productions and the manner in which they are utilised. It has been stated that the condition of the "chemical" trade is practically an indication of the commercial condition of this country, and, to a certain extent, the assertion is true; but "chemical" in this connection is a term of very wide meaning, for it includes not only those manufactures which deal with earthy and other minerals, but also those which are more properly designated metallurgical industries. The author of the work, the title of which we give below, has already published a treatise on "Metalliferous Minerals and Mining" (see p. 593, Vol. XXX.); but the present volume deals with a subject of even greater interest, for it describes the earthy minerals proper, then those which are compounds of earths and alkalies, and, noticing at some length such elements as carbon and sulphur, concludes with brief accounts of those metalliferous minerals which are distinguished by the extreme difficulty with which their metals are extracted and the rapidity with which the latter, when unalloyed, unite with oxygen. That, it will be seen, is a tolerably wide field; but though the work makes no pretensions to be a complete manual of mineralogy, it gives a sufficiently full account for those interested in mining pursuits and for the general reader in search of information. The volume opens with silicon, which, in one or other of its combinations, forms the most abundant mineral in the crust of the earth, and shares with oxygen the position of being the principal element of the 64 already known. Silicon combined with oxygen in the proportion of 52 to 48 forms about two-thirds of the crust of the earth, and is known as silica, the base of many more or less valuable natural products. In its pure state as rock crystal it stands high in the table of hardness, being 7 as compared with 10 for the diamond; and though infusible by itself, with soda it melts and forms glass. The behaviour of silica with the alkalies in the presence of heat and moisture has been exhaustively examined by M. Daubrée, and his experiments leave no room to doubt that silica has been dissolved out of the older rocks by the action of soda and potash, in company with water at high temperature, and has been redeposited in the various forms in which it occurs. The commonest of these is clay, a mixture of silica and alumina; the most beautiful those in which the dissolved silica has been mixed with iron, copper, manganese, &c., and under the influence of heat and pressure has become crystallised into transparent forms, more or less pleasingly coloured. The clear white varieties of quartz are pure silica; but quartz is usually either "smoky" or tinged yellow or rose, though nearly all shades of colour are to be found. Divided into the vitreous, chalcedonic, and jaspery varieties, quartz or silica is well known as rock crystal and amethyst; as chalcedony, agate, flint, onyx, &c.; and as jasper, opal, &c. The rock crystal is the material of which pebble spectacles and prisms for optical instruments are made, and the clearest and finest specimens come from Madagascar, where it is frequently found in blocks weighing from 50 to 100lb. The amethyst is quartz coloured with different shades of pale red to purplish blue and violet, owing to the presence of oxides of iron and manganese. Chalcedony ranges in colour from white through grey, green, and yellow to brown, and there are some bluish varieties not unfrequently called sapphire, which consists, however, mainly of alumina, and only about 5 per cent. of silica. In agate the colours are arranged in undulatory and zigzag lines, while the onyx has them in horizontal layers, white, brown, or black. Jasper has the colours in bands, dots, stripes, or flames, while opal is a hardened paste of silica, with from 5 to 13 per cent. of water, milk-white or pearl-grey in tint usually, but possessing a remarkable power of refracting the rays of light, and flashing with a rich variety of colour as the position of the specimen is changed. Silica is most generally associated with alumina—e.g., in the shape of clay; but those two substances combine to give us the more highly-prized gems, with the exception of the diamond, and such useful materials as corundum, emery, tourmaline, and mica. The sapphire is generally composed of 92 per cent. of alumina, with 5 or 6 per cent. of silica, and oxide of iron as the colouring agent; the ruby varies considerably in composition, and frequently contains a large percentage of magnesia; topaz contains from 50 to 60 per cent. of alumina, 29 to 34 per cent. of silica, and a quantity of fluorine; while in the emerald and beryl the proportion of alumina is reduced to about 16 per cent., and glucina in the proportion of about 12 per cent. helps the silica to form the substance of the gems. Pure alumina in the crystalline condition is called corundum; in an impurer state and mixed with other substances it is well known as emery; but it is chiefly because it is the oxide of the metal aluminium that alumina is considered as one of the most valuable of the earthy minerals. The other principal constituents of the rock masses are lime and magnesia, the former being an oxide of the metal calcium, while the latter is an oxide of the metal magnesium. Magnesia is an important component of talc, steatite, chlorite, asbestos, meerschaum, &c., and imparts to those substances the peculiar greasy feel which is well known in the case of steatite and asbestos. The second part of the work deals with the haloid minerals, the most important of which is common salt. Under that heading, Mr. Davies gives an interesting account of the rise and progress of the Cheshire salt-making industry, with a geological section of the country from the Hawkstone Hills to Delamere and Peckforton. The salt deposits of other parts of the United Kingdom are noticed with some detail, and there are useful notes on those of the Continent, and the various methods of obtaining chloride of sodium practised in different parts of the world. Mr. Davies supplies a section of the strata at the famous salt mine of Wieliczka, in Austria, and a page plate of the Hill of Salt at Bahadur Khel, in the Trans-Indus region, with a section through the locality. A short chapter on nitrate of soda, borax, baryta, gypsum, fluor spar, and alum shale is followed by four devoted to that important mineral phosphate of lime, so valuable in the preparation of manures. Commencing with the phosphatic deposit of Canada, the oldest stratigraphically, the author gives an account, illustrated in many cases by sections and diagrams, of the principal known deposits in various parts of the world, from which we learn that, owing to the high royalty demanded by the landowner, English phosphate digging is ceasing to be profitable in Cambridge, Suffolk, and Bedford, and will probably die out in the presence of a cheaper article from abroad. It is satisfactory to reflect that abundant supplies of this valuable, not to say indispensable, manure are available; but the geologist finds much to interest him in the fact that the phosphatic deposits of the Laurentian rocks of Canada and Norway are free from all traces of organic life, while in all the succeeding deposits, except those of Estremadura and Nassau, organic remains are found in abundance. Of all the earthy minerals, however, the diamond is at once the most interesting and the most valuable from the commercial point of view. The diamond is pure crystallised carbon, and is the principal amongst the carbonaceous substances which are classed as earthy minerals. It crystallises in several forms, and is often tinged yellow, green, red, orange, brown, and black; but when pure it is transparent, and is the hardest substance known. De Boordt, in 1607, suggested that the diamond is inflammable, and in 1673 Boyle proved that it is dissipated when exposed to great heat. Lavoisier determined that it is composed of carbon, and numerous experiments since have demonstrated the fact that, chemically speaking, the valuable diamond is exactly identical with a piece of coke. Mr. Davies says it is thought that the diamond is of vegetable origin, having been dissolved and redeposited in some such way as the rarer specimens of silica and alumina, which are known as gems; but on this point there is no evidence at all, and it is far more likely that diamonds are the results of the decomposition of carbonic acid under the combined influence of great heat and pressure. Mr. Davies gives much interesting information in connection with the statistics of diamond mining and the value and ownership of the most noted gems; but, so far as we have searched, has nothing to say about bort or carbonado, which is just at present attracting some attention in our columns. Next to the diamond the most interesting carbonaceous substance is plumbago or graphite, which in its unmixed state is also carbon pure and simple, but it is generally found conjoined with more or less alumina, iron, lime, &c. It is used in the manufacture of the so-called "blacklead" pencil, and blacklead for polishing fire-grates, and, although it is carbon, for the construction of crucibles intended to withstand the most intense heat. Where it occurs in masses it is usually mixed with iron pyrites, alumina, quartz, &c., but like most other minerals, when found in cracks and cavities, where it has been presumably redeposited, is generally pure. In New Mexico it is found in the coal-measures perfectly pure, intense heat having possibly driven off all bituminous matter. Some of the plumbago found in Ceylon only falls short of absolute purity by ·050 per cent. of ash. Jet is another of the carbonaceous substances which has a certain amount of interest, although its only use is for purposes of ornament. A good specimen of Whitby jet contained 79·97 carbon, 13·22 oxygen, 4·30 hydrogen, a little nitrogen and sulphur, and rather more than 1 per cent. of ash. Asphaltum has a higher percentage of carbon, less oxygen and more hydrogen (as a rule), but the proportions vary in specimens from different localities; while mineral caoutchouc, elaterite, or elastic bitumen, is composed mainly of carbon with hydrogen and a little oxygen. Mr. Davies gives some useful notes on the bituminous substances and the distillation of oil from the shales, with geological sections showing the position of the mineral in different localities. Amber is another carbonaceous substance in which the carbon is in the proportion of 72 per cent., with hydrogen and oxygen in equal amounts—viz., 10·5 per cent. It is most abundant on the Baltic coast of Germany,

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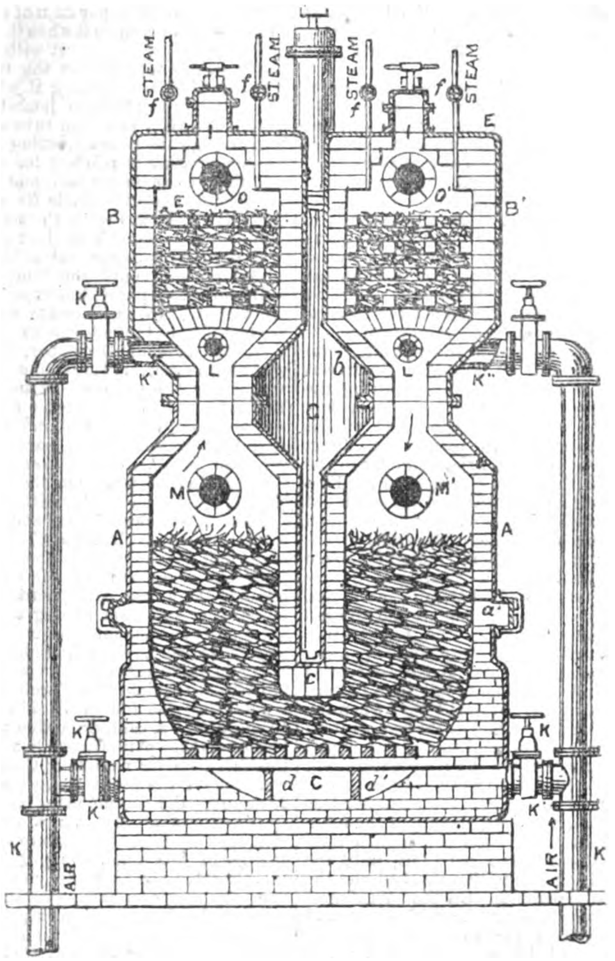
where it is found imbedded in clay of Tertiary age, out of which it is washed by the sea; but it is also obtained direct by digging, some portions of the land in the peninsula of Samland yielding amber at the rate of half a pound to a pound per cubic foot. Amber is undoubtedly of vegetable origin, being a gum which exuded from a class of trees called amber-pines. Sulphur is an abundant mineral in nature, occurring sometimes perfectly pure, or mixed with clay and bituminous substances, but is most extensively associated with the ores of the metalliferous minerals—notably iron and copper. The bulk of the copper pyrites now used in Great Britain comes from Spain and Portugal, the principal district from which the rich mineral is obtained being situated on the boundary line between the two countries. A very good idea of the extraordinary nature of the deposit is given by a general view of the Rio Tinto Mines. The fourth part of the work deals with certain metallic minerals, such as arsenic, cobalt, manganese, &c.; but as they are outside the title of this article, we must conclude with the intimation that, as a companion volume to "Metalliferous Minerals," Mr. Davies's work on "Earthy Minerals" is a useful addition to our library, and may be referred to by the student who wishes to know of what the earth's crust is composed, and in what manner the various substances have been utilised by man.

## TECHNICAL EDUCATION AND THE APPRENTICESHIP SYSTEM.

If any permanent good is to be obtained from the talk about technical education, it is time that some definite idea of what is meant by the phrase should be elicited. Every artisan and mechanic who has "served his time," is supposed to be, and is to a certain extent, technically educated in the rules and methods of his trade; but what is wanted is the technological education of those who are to be the employers, foremen, and workmen of the future—that is to say, they must be instructed in the principles of the processes they are to practise. That is the object of the City and Guilds of London Institute, and if the shorter word "technical" is used in that connection, it includes all that is meant by technological. In a paper read last week before the Society of Arts by Mr. Henry Cunynghame, the object to be aimed at is expressed in a few words:—"We require manual dexterity guided by wide views, and scientific knowledge accompanied by executive power." The technical school cannot therefore take the place of the workshop, nor a technological course of instruction replace the apprenticeship system. In the report of the Technical Education Commission, however, it is recommended that not only should charitable endowments be applied to technical instruction, but even that local authorities should be empowered to establish, maintain, and contribute to the establishment and maintenance of technical schools and colleges—a proposal which is calculated to alarm the ratepayers, especially those who already grumble at the School-board rate. Seeing that the majority of those who form the working classes leave school at the age of fourteen, there will be little spare time to instruct them in even the rudiments of a handicraft, while to supplant the apprenticeship system by technical training, schools may not be altogether profitable either to the pupils or to the trades into which they are to drafted. It is too often said that the system of training in classes is superior to the apprenticeship method, and so it undoubtedly is when compared to those instances in which apprentices were treated as errand boys and allowed to find out just what they could; but that is not what is meant by the apprenticeship system, by the indentures of which an employer or master binds himself to teach "all that art or mystery," &c. It is obviously to the interest of any firm employing mechanics or artisans, to make the best they can of the raw material which comes to them in the shape of apprentices, for their reputation depends on the quality of their goods, or on the manner in which they do their work. It is for that reason so many firms have supported the technological examinations' scheme of the City and Guilds Institute, for they understand that the solution of the problem does not consist in replacing workshop training with classes and lectures, but in supplementing that training by theoretical instruction at the period of life when the mind is most receptive. There is, however, a certain amount of technical instruction, which, if it could be imparted in the school, would be of considerable advantage: we mean that kind of instruction and examination which would discover the bent of the youthful mind, and enable boys to form some idea of their own inclinations. In Mr. Cunynghame's paper, however, we find some useful hints in connection with technical classes and the cost of the scientific apparatus necessary, for which the working classes cannot pay, and the expense of which it would not be fair to inflict upon the public. We quote a portion of the paper dealing with this point, because it will be found useful to many of our readers, some of whom, we are afraid, are not sufficiently aware that the majority of useful experiments can be performed with simple apparatus. "People are not sufficiently aware, because they have not been taught, that as far as the verification of the theory of light goes, such wave-lengths can be measured with all the accuracy that educational purposes require, with a small piece of a visiting card, a piece of fine wire gauze an inch square, and a two-foot rule, total cost, say, 1d. In the same way, a spectroscope can be made out of paper tubes, cheap lenses, a few pieces of glass, and a little bisulphide of carbon, at a total cost of, say 5s., which will divide the D sodium line in a manner quite sufficient for the instruction of mechanics. Instances of this kind might be multiplied indefinitely. There is no scientific instrument of any sort which cannot be made to serve for educational purposes, at a cost of as many shillings as it now costs pounds. But such a mode of study and teaching requires certain rules to be rigorously adhered to. In the first place all lacquer, French polish, ornamental paint, and varnish, must be strictly discouraged, and even forbidden. The students must be taught not to spend one moment on ornamentation of any kind. The one aim must be accurate fit and adjustment of essential parts, and absolute indifference to all others. This rule is harder to enforce in practice than might be imagined. When a new microscope comes home from the maker's, its polished mahogany case is opened, and to the eyes of the beginner, a vision of splendour is revealed in the golden gleam of the shining lacquered brass. All this he must studiously avoid. It is the mere joy of a child in a new toy. His only care or thought ought to be whether the lenses are optically true and achromatic, and, with these conditions satisfied, he should be carefully weaned from the prejudice in favour of varnish and veneer. . . . The first benefit of the adoption of the system of making the students construct their own apparatus is, therefore, economy. All that is needed is a store of flat glass, glass tubing, wood of different sizes, brass discs, screws, wire, and various chemicals, and a few simple tools, such as a fine tenon saw, pliers, and a few files, while, for general use, a glazier's diamond, a grindstone, and a large dividing protractor, and steel scale, a pair of accurate balances, and a few such apparatus, should be in every laboratory. . . . On the table I have here a set of tools and chemicals with which many of the apparatus here before you were made, and which is amply sufficient to make all that are given in the list. The cost of the whole comes to £6 10s. In this way a sum of £20 would go far to set up a technical class with the necessary tools and appliances, while if it were desired to do more elaborate work, the addition of a lathe, bench-vice, set of drills and other simple tools could be made for about £60. But not only is economy consulted by this system of teaching: the instruction is far more efficient. Suppose, for instance, it be desired to exhibit the qualities of polarised light. Whether will it be better to buy a shop-made polariscope with all the adjustments already made, or to cause the student to place his reflector at the true polarising angle, to secure it there with neat pieces of cork and sealing wax, to place his bundle of microscope glass plates in a tube; again securing the proper angle of inclination, and to tinker up the instrument till it works, at an outlay for materials of, say, a shilling? Which of two students will use a really fine instrument the best?—one who has been trained in the manner here advocated, or one who has always been provided with instruments ready made?" In concluding his paper, Mr. Cunynghame said:—"To attempt to do, at public expense, what can only be done in the workshop, is a mistake: it will fail in its results, and it is unjust to expect the nation to pay for it." There is abundant means in this country for the technical or technological education of the masses, and the problem is not so much how to do it, as to how to do it cheaply. With regard to the apparatus exhibited by Mr. Cunynghame, Prof. Guthrie said the author had spoken too slightingly of some of the instruments, for in Prof. Guthrie's opinion such apparatus as was shown was far more scientifically and absolutely accurate than that which would be produced by the ordinary optical instrument maker. It was simple in construction, but truthful in conception, and without any adornment. This method of bringing the hand and the mind to work together really lay at the basis of all true technical instruction; where the mind alone was employed, the knowledge acquired passed away; but when the mind and the hand had been educated together, the knowledge was never forgotten.

## THE MANUFACTURE OF ILLUMINATING AND HEATING GAS

Many processes for the manufacture of gas from water and its subsequent enrichment with hydrocarbons have been described in back volumes, but at the present time the United States seem to have a monopoly of new inventions in this connection, probably owing to the high price there charged for the ordinary coal-gas. Mr. Boult, of High Holborn, has recently patented in this country, on behalf of John Hanlon, of New York, an improved method of making illuminating and heating gas, the invention being more immediately connected with that process and apparatus in which steam is decomposed and bituminous coal is distilled in the same cupola or generating furnace; in which hydrocarbon oil is vaporised either in the generator or in a connected fixing-chamber which is heated by the waste gaseous products of combustion of the fuel in the generating-chamber; and in which the resulting gases and vapours are combined and converted into a fixed gas in the heated fixing-chamber. The object of the invention is to improve the manufacture of illuminating gas by so conducting the operation as to effect a great economy in the use of hydrocarbon liquid by which the gas is carburetted, that is, to prevent destructive decomposition or reduction to lamp-black or solid carbon, and consequent waste of the hydrocarbons which impart the illuminating quality to gas. Another object is to improve the apparatus in such manner as to better preserve the grate bars from the destructive action of steam and hot gases; to simplify and improve the coal-charging apparatus; and to provide a superheater so constructed and provided with discharge-pipes and valves that the carburetted gas may be discharged immediately upon being fixed, whereby injuriously long exposure of the hydrocarbons to a large body of heated refractory material is avoided, and gas of more uniform quality and candle-power is produced. The illustration represents the generating and steam superheating chambers in vertical section. The generating apparatus G is composed of two furnaces or chambers, $A\ A^1$, connected by a common base and freely communicating with each other above the grate C, which is common to both; and they are surmounted by steam superheating and decomposing chambers, $B\ B^1$, connected by the necks $b\ b^1$. The generators and superheaters are constructed of fire brick, covered by jackets of plate iron, and mounted on a brick or stone foundation. The decomposing chambers, $A\ A^1$, are represented as independent structures, slightly separated from each other down to near their bases, a short distance above the grate—each having a distinct inclosing wall and jacket down to the arch *c* above the grate chamber, but it is obvious that they might both be built in one structure, inclosed in a common wall and covered by a single jacket, and separated by a division wall resting upon the arch *c*: this division wall might be strengthened and made tight by a central iron plate. The chambers, $A\ A^1$, have their bottoms curved and sloping from their outer sides down to the bottom of the ash-pit, in order to reduce the grate surface, and so that the chambers may be more readily cleaned. The ash-pit is divided into three separate compartments by the partition walls, $d\ d^1$, extending from front to rear thereof, so that the gases from



from one generating chamber are not allowed to pass down through the grate, and thereby corrode and burn it out, but are compelled to pass above the grate to the adjoining generating chamber. Tight-fitting doors, *a*, close passages into each compartment of the ash-pit. The steam superheating and decomposing chambers, B $B^1$, are connected with the generating chambers by contracted necks, *b* $b^1$, and have near their bases arches of masonry supporting the cellular brickwork, E $E^1$, and iron scrap; they are also provided with short smoke stacks or passages, I $I^1$, having tight-fitting lids or caps; these passages also serve as man-holes, to give access to the chambers for the purpose of laying, repairing, and cleaning the cellular brick-work. Steam-pipes having valves, *f*, are connected with the top of each superheating chamber. A coal-charging hopper (not shown in the figure) connects by a chute with the upper portion of each generator, and the hopper has at its bottom a water-cooled valve, provided with a stem and operating lever. The conical portion of the hopper is constructed of sufficient size to hold a single charge of coal, and this chamber is separated from the main fuel chamber by a cut-off slide, constructed with separated bars like a grid-iron. The fuel chamber should be made large enough to hold a number of charges of coal, and it is closed at the top by a tight-fitting lid. An air-blast pipe, K, connects by branch, $K^1$, having valve, *k*, with the base of each generating chamber below the grate, and by a branch, $K^{11}$, having a valve, $k^1$, with the base of each steam superheating chamber. A sliding oil supply pipe (not shown in the figure), having a pivoted operating lever, passes through a stuffing-box and sleeve near the base of each steam superheating and decomposing chamber, to supply oil for enriching the gases passed from each generating chamber. When oil is admitted the supply-pipe is projected some distance into the chamber, in order that the oil may drop freely through the passage in the neck, *b* or $b^1$, down into the rising and outgoing current of hot gas. Each generating chamber is provided with a number of openings, $a^1$, closed by tight-fitting caps; one set just above the grate bars, and another set higher up, for the insertion of bars to break up the coal or coke, and break down the clinker. Gas discharge-pipes, M $M^1$, having water-cooled valves, connect near the tops of the generating chambers, A $A^1$, and with vertical stand-pipes (not shown). Pipes, M $M^1$, are for the escape of gases resulting from the decomposed steam, coal, and oil on their way to the fixing-chamber, and also for the escape of products of combustion. The superheating and decomposing chambers have, connecting near their tops, the outlet-pipes, O $O^1$, having water-cooled valves leading to the stand-pipes, for the escape of products of combustion. The stand-pipes connect at their lower ends with the base of the fixing chamber. The lower ends of the stand-pipes, from just above the connecting-pipes, M $M^1$, downward, and where they are exposed to the greatest heat, are lined with fire brick, while the upper ends, through which but a small proportion of hot products pass, are simple iron pipes. The fixing-chamber is constructed of firebrick, covered with a tight jacket of plate iron, and is mounted on a brick or stone foundation; it is provided near the base with a perforated arch for supporting the cellular brickwork filling. This brickwork is separated into three sections or bodies by intermediate spaces, and at each space, above each body of brickwork there connects a gas eduction-pipe leading to the hydraulic seal-box. An air-blast pipe, having a valve, connects with the base of the fixing-chamber below the arch, for supplying air to produce complete combustion of gaseous products from the generator while heating up the apparatus. The two generating chambers are operated reciprocally, the superheated steam being passed alternately down into one, and the resulting gases up through the other, while the fresh charge of bituminous coal is also distilled alternately, first in one and then in the other chamber, but always being freshly charged into that chamber least highly heated, and up through which the gases are passed on their way to the outlet-pipe and fixing-chamber. A fire is first kindled on the grate, and it is urged by air-blasts admitted through pipes, $K^1$, by opening valves, *k*, on each side of the grate, while fuel, preferably anthracite coal, or coke, is gradually fed in, till a bed of highly-heated or incandescent fuel, several feet thick, is formed in each chamber. During the admission of the air-blasts below the grate, the cap of smoke stack is open, and at first the valves on outlet pipes, M $M^1$, are opened for the escape of products of combustion into fixing-chamber; then, as the beds of fuel increase in the generators, and carbonic oxide is given off, air is admitted to the base of fixing-chamber, for causing complete combustion of the hot carbonic oxide, and thereby heating the refractory brickwork in the fixing-chamber. Near the end of the operation of heating up, air-blasts are admitted by branch pipes, $K^{11}$, into the bases of chambers, B $B^1$, for burning hot products therein, and heating the contained brickwork and iron scrap. The beds of fuel in the generators being raised to incandescence, and all the chambers being properly heated, the valves of the air-blast pipes are closed, and other operations having been performed, steam is admitted by pipes, *f*, into the top of superheating-chamber, B, where it is superheated and partially decomposed by passage down through the highly-heated brickwork and iron scrap contained therein, and the resulting hydrogen and superheated steam are passed down into the incandescent fuel in chamber A, where decomposition is completed: the resulting gases passing below arch, *c*, and above the grate up through the hot fuel in chamber, $A^1$, where any carbonic acid present is converted into carbonic oxide. The partitions, *d*, $d^1$, in the ash-pit prevent the current of gases from passing through and below the grate, whereby it is preserved from corrosion. About the time that steam is admitted to superheater, B, a charge of bituminous coal is dropped upon the bed of hot fuel in chamber, $A^1$, so that the gases resulting from the steam are passed up through the distilling charge of coal, and thereby combine with the rich hydrocarbon vapours, and carry them into the fixing-chamber. If a rich gas is desired for illuminating purposes, hydrocarbon oil is admitted by pipe into chamber $A^1$ where it is vapourised, and the vapours mingled with the outgoing gas pass through pipe $M^1$, to the fixing-chamber. If the heat in chamber $A^1$, is so great as to be destructive of the oil, it may be admitted at any desired point in the stand-pipe, or even into the fixing-chamber, for carburetting the gas. It is intended, however, that the generating-chamber in which coal is last fed, and up through, and out of which the gas is passed, shall not be at such high temperature as to change the hydrocarbons of the coal, or the liquid, into lamp black or hard carbon. The large volume of hydrogen entering from the adjacent chamber assists materially in carrying the hydrocarbons forward, and preventing them from burning. The iron, which is oxidised by the passage of steam through it, is revivified by carbonic oxide, the steam and gases being taken in the reverse direction, the alternating processes forming part of the claim in the patent.

## DR. HENRY DRAPER'S EXPERIMENTS ON THE USE OF CARBON BISULPHIDE IN PRISMS.[*]

THE photographs which were taken in the research on the presence of oxygen in the sun, in the earlier as well as in the later series of experiments,[†] were obtained by the use of two hollow prisms filled with carbon bisulphide. These prisms were loaned for this purpose by Mr. Rutherfurd, having been made by him for producing his celebrated solar prismatic spectrum. The photographic work for the oxygen research was done in New York in a back room of the third story of Dr. Draper's residence. The temperature of this room proved to be remarkably uniform, the quality of the photographs, and especially the sharpness of definition, being all that could be desired. When, however, the preliminary experiments required for the continuation and extension of this research were undertaken in the new physical laboratory (which Dr. Draper had built above his stable in the rear of his house, and which was completed in 1880) it was found practically impossible to use carbon bisulphide prisms in this room owing to the rapid variations of the temperature there. No definition whatever could be obtained with the same prisms which had performed so well in the main house. In consequence, the use of these prisms had to be abandoned and a series of experiments was made to obtain the spectrum by other means. First a Rutherfurd silvered glass grating of 8,640 lines to the inch was employed, and subsequently a train of six flint-glass prisms made by Steinheil and loaned by Mr. Rutherfurd. With reference to these experiments, Dr. Draper says: "The exposures required when using the silvered grating were so long that experimentation was very tedious; but when, in addition, the definition did not equal that of the two bisulphide prisms formerly used, a change became necessary. If we could overcome the effect of temperature on bisulphide it would doubtless serve our purpose best, because it is more transparent, less coloured, and loses less light by reflection than glass prisms, since there are only two prisms needed to do the work of four flints. But the instability of a bisulphide train is so marked in the new laboratory on account of the fluctuations of temperature that we have not been able to depend upon it. Possibly, if the prisms were inclosed in cotton batting, or immersed in water, these difficulties might be overcome."

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[*] From the *American Journal of Science*.

[†] The results which were obtained by Dr. Draper in his investigations on the cause of the difficulties encountered in the use of carbon bisulphide in prisms seemed so valuable and so likely to be of service to others engaged in photographing the prismatic spectrum, that at the suggestion of several of his scientific friends it was decided to publish them. At the request of Mrs. Draper, therefore, and with her kind assistance, I have collected from Dr. Draper's copious notes the facts in relation to his experiments which are detailed in the following pages; and have also made some supplementary measurements to test the efficiency of the apparatus.—GEORGE F. BARKER.

With the flint prisms, the definition of the sun spectrum was excellent, but it was found impossible to get the line H on the photographic plate through the train. The silvered glass grating permitted the spectrum from F to a long distance above H to be obtained at one exposure on an eight-inch plate; but the definition given by it on the sun spectrum was inferior to that obtained with the prisms. The definition of the flint train, however, good as it was, only equalled and did not surpass that of the bisulphide prisms used in the oxygen research; "the rippled line below G is as well defined," Dr. Draper says, "as I have ever seen it with the two bisulphide prisms." On the spectrum of the carbon arc, the dispersion given by the train between G and H was double that given by the silvered grating in the spectrum of the first order; while that given by "the two bisulphide prisms between G and H is slightly greater than that of the six flint prisms." Moreover, while the definition on the lines of the sun spectrum was best with the flint prisms, that on the spark spectrum lines was best with the grating. These experiments extended through nearly two years, from March, 1880, until early in the winter of 1881-2.

Among the earliest experiments which were undertaken in the new laboratory was a series made to test the performance of a bisulphide prism of Thollon's construction, made by Hilger, of London, and obtained from him by Dr. Draper when in Europe, early in 1879. This prism consists of a glass bottle having two plane sides making an angle of 90° with one another, upon which are cemented two prisms of flint glass four by two inches on the face, having each a refracting angle of 18°. The refracting edges of these glass prisms are opposed to that of the bisulphide prism. Hence the refracting angle of the compound prism is 54°. The same difficulties were experienced with this prism as with the Rutherfurd bisulphide prisms. Owing to the temperature variations, the spectrum lines were "woolly," and no definition was possible. Dr. Draper says: "The bisulphide prism touched with the finger or breathed on loses all definition at once." It was found, however, that the dispersive power of the Thollon prism was equal to that of about four of the Steinheil flint prisms; and this fact, together with the unsatisfactory character of the results obtained with the train of prisms as well as with the grating, led Dr. Draper to undertake an investigation into the causes of this unsteadiness of the bisulphide, with a view to remedying it if practicable.

The same difficulty has been encountered by all experimenters who have endeavoured to use bisulphide prisms. Mr. Rutherfurd himself found it to be very serious, and M. Thollon says such prisms must be protected carefully from temperature variations. It was while using these prisms that Mr. Rutherfurd made an important observation. He noticed that "if a good prism which, with a high power, refuses to define the soda line (a more stringent test than solar lines) is violently shaken and then placed in position, it will for a few minutes define beautifully, but gradually settle into its former condition. It occurred to Dr. Draper, therefore, that possibly the striæ caused by convection currents produced by inequalities of temperature, and which caused the bad definition, might be destroyed by an active agitation of the liquid. Acting on this suggestion, on the 19th November, 1881, he placed a small propeller wheel in the bisulphide contained in the Thollon prism, its shaft passing out through the stopper. By means of a small electric motor, this propeller could be rotated with any convenient speed. The result was marvellous; by thus keeping the liquid in agitation all inequalities in its density were prevented and the definition became excellent. On the 21st November, with the stirrer revolving five times a second, the definition was so perfect that even with a faint flame the sodium line could be seen distinctly reversed. A series of comparisons was now undertaken between the train of Steinheil prisms and the Thollon prism as arranged with the stirrer. On December 2nd, using sunlight, the relative dispersion of the two was found to be very nearly equal, the flint train giving perhaps one-eighth more; but the amount of light transmitted by the bisulphide prism was at least four times and in the region about G eight times as great as that obtained from the Steinheil prisms.

But now another source of error was developed. Although when the propeller was running the definition of the bisulphide prism was not affected by changes of temperature, yet now these changes of temperature, by changing the refractive index of the liquid, caused a continual shifting of the position of the lines in the spectrum, either in one direction or the other. It is obvious, therefore, that during an exposure of any considerable duration, such as is often necessary with faint spectra, this change of position in the lines due to temperature change would absolutely destroy the definition on the photographic plate. In the hope of correcting this new difficulty, an even temperature box was constructed about the prism, and was filled with cotton. On the morning of December 8th it was found that the thermometer had fallen during the night 9° F., and that the sodium lines had shifted toward the more refrangible end of the spectrum a distance of 0·75 inch.[*] A direct experiment, made by placing a thermometer in the bisulphide, showed that for a change of 3·75° F. a change took place in the position of these lines of 0·375in. The box containing the prism was then enlarged to 30in. on a side and a plate of iron 6in. square was let in to the bottom, and so arranged that it could be heated by a gas flame. Subsequently an iron tube closed at the upper end and 9in. long was passed through the plate and allowed to project 7in. into the box. The temperature within was regulated by two compound expansion bars made of strips of vulcanite and brass riveted together and included in the circuit of a battery and an electromagnet so arranged that when the ends of the bars came in contact as the temperature rose the circuit was closed and the electromagnet turned down the gas. When the temperature fell, the circuit was opened and the gas was again turned on. On the 16th of December the regulator was adjusted for 77° F., the temperature of the room being 63° F. After four hours the sodium lines ceased to move towards the red; but, until the stirrer was started, the definition was bad and the lines could not be separated. On the morning of December 20th the thermometer in the box had fallen over night from 79° to 65° F., and the sodium lines had receded toward the violet end of the spectrum a distance of 1·375in. On turning on the heat, the prism did not appear to feel the effect for half an hour. Then the lines began to move toward the red end of the spectrum and continued to do so for more than five hours. On turning off the heat, the lines began to recede in half an hour; but although it was again turned on, they did not become stationary for an hour. On the 23rd the even temperature box was enlarged and a second box constructed within it, the space between the two being filled with cotton. On the 29th the regulator was started at 7 a.m. At 1 p.m. the temperature became stationary at 70° F., and the spectrum remained at rest for two hours. On the morning of January 1st, 1882, the temperature of the box was 54° F., having cooled from 72° F. over night, and the sodium lines had moved a distance of 1·8in. From these experiments, the conclusion was reached that if a change of over 10° F. is to be made in the box, it is doubtful whether with this apparatus the spectrum can be made stationary on the same day. The heat was, therefore, left on over night, and the temperature was found to be readily controlled the next day. There were fluctuations of course, but they were not enough to injure the definition if the exposure was not over 15 or 20 minutes. On the 25th of January some changes were made in the heating tube by placing a funnel upon its lower end, by continuing it up through the top of the box, and by making an opening on one side of it within the box. A relay was also arranged with a damper so as to close the top of this tube whenever the circuit was broken by the separation of the differential bars in the box, and to open it when the circuit was closed. This relay acted in concert with the electromagnet above mentioned, closing the tube when the gas was turned on and opening it when it was turned off. On lighting the gas jet below the funnel, the heated air rises into the tube and passes into the box through the lateral opening in the tube. When the temperature is reached for which the bars are set, they come in contact and close the circuit. The electromagnet attracts its armature and thus turns down the gas while the relay also closes, and thus opens the damper on the top of the tube. The heated air now passes out of the box through the lateral opening until the temperature has fallen sufficiently to separate the expansion bars and open the circuit. No experiments with this apparatus are recorded in the note-books.

On the 27th of December, 1884, the apparatus was put in order, and some experiments were made with it for the purposes of testing its efficiency. The automatic arrangement for regulating the heat was easily adjusted and found to work well. The definition of the sodium lines, which at first was very bad, became admirable in a few moments after starting the stirrer. On the 30th the first systematic test was made with it. The gas was lighted at 9 o'clock a.m., and at 11h. 20m. the temperature of the box was 67·5° F. The cross wires of a small telescope were then set on the less refrangible component of the sodium line. In 15 minutes the other component was on the cross wires, the spectrum having shifted the distance between these sodium lines in this time. The displacement was toward the red, and the prism was rising in temperature. The second similar change in position required also 15 minutes; but the third required 19, the fourth 35 minutes, and the fifth 49 minutes. A centigrade thermometer reading to tenths was then placed in the box. At 5h. 20m. p.m. this thermometer read 21·3° C., and the cross wires were set on the less refrangible sodium line. In 25 minutes the thermometer read 21·4° C., and the spectrum had moved over a little more than the distance between the components. A second change of this amount required 41 minutes, the thermometer showing no change. At 1h. 2m. a.m. the spectrum had again shifted by a distance equal to that between the components of the sodium line, but had required 97 minutes to accomplish it, the thermometer reading 22·3° C. at the beginning and at the close of the experiment. The latter part of the time the spectrum shifted by only the width of one of the components in an hour. In a second experiment an hour and six minutes was required for this amount of displacement. The thermostat was then left in action over night. At 9h. 10m. the next morning the thermometer read 22° C., not having perceptibly changed since the last reading, while the sodium lines had shifted in seven hours by only a little more than the distance between them.

The gas was then turned off and the entire apparatus allowed to remain at rest for several days, the temperature of the box, the position of the sodium lines, and their definition being observed by Mrs. Draper from time to time. The following are the values obtained:—

| Date. | Time. | Temp. of Room. | Temp. of Box. | Definition. | Displacement. |
|---|---|---|---|---|---|
| Dec. 31st. | 10 p.m. | 68° F. | 18·2° C. | Excellent. | 1·25 inches. |
| Jan. 1st. | 12 m. | 69° F. | 18 4° C. | " | 1·166 " |
| " | 3 p.m. | 68° F. | 18·6° C. | " | 1·083 " |
| Jan. 2nd. | 10.45 a.m. | 56° F. | 13·0° C. | Good. | 2·416 " |
| Jan. 4th. | 12.30 p.m. | 50° F. | 9 6° C. | Fair. | 3·583 " |
| " | 4.40 p.m. | " | " | Excellent. | 3·583 " |
| (*Gas lighted in thermostat.*) | | | | | |
| " | 7.30 p.m. | 50° F. | 15·2° C. | Entirely gone. | 2 083 " |
| Jan. 5th. | 10.25 a.m. | 50° F. | 9·4° C. | Excellent. | — |
| (*Gas lighted in thermostat.*) | | | | | |
| " | 10.30 a.m. | 50° F. | 10 2° C. | Fair. | — |
| " | 10.45 a.m. | " | 10 9° C. | Bad. | — |
| " | 10.55 a.m. | " | 12·2° C. | Entirely gone. | — |
| (Started the motor and in five minutes the definition was good. Put out gas and a few minutes later stopped the motor. Definition lessened very slowly.) | | | | | |
| " | 11·15 a.m. | 50° F. | 11·2° C. | Entirely gone. | — |

The results which have been given in the preceding pages seem to have a two-fold bearing. In the first place they prove that by the simple expedient of stirring the liquid in a prism by means of a propeller or other device, so as to keep it in active motion, all striæ due to temperature changes may be prevented and the definition rendered perfect. Even carbon bisulphide, whose extreme mobility and high expansion-coefficient make it extremely sensitive to variations of temperature, may be made in this way to give the most admirable definition; so complete, indeed, that in the spectrum given by such a prism a fine reversed line has been seen in one of the components of the sodium line. The practical value of this simple device is very considerable. The Thollon bisulphide prism above mentioned, while giving 7-8ths as much dispersion as six flint prisms, gives four times the light in the entire spectrum and eight times the light in the region near G. For photographic purposes, now that the definition can be made permanently sharp and the shifting prevented, this prism must replace trains of glass prisms, and even gratings unless these are of large size and are used with telescopes of proportionately large apertures.

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[*] These measurements were made by Mr. C. D. Chapman, who at that time was acting as Dr. Draper's assistant.

In the second place this investigation has called attention in a very marked manner to the change in refracting power with change of temperature. This subject has already been discussed with reference to liquids by several authors, especially by Gladstone and Dale in 1858, and with reference to glass by Mendenhall in 1876 and Hastings in 1878 Both these physicists confirm the statement of Arago and Neumann that for glass the law is precisely the reverse of that given for liquids, and that the refractive index increases with the temperature. Mendenhall calls attention to the effect of this change upon the determination of the position of spectrum lines, especially with a train of prisms, and suggests that it may account for the discrepancies observed in the values given by different observers for the same line. In the case of the Thollon prism described in this paper, it will be observed that the deviation, and consequently the refractive index, increases in a very marked manner as the temperature diminishes; confirming Gladstone and Dale's law for carbon bisulphide. When the prism was cooled from 22° C. to 9·6°, the double sodium line moved toward the violet end of the spectrum over a distance of 3·583in.[*] As Mendenhall has shown that no change takes place in the angle of a glass prism with change of temperature, it follows that the flint-glass prisms composing the sides of the Thollon prism change only in their specific refraction with change of temperature. Hence the change of the refractive index observed in this prism as above stated is a differential result due to the excess of the change in the index of the bisulphide in one direction over that of the flint glass in the other.

Moreover it has now been most clearly shown that by means of a suitable thermostatic arrangement it is quiet possible to preserve the temperature of the prism so uniform that no material change of position shall take place in the spectrum lines, at least during any reasonable exposure. The numerical results above given prove that in the apparatus as arranged by Dr. Draper the temperature did not vary 0·1° C. for more than seven hours, and that during that time the sodium lines did not change their position by an amount equal to the distance between them. Hence this source of difficulty, hitherto so serious in spectrum photography, especially when the exposure is a long one, is entirely obviated.

These experiments, moreover, confirm the opinion that the irregularities in the bisulphide, which are the cause of its bad definition, are produced by an inequality between the temperature of the liquid and that of its inclosing vessel, thus producing convection currents in the liquid. So long as the temperatures of the prism and of its contents rise and fall together, and with the surrounding objects, so long the definition remains perfect, notwithstanding the temperature change. It is only when considerable changes of temperature take place suddenly that the striæ due to these convection currents appear and spoil the definition. As this is the condition in most working laboratories, the advantages there of a method of completely obviating the evil by agitation enables the experimenter to secure good definition with any changes of temperature. But now these changes of temperature, though they cannot produce bad definition, do cause shifting of the lines. The even temperature box already described cures this trouble completely. When this box has been at a constant temperature for a sufficient time, the definition is good even without the stirrer. Even when the temperature of the box is changing quite rapidly, good definition can be always secured by starting the stirrer.

It will ever be a source of profound regret to the many friends of Dr. Henry Draper that he did not live to complete the research to which the foregoing investigation was preliminary. With his new and admirably equipped laboratory, and with this powerful and thoroughly corrected photographic spectroscope at his command as one of its first fruits, no one can doubt that he would have secured with it results of the highest value to astronomical, and especially to solar, physics.

## ADJUSTABLE BEADING, RABBETING, AND SLITTING PLANE.

THE tool shown in the annexed engravings has been patented in the United States by Mr. Franks, and is one of merit, covering a large field of operations, and being very efficient in each, besides being light and handy and occupying much less room in the toolbox than would be required for the several tools whose place it fills. Fig. 1 is a side, and Fig. 2 a top view of the tool as a whole. Pieces A and B form the body of the plane, between which the bits and the tools are carried, except the slitting knife, which is carried by A above. In the figure, T is a beading tool shown in position, having a bearing or seating in both A and B, so as to support it on both sides, and being locked in position by the thread screw C. At G is a depth gauge, which is moved over into the hole at D, when that position is most suitable for the kind of work in hand. Piece B is made adjustable in its distance from A, so as to accommodate different widths of bits by sliding it on the arms M, securing it in its adjusted position by the set-screws S. Similarly, the fence F slides on arms M, and is secured in its adjusted position by the set-screws H, thus enabling it to regulate the distance from the edge of the board at which the bits shall operate, and also to guide the bits true to the edge of the board or work. F is provided with an upper and a lower power of holes, so that it may be set on the arms H at two different heights, as may best suit the nature of the work. W in Fig 1 is a spur for cutting the end grain of the wood in advance of the bit, as it is necessary on dado and other cross-grain work. The construction of the spur is seen more clearly in Fig. 3. The pieces A and B are provided with a recess, having four arms or branches, while the spur itself has but three, so that the spur may be set as in Fig. 1, and be out of action; its screw being loosened, it may be given a half-turn, so that one of its arms will come below B, as at X in Fig. 5. The cutting edges of the spurs come exactly flush with the outside faces of A and B, and the bits are so held in their seats that their edges also come exactly flush with their outside faces, which therefore act as guides to the bit. Fig. 4 shows a plough in position on the work, A and B being shown in section. It is seen that their inner edges being bevelled will, in using a beading tool, act as a gauge regulating the depth of the cut, which will equal the amount to which the cutting edge of the bit projects beyond the bevels of A and B. Similarly in grooving or ploughing, the amount to which the bit projects below the lowest points or edges of A and B regulates the thickness of the shaving, and as A and B follow the bit into the work, the blade being once set, the work may proceed without altering or touching the bit, which will operate until prevented by the depth-gauge meeting the surface of the work. This principle of the side pieces A and B entering the work with the bit and being adjustable in width apart to suit various widths of bits, gives to the tool the capacity to serve for a very wide range of work. It will be seen that this tool, which is made by the Stanley Rule and Level Company, of New York, is capable of doing a great variety of work, and it is supplied with nine bits, nine beading tools, and a tonguing bit, provided with an adjustable depth gauge.

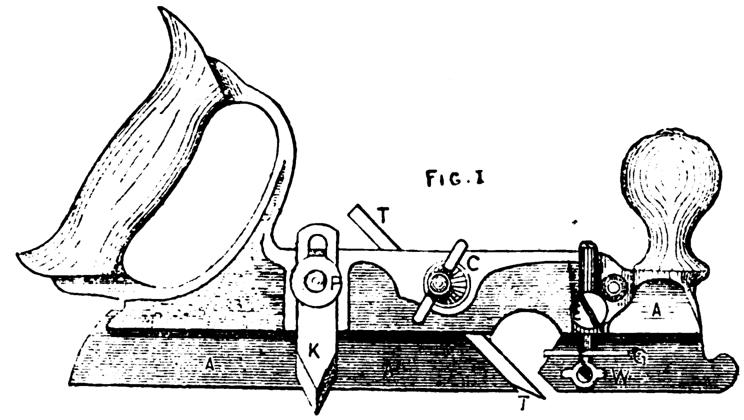


FIG. 1

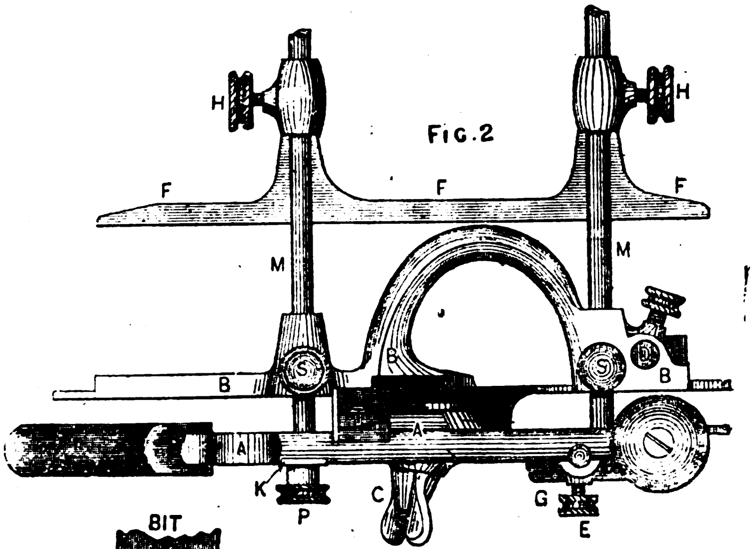


FIG. 2

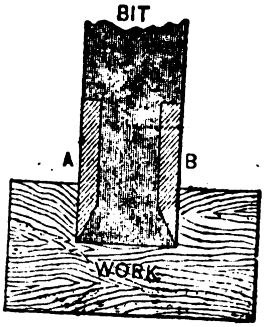
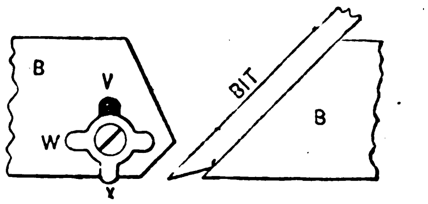


FIG. 3



## PROF. LANGLEY ON THE SOLAR RAYS AND THE ATMOSPHERE.

AT the Royal Institution Prof. Langley, of the Allegheny Observatory, Pennsylvania, recently delivered his promised lecture on "Sunlight, and its Absorption by the Earth's Atmosphere," in the course of which he said that Plato once asked what would be the feelings of a man who had lived in a cavern all his life when he was brought for the first time out into the glorious sunlight? Are not the dwellers upon earth somewhat in the same condition? The supposed transparency of the atmosphere above us is deceptive in many ways;

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[*] In the earlier series of experiments the change in position of the Na lines was very closely 0·1in. for one degree Fahrenheit. In the later series it was almost exactly 0·8in. for one degree Centigrade. The results of the two series cannot be compared together owing to a change in the adjustment of the apparatus during the interval.

we have never seen the sun as it really is, and there is reason to suppose that the true colour of the sun is blue, or bluish white. Our atmosphere forms a kind of coloured ceiling, so we do not see the normal colour of the sun; if we lived always under a transparent roof of a red colour, should we not believe the colour of the sun to be red, because we had never had an opportunity of getting outside the roof? Might not some of those fishes with large eyes, dredged up from great depths, have been of opinion that the sun has a greenish hue? His own researches tended to prove that our atmosphere has an orange tinge, and that the rays of the sun, with their large proportion of blue, reach the surface of the earth of the colour we call white.

is the experience of every one, in all parts of the world, that when the sun is low on the horizon his rays are more orange than at other times, and this is due to the large volume of the earth's atmosphere through which they then pass before reaching the eye. Prof. Tyndall discovered that the blue colour of the sky is due to fine particles in the air, which exercise selective absorption of the rays of the solar light. Prof. Langley, by the aid of the electric light, threw a bluish white disc of light upon the screen; then he made known that he was using blue light, which appeared nearly white upon the screen, because he passed it through orange glass, representing the atmosphere of the earth. In analysing light, a glass prism squeezes the rays of the red end of the spectrum together; a Rowland's grating gives the effect of twenty or thirty prisms, without unduly compressing the red end of the spectrum; the one he held in his hand contained a hundred lines within the width of a single human hair. When measuring the influence of the invisible ultra-red rays, they had to work in the dark; he found that the thermopile was not sensitive enough for the purpose, so invented the bolometer, in which an infinitely fine wire of platinum, or iron, has its temperature changed in different parts of the spectrum; as its temperature changes, it varies in electrical conductivity, and the amount of such change is indicated on a very sensitive galvanometer. An iron wire, sometimes used in the bolometer, was made by him out of a leaf of iron so thin that 15,000 would occupy but 1in.; these leaves were made in a competition between English and American iron manufacturers. To get as high as he could above the bottom of the earth's atmosphere, he at first thought of the Peak of Teneriffe, but it was too cloudy there; the same objection applied to the Rocky Mountains; he wanted the driest place he could get. As he had a military escort to help him, one of the peaks of the Allegheny Mountains, in California, was chosen, where the mountains rise from a torrid, burning desert, peopled only with grey rattlesnakes with a most venomous bite—a desert dotted with the skeletons of animals and emigrants. The mountain selected rose 12,000ft. above the plain and 15,000ft. above sea level. The heat at the bottom was intense, tanning them like Indians, and the first forest trees began to grow only at a height of 6,000ft. above that level. It took four days to climb the mountain, and the mules, which carried the instruments, ascended by a longer route. Measurements of the heating power of different parts of the spectrum were taken at the top and bottom of this mountain, with the result that at the higher station he found the ultra-red end greatly elongated. He measured the heating power of rays far beyond the point where the radiation had been previously thought to cease, and beyond the point where Captain Abney had photographed them with so much precision. He had also discovered that some of the blue rays were ten to twenty times more intense at the top of the mountain than at the bottom. His expedition to Mount Whitney had discovered that without the protecting veil of aqueous vapour in the atmosphere mercury would freeze in the direct rays of the sun, also that the power of the solar radiation had been previously underestimated, likewise that the absorption of the atmosphere is nearly double that previously supposed. Some of these experiments were carried on at the expense of a citizen of Pittsburgh.

## SOLDERING AND REPAIRING PLATINUM VESSELS IN THE LABORATORY.*

It frequently happens in the laboratory that platinum vessels, after long-continued use, begin to show signs of wear, and become perforated with minute pinholes. When they have reached this stage they are usually accounted of no further utility, and are disposed of as scrap; not that it is impossible to repair them—for with fine gold wire and an oxyhydrogen jet this is easily feasible—but that the proper appliances and skill are not in possession of all. Irrespective of the manipulation of the hydrogen jet, it is rather difficult without long practice to hold the end of the fine wire precisely over the aperture and to keep it in position. It occurred to me that if the gold in a finely-divided condition could be placed in very intimate contact with the platinum, judging from the fusibility of gold-platinum alloys, union could be effected at a lower temperature over the ordinary gas blowpipe. I tried the experiment, and found the supposition correct. The substance I used was auric chloride, $AuCl_3$, which, as is well known, splits up on heating, first into aurous chloride, and at a higher temperature gives off all its chlorine and leaves metallic gold. Operating on a perforated platinum basin, in the first instance, I placed a few milligrammes of the aurous chloride from a 15-grain tube precisely over the perforation, and then gently heated to about 200° C. till the salt melted and ran through the holes. A little further heating caused the reduced gold to solidify on each side of the basin. The blowpipe was now brought to bear on the bottom of the dish, right over the particular spots it was wished to solder, and in a few moments, at a yellow-red heat (in daylight), the gold was seen to "run." On the vessel being immediately withdrawn a very neat soldering was evident. The operation was repeated several times, till in a few minutes the dish had been rendered quite tight and serviceable.

Using the gold salt in this way the principal difficulty experienced in holding gold wire unflinchingly in the exact position vanishes, while only a comparatively low temperature and small amount of gold is necessary. Care must be taken to withdraw the platinum from the flame just at the moment the gold is seen to run, for if the heat be continued longer the gold alloys with a larger surface of platinum spreads, and leaves the aperture empty. As in the case of all gold-soldered vessels, the article cannot afterwards be safely exposed to a temperature higher than that at which the soldering was effected, and on this account it is advisable to use as small an amount of auric chloride as possible. When the perforations are of comparatively large size the repairing is not so easy, owing to the auric chloride, on fusing, refusing to fill them. I find, however, that if some spongy platinum be mixed with a few milligrammes of the gold salt, pressed into the perforation, and heat applied as directed, a very good soldering can be effected. It is well to hammer the surface of the platinum while hot, so as to secure perfect union and welding of the two surfaces. This may be done in a few minutes in such a manner as to render the repair indistinguishable. Strips of platinum may be joined together in much the same way as already described. A few crystals of auric chloride placed on each clean surface and gently heated till nearly black, then bound together, and further heated for a few moments in the blowpipe flame. Rings and tubes can also be formed on a mandrel, and soldered in the same fashion, and the chemist thus enabled to build up small pieces of apparatus from sheet platinum in the laboratory.

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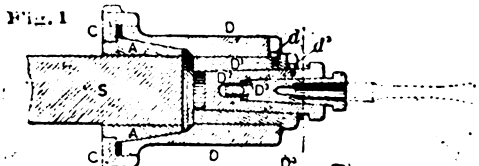
* By J. W. Pratt, F.C.S., in the *Chemical News*.

Fig. 1



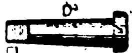


Fig. 1a

Fig. 2

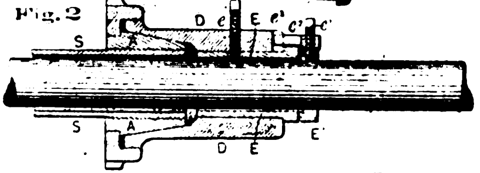


Fig. 3

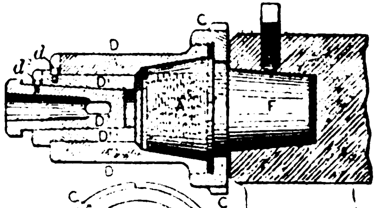
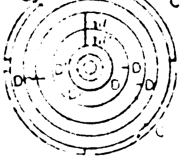


Fig. 4



## BIRKMANN'S LATHE AND DRILL PRESS CHUCK.

This chuck, the invention of George Birkmann, 258, West 29th street, New York City, is represented in the accompanying detail engravings. It consists of a conical sleeve adapted to be screwed It the spindle, or to be otherwise attached to either the loose or fast spindle. This sleeve is connected by means of a screw collar with a cylindrical socket adapted to receive smaller sockets or bushings for holding pieces of different sizes. Fig. 1 is a section of chuck with detachable sockets in place, Fig 1*a*, a side view of the smallest tool socket; Fig. 2 is a section of the chuck arranged to hold a shaft; Fig. 3 represents the chuck attached to the tail stock spindle of a lathe, and Fig. 4 is an end elevation and part section of chuck. In these engravings A represents the conical sleeve that screws to the spindle S, shown in Figs. 1 and 2; C is the threaded collar that holds the main socket D in place. The main socket receives one or more smaller sockets, $D_1$, $D^2$, $D^3$, as clearly shown. When the chuck is to be used for shafts, cylinders, sockets E, Fig. 2 are used, which are secured by set screws; collar $E^1$ prevents longitudinal motion. Fig. 3, representing the chuck on the tool spindle, requires no explanation. This chuck, we (*American Machinist*) are informed by Mr. Birkmann, is in use by himself and others for various kinds of work for which it is suited with satisfactory results.

**Mercuric Chloride as a Disinfectant.**—Dr. George M. Sternberg, in his recent reports to the American Public Health Association, confirms the opinion arrived at of late years in more than one quarter as to the very powerful antiseptic action of perchloride of mercury. He relates experiments in proof of the inhibiting action of very dilute solutions upon the development of the bacilli of anthrax and other micro-organisms, and sums up his conclusions thus:—"Mercuric chloride, in aqueous solution, in the proportion of 1 in 10,000, is a reliable agent for the destruction of micrococci and bacilli in active growth not containing spores; and in the proportion of 1 in 1,000 it destroys the spores of bacilli, provided that the micro-organisms to be destroyed are fairly exposed to its action for a sufficient length of time. A standard solution of 1 in 1,000 may be safely recommended for the disinfection of bedding and clothing which can be washed, for washing the floors and walls of infected apartments, for disinfecting the hands and instruments of surgeons and gynæcologists, and as a disinfecting wash for superficial wounds or mucous surfaces. For continuous application to wounds, &c., a solution of 1 in 10,000, or less, should be effective. A standard solution of 1 in 500, with the same quantity of potassium permanganate, may be safely recommended for the disinfection of liquid fæcal discharges, and other fluid material supposed to contained 'disease germs,' provided the time of exposure is not less than two hours, and the quantity of material to be disinfected is not in excess of that of the standard solution used."

In Prussia all express trains are to be provided with means of communication before the close of the current year, and all other passenger trains within a year more. The Prussian railways simply use a cord, running outside and just above the level of the window. This cord is to be connected with the locomotive whistle for giving the signal.

# SCIENTIFIC NEWS.

THE death is announced, at the untimely age of 28, of Mr. Alan Bagot, the author of several well-known works on colliery ventilation, mining accidents, and lately of the "Principles of Civil Engineering as applied to Agriculture and Estate Management." He was also the inventor of apparatus for saving life and preventing accidents in mines.

The death is also announced of Mr. J. D'Aguilar Samuda, the famous shipbuilder of Millwall.

The results of a large number of observations of comets and small planets made during 1884 at the Vienna Observatory are given in Nos. 2658-9 of the *Astronomische Nachrichten*, which also contain a series of observations of Hyperion made at Washington in 1881-1885 by Prof. Asaph Hall.

It has been pointed out that at the time of totality in the solar eclipse of Sept. 9 next, Jupiter will be within the coronal limits. At the middle of the eclipse, as observed from Castle Point, south-east coast of the North Island, New Zealand, the distance of Jupiter from the moon's limb will be 46′. Saturn was within the coronal limits during the eclipse of Dec., 1870, but does not appear to have been observed.

The two small planets, Nos. 245 and 247, discovered respectively by Mr. Pogson, of Madras, on Feb. 6, and by Dr. Luther, of Düsseldorf, on March 14, have been named Vera and Eukrate.

The arrangements for the meeting of the British Association at Aberdeen in September next are being completed, in accordance with the suggestions of Prof. Bonney. Upwards of £2,000 has been promised to the guarantee fund. The Artists' Society will hold its exhibition during the meeting instead of in the summer, and it will be free to members of the Association; natural history and archæological exhibitions have also been suggested.

The next meeting of the American Association will be held at Ann Arbor, Michigan, commencing August 26.

The Hon. Donald A. Smith has since September last given to McGill College, Montreal, the sum of £24,000 for the establishment of separate lectures for women preparing for the B.A. or equivalent degree.

Mr. R. Meldola has been appointed Professor of Chemistry in the Finsbury Technical College.

Mr. Shelford Bidwell, M.A., read a paper before the Royal Society last week "On the Changes Produced by Magnetisation in the Length of Rods of Iron, Steel, and Nickel." He finds that the length of an iron rod is increased by magnetism up to a certain critical value of the magnetising force, and if that is passed the elongation is diminished in proportion as the magnetising force increases. The amount of the maximum elongation appears to vary inversely as the square root of the diameter of the rod. In soft steel magnetisation produces elongation; and with hard steel the critical value of the magnetising force becomes very high. In soft steel a temporary elongation once produced may be maintained by a magnetising force too small in itself to produce any elongation. Nickel continues to retract with magnetising forces far exceeding those which produce the maximum elongation of iron. The greatest observed retraction of nickel is more than three times the maximum observed elongation of iron, and the limit has not yet been reached.

Part VI. of the third volume of the *Journal* of the Liverpool Astronomical Society contains a variety of short papers on astronomical subjects, and an interesting report on the Planetary Section, with observations of Saturn by the members of the Section.

At the meeting of the San Francisco Microscopical Society on March 11, Dr. Mouser exhibited his Thoma microtome, the construction of which is based on the principle that a body sliding between two inclined planes and touching the latter at five points only, will slide evenly and exactly over such planes, even if they are not geometrically true. A knife attached to such a carrier will therefore always cut perfectly parallel sections, and well-hardened tissues have been cut as thin as ·002mm. Mr. Breckenfeld, the secretary, exhibited a graduated "blue-glass modifier," which consists of a glass disc revolving upon an adapter under the stage of the microscope. It is "flashed" from clear glass to dark blue, and one-half of its surface being lightly ground, any desired tint of field may be obtained, from white to deep blue, either transparent or translucent, by merely revolving the disc.

At the meeting held on March 25 Mr. Berteling gave a demonstration of the capabilities of a new ophthalmoscope. A small circular film of thin glass is adjusted in the main axis of the instrument at such an angle, that, while it does not obstruct the rays of light illuminating the interior of the eye under examination, it reflects the image of the brightly illuminated "optic disc," which image is then amplified by a suitable lens system. In this way, a most thorough examination of the interior of the eye can be made with perfect comfort to the patient and without manipulative difficulty to the operator.

Dr. C. P. Bates exhibited a "warm stage," for use in the study of bacteria and similar organisms. The cell is laid upon a wooden slide resting on the stage, which slide has a central perforation for admitting the rays necessary for illumination, and is heated by two twisted copper wires, which form a loop directly under the culture cell, and then, passing out of the slide at either end, meet directly in front of it, and are there again joined and prolonged a distance of several inches. The free end is made to pass through the perforated chimney of a small lamp, and by adjusting the flame of this along the wire, the temperature of the culture cell may be raised or lowered until the desired point is reached. A delicate thermometer, adjustable on the slide, registers the temperature with great exactness. By the peculiar arrangement of the wires, the *entire slide* is heated with absolute uniformity.

M. J. Héricourt has presented a paper to the Paris Academy of Sciences, in which he states that in all waters, whatever their origin, there exist curved bacilli of variable forms and dimensions, among which those of the type described as choleriform are constantly found. The curved bacilli do not exist in the atmosphere under their characteristic form; they are there, however, in the state of germs. All substances capable of serving as nutriment to germs or bacteria contain curved bacilli.

M. Scheurer-Kastner read a paper before the Paris Academy of Sciences in which he stated that the heat of combustion of coal is much higher than has hitherto been supposed.

Water-gas as an illuminant has been condemned by the Massachusetts Board of Health on account of the large quantity (30 per cent.) of carbonic oxide it contains. Water-gas is odourless; and carbonic oxide being a deadly poison, it is considered risky to permit the general use of the gas. Coal-gas contains about 7 per cent. of carbonic oxide, but its odour is a sufficient safeguard. Water-gas can, however, be used with safety by impregnating it with some powerful odour; and by using it to heat incandescent caps of magnesia wire, it produces a brilliant and economical light.

The *Alaska* has been fitted with a new rudder in the United States. Its total weight is 15 tons, and it is stated that it is the largest piece of work of the kind ever made in America.

**The Franklin Institute's "Novelty" Exhibition.—The Franklin Institute purposes next Fall to open another exhibition in its building at Thirty-Second-street and Lancaster-avenue, where the late highly successful Electrical Exhibition was held, and a general circular has been issued giving information to the public. The new exhibition will be known as the "Novelties Exhibition," and will open on Sept 15 and will close on Oct. 31. Its exhibits will be restricted to such recent discoveries and inventions in the sciences, arts, and manufactures as are worthy, by reason of merit, to be admitted. Application for space can be made at once, and in announcing their plans the institute managers say that, while they will allow the widest latitude in the character of the objects admitted, the aim and intention will be to confine the same to such as shall possess, first, the qualification of "novelty," and second, the qualification of "merit," which shall redeem them from triviality. Awards of medals and certificates of merit will be made.**

# LETTERS TO THE EDITOR.

*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

*All Cheques and Post-office Orders to be made payable to* J. PASSMORE EDWARDS.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

> **"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original."**
> —*Montaigne's Essays.*

## ζ HERCULIS.

[24165.]—WILL "A Fellow of the Royal Astronomical Society," or Mr. Sadler, be so kind as to examine the above star, and state the present distance of its components?

The latest date of measurement of this rapid binary given in Webb's 2nd edition is 1880, where it is stated as 1·4″, which would appear to be a maximum; but on looking at it last night (an exceptionally fine one certainly) with my 4in. Wray I was much surprised to see it distinctly double. I suppose that, theoretically, a 4in. should almost divide 1·1″, but I fear theoretically only, and although my telescope is an excellent one, I cannot doubt that the star has widened since 1880. **Beta.**

## HYPERION—DOUBLE STARS—TESTS FOR A 6½in. REFLECTOR.

[24166.]—I DID not *decide* that Mr. Holmes (letter 24100, p. 146) did not see Hyperion on March 14th. I merely said that I did not think it *probable* he saw so faint an object so long after the opposition of Saturn. Hyperion was not measured at Washington on the 14th of last month. On the 10th and 17th it was called "faint," and on the 20th "very faint," with the 26in. refractor. I know of no evidence tending to show variability in either Hyperion or Titan. Prof. Hall remarks that the number of faint stars near Saturn's path in 1885 rendered the identification of Hyperion rather difficult. Mr. Holmes will, I think, find, on looking again at the "E. M." for February 1883, that the letters referred to by myself are on the close *comes* of $\theta$ Aurigæ; in fact the discussion was started by a letter from Prebendary Webb on the smallness of the *comes*. This *comes* is, as I have said, probably variable; for we have the evidence of the first of all double-star observers as to its magnitude in 1875, 1876, and 1877. De. would certainly not have given the colour of a star so small as 10·0 Σ. on four different occasions; and he writes of the two stars, and the seeing at the time, as follows:—

1875·693 3·0 *bianco verde chiaro*: 7·0 *azzurro cinereo*: bene.
1876·074 3·0 *bianca*: 8·0 *azzurro chiaro*: ottima.
1876·786 3·0 *gialla chiaro*: 7·5 *azzurra*: colori certi: sufficiente.
1877·263 3·0 *verde chiaro*: 8·0: *cinerea*: discreta.

All the measures were made with a power of 500 on the 7½in. refractor, and the last measure by daylight. Mr. Tarrant, who has examined this object on several occasions during the last fortnight with three reflectors, by With and Calver, of 8½in., 10½in., and 12½in. apertures, writes to me that he should rate it at about 8½ mag., but that it looks smaller from its colour—to him very blue.

$\alpha^2$ Cancri *is* mentioned by Webb in the 4th edition of "Celestial Objects," and Mr. Holmes will find notes on it as a double star in the ENGLISH MECHANIC for April 1 and June 24, 1881. It is called $\alpha^2$ because if there chance to be two or more stars close together, and all are called $\alpha$, the preceding one of all is called $\alpha^1$, the second $\alpha^2$, and so on, e.g., $\alpha^1$ $\alpha^2$ Capricorni, $\beta^1$ $\beta^2$ Capricorni, &c. The place of $\alpha^2$ Cancri for 1880 is 8h. 51m. 54s. + 12° 19′, and it is about 4½ mag. $\alpha^1$ Cancri is a small 6 mag. star about 2½ minutes of time preceding, and 15′ south of $\alpha^2$. $\alpha^1$ is not catalogued as a double star, but $\alpha^2$ is H 110, having a faint companion at 325° : 11½″; $\alpha^2$ is the star shown by Proctor.

I am obliged to Mr. Hirst (letter 24101) for his communication. I should be glad if he would look up $\gamma$ Lupi and $h$ 5114 Telescopii. The latter is Lac. 8091, and its place for 1885·0 is XIXh. 18m. 34s. − 54° 33·2′. There is something very mysterious about both these pairs; unfortunately the double star measures of the Sydney Observatory are so unreliable and so carelessly made, that little can be made out from the recent observations of these two objects there.

"Aleph" (letter 24102, page 146) will find many tests for a 6½in. reflector in the last twenty volumes of the ENGLISH MECHANIC; but, in case he has only recently become a subscriber, I append a list of some naked-eye pairs visible at this season. I have given the distances without the angles, that he may not be biassed. The magnitudes are in Struve's scale, and the stars are arranged in order of difficulty, so that, while he should see χ Turdi Solitarii, γ Crateris, and 44 Virginis easily with that aperture, he will probably find ζ Böotis or 46 Virginis too severe for him until he has had considerable practice with his instrument.

DIVIDING TESTS (1).

| | A. B. C. | |
|---|---|---|
| χ Turdi Sol. | 6·0, 7·3, 8·2 | : 35·0″; 1·39″ (B—C). |
| O.Σ. 235. | 6·0, 7·7 | : 1·30. |
| ξ Scorpii. | 4·9, 5·2, 7·2 | : 1·31 (A—B); 7·3. |
| 14 Lyncis. | 6 0, 7·1 | : 1·0. |
| ν Scorpii. | 4 0, 6·5 (A—B); | : 0·81; 40·8 (A—C). |
| | 7·0, 8·0 (C—D); | : 2·07. |
| μ² Boötis. | 4·5, 6·5, 7·8 | : 108·4; 0·75 (B—C). |
| 25 Can. Ven. | 5·7, 7·6 | : 0·70. |
| ζ Boötis. | 3·5, 3·9 | : 0·66. |

DEFINING TESTS (2).

| | | |
|---|---|---|
| γ Crateris. | 4 0, 10·0 | : 5·14″. |
| η Draconis. | 3·0, 9·5 | : 4·88. |
| 90 Herculis. | 5·8, 9·2 | : 1·83. |
| 11 Scorpii. | 6 0, 10·3 | : 3·35. |
| κ Leonis. | 5·0, 10·5 | : 3 05. |
| 6 Serpentis. | 4 6, 9·4 | : 2·28. |
| 46 Virginis. | 5·7, 9·0 | : 1·25. |

SPACE-PENETRATING TESTS (3).

| | | |
|---|---|---|
| 44 Virginis. | 6·0, 11·2 | : 21″0. |
| γ Libræ. | 4·5, 11·7 | : 41·3. |
| ρ Boötis. | 3·6, 11·7 | : 53 3. |
| 85 Virginis. | 6·0, 11·8 | : 43·3. |
| 53 Virginis | 5·5, 12·3 | : 70 9. |
| 72 Virginis. | 6 0, 12 0 | : 29·2. |
| B.A.C. 3607. | 5·7, 12·2 | : 24·6. |

The place of χ Turdi Solitarii for 1880 is XIVh. 18m. 47s. − 19° 26′; of O. Σ. 235 XIh. 25m. 31s. + 61° 45′; of B.A.C. 3607, Xh. 26m. 14s. + 41°·12′. "Aleph." will find all the others shown on any decent map. It is remarkable that all the faint companions in list 2 are of a markedly blue hue, as also are the companions of ξ and ν Scorpii, 14 Lyncis, and 25 Canum. A of 44 Virginis is a very close pair, the distance not exceeding 0·35″.

April 22nd. **H. Sadler.**

P.S.—The distance of ξ Ursæ Majoris is now about 1 8″, and it is therefore more of a test for a 2½in. than a 6½in. telescope. I saw it well divided with the 3·2in. Sheepshanks equatoreal, power 230, a few nights ago.

## DARK TRANSIT OF JUPITER'S FOURTH SATELLITE.

[24167.]—THIS was well seen at Shaftesbury on April 18th. At 20h. 15m. the fourth satellite appeared as dark as the shadow of the third just then approaching the limb. The air was unsteady, but at moments of good definition the outline of IV. was sharp and circular. It was watched until egress, and was only lost sight of for two minutes, after which it was seen passing off the planet, being then of a very dull slate colour. For an hour after egress it appeared very faint. Observation then ended. Instrument 8½ Calver reflector.

April 24th. **T. Perkins, M.A.**

## TRANSIT OF JUPITER'S III. SATELLITE.

[24168.]—AT 7 p.m. on the 25th I turned my telescope on Jupiter, and found the III. Satellite just visible as a dark dot 54 minutes from egress. I was called away, and returned to find it just within the limb; it then appeared a shade brighter than the planet. I watched it to egress; but detected no diminution in brightness, as recorded by Mr. Tweedale with respect to Satellite IV. after egression on 18th inst. **T. R. Clapham.**

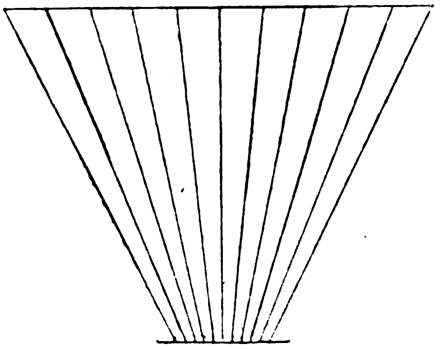
## SOLAR ECLIPSES AND OCCULTATIONS BY THE MOON.

[24169.]—THE accompanying communication was "rejected" by the Council of the Royal Astronomical Society, "after careful consideration," from appearing in their *Monthly Notices* on the plea that a similar communication had been published in the ENGLISH MECHANIC, and that it was against their "rule" (query, Which rule? and where expressed?) to allow it to appear under these circumstances. It is desirable that your readers should be aware how disinterestedly the progress of science is regarded by the Council; and as many amateurs are availing themselves of the new method of computation, I hope you will think it worth while to republish it at length.

That it is possible to make short work of the computation of the circumstances attending solar eclipses and occultations by the moon, is a discovery which cannot but be welcomed both by professional and amateur astronomers. Those circumstances differ much in different places, even though not very remote from each other: and therefore, unless a calculation be made for each place separately, it is impossible to predict the time and the angles connected with these phenomena with anything like the accuracy requisite for a valuable observation of their occurrence. The method of Woolhouse, as given in the appendix to the *Nautical Almanac* of 1836, occupies 98 pages, the figures alone including 7 pages. The method of Shadwell (an abbreviation of the former) fills a volume of 136 pages, and the figures of each eclipse take up 2¼ of those pages. The method devised by Penrose—which suggested the method to which I desire now to call your attention—is almost entirely graphic; but drawn on so small a scale that its accuracy can scarcely be relied upon to less than four minutes of time.

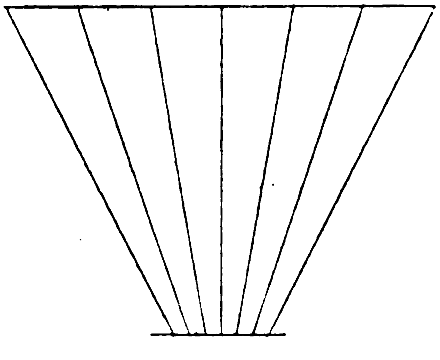
It is now proposed to introduce a method which is partly graphic and partly computational, by means of which correct results can be obtained to within half a minute, and which can be worked out to three-quarters of an hour.

FIG. 1.



In all previous methods of working out eclipses and occultations by a graphic process, as given in the various treatises on astronomy, the principle of the computation has been to represent on the projection of a single spheroid any requisite number of similar ellipses, diminishing in magnitude as they recede from the equator; whereas in my newly-devised method the principle is, as suggested by Penrose, to construct a single ellipse, and then to have that ellipse referred to different and receding equators.

FIG. 2.



The construction of an ellipse, when strict accuracy is insisted upon, is, however, a tedious and somewhat difficult process, and where that process has to be repeated for every separate case of eclipse or occultation, it is no wonder that computers shrink from the attempt, notwithstanding that the results of the calculation are so desirable and valuable. The first advantage of the new method consists in this: That a system of ellipses has to be delineated once for all, and in order to insure a due degree of accuracy, the common semi-major axis of these ellipses is 10in. long. They are concentric, and have their semi-minor axes of various lengths, 10 sin. 5°, 10 sin. 10°, 10 sin. 15°, &c., up to 10 sin. 25°. The ordinates drawn to these ellipses have for their abscissæ 10 sin. 15°, 10 sin. 30°, 10 sin. 45°, &c., corresponding to the hours I., II., III., &c., and these may again be easily divided into intervals of 10 minutes each. The system of ellipses thus drawn is treasured up for constant use.

The scale upon which the diagram has to be drawn must next be calculated. Ten divisions of it are exactly equal in inches to the numerical value of the quantity $\frac{100}{P\,\rho\,\cos.\,l}$, where P is the moon's horizontal parallax, ρ the earth's radius, and *l* the *geocentric* latitude of the place of observation. This scale is thence called the latitude parallax scale.

It is only necessary further to say that the moon's relative horary motions in Right Ascension and Declination are taken from the *Nautical Almanac* by the usual methods, and by this means is plotted to scale the moon's relative orbit, which orbit must be subdivided into hours and minutes. Allowance can also be made for its *curvature* in particular cases.

A few additional remarks will help us to complete the computation.

Having calculated the sun's hour angle at the instant of Greenwich Time of true conjunction, let two lines be drawn at right angles to each other, and let them be so placed that when the ellipse is copied from the before-mentioned system of ellipses, *which corresponds to the sun's declination*, the place of the sun, as shown by the hour-angle on the ellipse may be found in *the centre of the paper*, so as to give room for the whole diagram, and the ellipse must be *above* or *below* the major axis according as the declination is *south* or *north*.

The moon's relative orbit is drawn by means of two co-ordinates, one corresponding to the Relative Horary Motion in Right Ascension, and the other to the Relative Horary Motion in Declination. And the distance of the former co-ordinate axis from the major axis of the ellipse first drawn (and to which it is parallel) is equal to the quantity,

$$\text{Diff.} - \text{dec.} \backsim P\rho\,\sin.\,l\,\cos.\,\delta$$

being *above* or *below* it, according as this quantity is *positive* or *negative*. The algebraical sign of the moon's Relative Horary Motion in declination indicates whether the moon's motion is *ascending* or *descending*. Thus drawn, the moon's Relative Orbit is subdivided into hours and minutes ranging along its whole length, the point where it intersects the vertical line being made to indicate the sun's hour angle at conjunction.

Lastly, from the latitude-parallax scale there is taken an extent equal to the sum of the semidiameters of the sun and moon, and the extremities of this line are so arranged as to indicate the same hour and minute in both the ellipse first drawn and the moon's relative orbit. This gives at once the local times (apparent) of beginning and ending, from which the local mean time or the Greenwich mean times may be found at once.

The magnitude of the eclipse is found by subtracting from the sum of the semidiameters the least distance of the centres of the moon and sun, and dividing the difference by the sun's diameter.

To find the duration of totality in a total eclipse, or the interval between the formation and rupture of the ring in an annular eclipse, subtract the diameters of the moon and sun, or *vice versâ*. Then measure off this difference on the latitude-parallax scale, and apply the said difference to the moon's horary scale. The interval sought will thus be exhibited in minutes.

To find the direction of the zenith or vertex, draw lines from the centre of the earth (which is indicated by the diff. − dec.) to the places respectively of beginning and ending, and measure the angle between these and the lines which join the contemporaneous times of beginning and ending on the ellipse and on the moon's relative orbit.

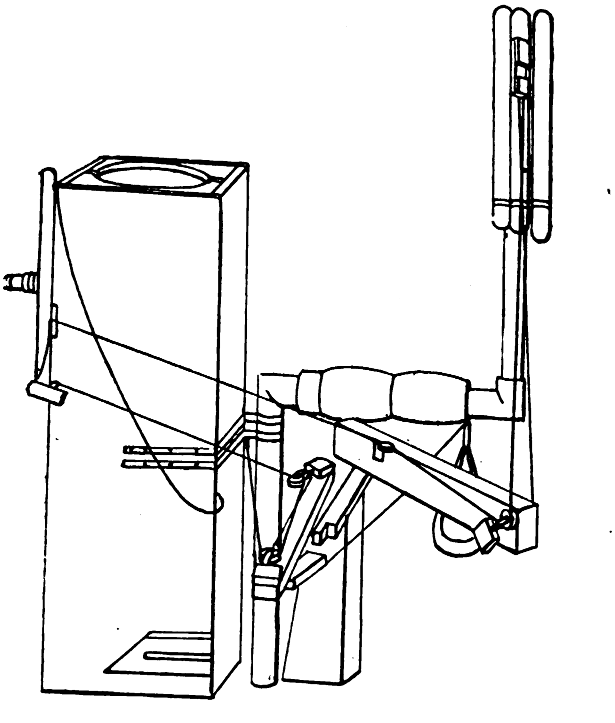
**James Pearson, M.A., F.R.A.S.,**
Late Scholar of Trinity College, Cambridge.

POSTSCRIPT.—The subdivisions (1) of the latitude-parallax scale, and (2) of the moon's horary scale, may be much facilitated by employing two separate diagrams constructed as follows:—

1. Let two parallel lines be drawn 5in. or 6in. apart from each other with a line at right angles to each for a central line, and let the scale be extended to five divisions on each side of each line.
2. Let another diagram be constructed similar to the former, but with six divisions instead of 10.
3. To take out the moon's Hor. Mot. in R.A. from the *Nautical Almanac*, call the seconds of time as minutes of arc, and increase them by half as much again. Then multiply the result by the cosine of the moon's Dec.
4. To take out the moon's Hor. Mot. in Dec., call the seconds of arc as minutes of arc, and divide by 10.

## A CHEAP AND EASILY-CONSTRUCTED TELESCOPE STAND.

[24170.]—As "Montmartre," on page 451, Vol. XL., stated that he feared to mount his telescope on the stand I described on page 407, Vol. XL, and recommended to him, from its weight being 100lb., and also from the satisfaction I experienced in the use of the 6½in. reflector as there described, I resolved to dismount my 12in. Calver, weighing 150lb.,



from its common altazimuth stand, and mount it like the 6½in. Of this I now inclose a photograph, and I can strongly recommend it to anyone requiring a useful, handy, and steady stand—as also a cheap one—and easily put together by anyone. I have used larger tubing than on the other stand, it consisting of 2½in. turning in 3in. tube, and I also have made the arms turning with the spindle of unequal lengths, so as to keep the telescope as near the post as possible, and the longer arm carrying a weight to counterpoise the telescope when vertical. I have not been able to place the eyepiece opposite the centre of motion, owing to the narrow house I have got to put it in, so that it is not the best form of stand; but it is so handy and smooth in its motions, and also so steady, that I am quite satisfied with it, and intend to mount my 15in. in a similar manner. I have photographed it in a vertical position as best for showing the levers and strings for directing it and regulating its motions, as also its attachment to the tube. The weights for balancing it in altitude are sash weights, and being hung on a piece of wood placed inside the upright tube any required tension can be given to the string which raises or lowers the direction of the telescope by keeping the weights farther from or nearer to the tube by a cross pin through the wood.

The strings cross the telescope so near the centre of motion as not to be interfered with by the telescope in any position. The photo will show that the spindle, 2½in., carrying the horizontal arms, 3in., turns in a socket piece of 3in. tube, which is fixed to a post in the ground. Through the horizontal arms is a 2½in. tube, having elbow pieces at each end, into which are screwed two lengths of 2½in. tube, one pointed up and the other down. One of these carries the telescope and the other weights—so heavy as just to allow the telescope to point upwards when uncontrolled. On the spindle, and close to the arms, is fixed a wooden lever 4 by 2in., and 3ft. long, on which are fixed two pulleys, one near the spindle and the other on the end and side of the lever. Through these pulleys a string runs from a gimlet in the bottom and side of the telescope, near the eyepiece, through another pulley fixed on the end of the upright tube, and thence returning to the end of the lever again. This string governs the telescope in altitude. This lever is not fixed at a right angle to the arms; but so as for its end carrying the pulley to be under the tube carrying the weights.

A second and double lever, or a fast-and-loose one, is put on to the socket piece in which the spindle turns. It is made of two pieces of 2in. square wood, one 3 and the other 2ft. long, having a joint at one end and a hollow to embrace the socket and a thumb screw at the other end of the shorter piece to screw into the longer, and bite the socket like nut-crackers. On this lever are fixed four pulleys, the first near the post and under the bottom of the lever, and the second at the end and on the same side of the lever. A string runs through these two pulleys from the end of the arm, through the second pulley, and thence through the first, and to a weight hanging close to the post, which will pull the telescope after a star. To control this motion a second string runs through two pulleys on the other side of the lever, one on the end and the other near the post, from a second gimlet in the bottom and side of the telescope, just below the other, to the other end of the arm. This string will allow the telescope to move after the star just as fast as the gimlet is turned; and with these two motions a star may be kept in the field as long as required, and the motion is smooth and steady. This fast-and-loose lever is usually placed at right angles to the arms, and the telescope will turn about 45° before it requires to be moved, and it is very seldom the telescope is kept for so long a time on one object. The thumbscrew may be screwed just so tight as to allow of the lever being moved by a hand placed on its end and a second hand on the other lever, and thus the telescope may be turned in any direction without unscrewing the thumb-screw, and yet the lever will be stiff enough to govern the direction of the telescope.

A disc of wood about a foot diameter fixed in the top of the post, and through this the socket protrudes, and on it the levers lie if left loose. Such is the stand I have now used for three months, and can strongly recommend for either reflector or refractor. **Philip Vallance.**

## THE DOUBLE TELESCOPE.

[24171.]—I have to thank "F.R.A.S." for reply 23918, 13th March, giving his opinion concerning result of dividing an 8in. object-glass down the centre and mounting the two halves binocularly (after the suggestion of "W. T. N.," 23850, of 20th Feb.), compared with result of two whole 3¾ o.g.s reduced by ⅝ segment only. He assumes that two halves will give the same aggregate light as one whole undivided area; but he inclines to doubt the definition of the larger halves equalling that of the smaller whole lenses. It is evident that when a half-lens is asked to do the work of a whole one, which, in this case, it is asked to do in all points except in quantity of light (which, of course, is at least halved), the result must necessarily suffer somewhere in comparison.

Against this detraction, however, has to be placed the gain derived by bringing the two eyes instead of one into the consideration, and it is upon the inclusive calculation that I should wish all the opinions I can elicit before proposing to have the 8in. o.g. divided.

The alternative suggestion of Thompson (23921), March 13, to shunt the focal images of two parallel telescopes (of whatever width apart) into the requisite exact eye width of a single observer, by means of prisms or flats, as there sketched by him, for binocular use, is quite feasible, and I am disposed to think it was the plan adopted in the 7ft. double reflecting telescope, made by one of the Herschels, to which I alluded in my first letter (23670), Dec. 26, 1884. Personally, I have no belief in the successful application of prisms to the focal images of object-glasses, for I once thought I was going to solve the question by a binocular eyepiece, which would, by prisms, divide the focal image given by a telescope of any aperture into two pictures. It was duly made, and the maker even read a paper upon it before the R. A. S., but in practice it yielded disappointment only—great loss of light and poor definition.

Monsieur Joubert, the director of the Observatoire du Trocadero, at Paris, persists that it is right in theory and only faulty in construction; but after lending it to him for a year to perfect, it remains a non-success, though he still maintains his view.

These remarks would not apply to flats, which might be used with reflectors upon Thompson's plan, for while it would be exceedingly difficult to procure a perfect pair of 8in. lenses to work together binocularly, Mr. Calver would probably be able to turn out an exact pair of 10in. or 12in. mirrors for anyone disposed to mount them into a binocular reflector.

Here, however, is the great pull in "W. T. N.'s" proposition to divide a large object-glass—viz., that the perfect pair of semi-o.g.'s is insured *ipso facto*, ready made, by the operation.

Following up the letter of Mr. Phillip Vallance (23709), of 9th Jan., on the exceptional value for binocular use of his plan of mounting all telescopes with their eyepieces at a fixed uniform height by transferring the axis from the centre to the eyepiece and by means of counterweights, I found, on availing of his friendly invitation to revisit him in the country, that he now employs a second telescope to act as counterweight to the fellow one, so that he has several pairs of instruments now so mounted in counterbalance cradles always ready for work, of which an observer can make use in all directions without altering the level of his eyes or changing his seat, which revolves round the central pillar supporting the axis which carries the cradles.

This led me to feel that if this ingenious arrangement could be combined with an equatorial motion, we should reach perfection in this department.

It was recently remarked that if we went to the North Pole with our telescopes we might leave our equatorial stands at home, and I asked myself whether, instead of going to the North Pole, we could bring the North Pole to us for this purpose? Why should we not lay a floor in our observing chamber, on our own equatorial plane, in steps, fix our telescope pillar—à la Phillip Vallance—at right angles to such inclined (stepped) floor, and observe on a revolving seat with unequal legs cut to match the steps in the floor. **Montmartre.**

## CUTTING SCREW-THREADS.

[24172.]—At page 125 "Bow" (par 5) confuses indeterminate centring, which every screw-thread gives for itself, with that predicable centring which we need for interchangeable mandrels. What is not practicable is the making of a screw-nose which will serve as a centring agent for chucks which have been turned up on other screw-noses. The roughest screw-nose in the world will find a centre for itself, and will remain true for all chucks which, having been fitted to its thread and scraped up to its face, are subsequently turned up in their place. This is the system which interchangeable mandrels will supersede, just as interchangeable objectives for microscopes have superseded the old system, by which the buyer of a microscope-stand had in future to go back to that particular maker for all its appendages.

It is interesting to know that our old friend, "J. K. P." has made two pairs of lathes on which, two and two, chucks are transferable. Doubtless an expert workman like "J. K. P." could, with "a few judicious touches in a screwing lathe," make two mandrels side by side interchangeable. But that is not the universal interchangeability which the model standard mandrel-head is designed to achieve. Nor is it quite what was achieved by Mr. Evans, whose two mandrels, the first time that they were tested in the reversible chuck, ran so true that Mr. Evans said he had "never seen anything run so true in his life." Here there had been no judicious touching-up; the two mandrels ran absolutely true at once, and simply by the aid of the principles on which they had been constructed. If these results were attainable without the cylinder base and wide mandrel-face, how was it that Mr. Evans, who had spent much time in endeavouring to make chucks transferable without transfer chucks, never before accomplished it? How is it that, in accurate tool-making, the old screw fittings for shifting head-stock and for mandrel back-centre have both been superseded by cylinders?

I do not see why "a cutter made for a screw of any particular number of threads will not do for any other number." Perhaps "J. K. P." will kindly explain.

"Vulcan's" valuable letters are evidently the outcome of conscientious thinking, as well as ample practical knowledge. And he is so frank in setting himself right, that it is a pleasure to debate with him. In 24038, my second paragraph, line 15 should have read, "each transverse element radial to the cylinder." Perhaps we can develop somewhat further the points contained in this letter. What are the things we are talking about?

The object at which we are aiming is the formation of an angular thread derived from an isosceles triangle and truncated so that its altitude is equal to the length of its base. A triangle answering this purpose must be taller than that of 53° 8′, which is the isosceles triangle drawn in a square and occupying for its base one side of the square.

If we take an isosceles triangle of 50° we have 7½ per cent. of the length of its base for truncation and, in threads for scientific work, this gives a sufficiently blunt top for practical purposes. Of course, the thread would be roughed out by the ordinary chaser or point tool in the slide rest, and the only question is: By what method can an angular thread of 50° he best trued up and finished off, and, if necessary, in hard steel?

As a means for trueing up such threads with the utmost accuracy, I pointed out that the ordinary chaser cannot be used because no multiple-point tool can be made so as to cut an accurate thread. Then I showed that the angle of the thread cut by a V-point tool depends upon the accuracy with which its cutting plane is kept upon the line of centres: that the cutting velocity which can be given to such a tool when fixed in the slide-rest is inadequate for properly finishing the surface of the thread, or for completing its final portion. And I say that, by the use of a revolving V-cutter, or V grinding-wheel, traversed by means of change-wheel arrangements, and having its axis tilted for the pitch of the thread, the most perfect thread possible can be trued up with ease and certainty. In reply to Mr. Wenham's objections, I have shown, and so has Mr. Hines, that while the revolving lap-wheel or cutter would be inapplicable to a square-thread for want of proper clearance, it is perfectly applicable to a V-thread of 50° inasmuch as the revolving cutter or lap-wheel clears itself in cutting a spiral thread of this angle. Mr. Wenham persists in his assertion; but, after adopting the tactics of the fox in dodging about and running away from the issue, he gets cornered by Mr. Hines. He then takes to throwing the stink-pot, and declares that Mr. Hines' tools cannot be good because the noses of his mandrels are soft. It is obvious that we are always much indebted to practical workers like Mr. Hines when they leave their shop for an hour and sit down to tell us about their methods of doing difficult work, and it is necessary to reprobate offensive stratagems which would only prevent such men from contributing to our columns.

Mr. Wenham (page 126) says that the circular cutter, whether for V-threads or for square-threads, produces similar errors. He says: "It would be excessively difficult to adjust the inclined axis of the milling cutter in the line of centres," and so on. And he gives a simile of a cedar pencil marked with a spiral line, and a coin held with its edge to the spiral. Now, if anyone will draw two circles touching each other, say of the sizes of a shilling and a crown, and will then draw a straight line joining their centres, he will see that it is not possible to get the revolving cutter off the line of centres. Whether the axis of the revolving cutter is above or below that of the screw to be cut makes no difference whatever to the angle of the groove inasmuch as the cut finishes on the line of centres. Now, the inclination of the axis of the revolving cutter is given by a divided head upon the square which holds it in the slide-rest, and may be determined to a fraction of a degree, just as by means of the division plate on the mandrel-pulley any angular measurement can be set out on work between centres. The traverse of the cutter is, of course, determined by the change wheels under the guidance of the slide-rest, and there is, therefore, no difficulty whatever at any step of the process.

As to the shape of the groove left by the traverse of the revolving cutter, the best demonstration will be given by setting up on a small planing machine a slab of wood, plaster of Paris, or brass, and ploughing out the grooves which represent a screw-thread upon the flat. We take an oblong slab and plane across it parallel grooves, as if we were making a rack. If the slab is clamped down with its side parallel to these grooves, we get a strip of the surface of a screw whose radius is infinite, and the pitch of whose thread is zero. If the slab be fixed on a revolving plate, and we set its side at an angle, its grooves will represent developed threads of a corresponding pitch. By the shape of the cutting tool we determine the shape of the groove. The whole subject is now before us. If, instead of planing out the grooves of our rack by an ordinary ploughing tool we rig up a revolving cutter with its cutting plane normal to the movement of the planer-bed, the revolving fly cutter produces its counterpart groove as precisely as the planing tool. The only difference is that undercutting can be done with the planing tool, but not with the revolving cutter. In all these cases the fly cutter will cut a counterpart groove up to the limits of a full square, and, so far, will clear itself. At the end of the slab where the threads run out, we see their axial section. Any of these threads which do not undercut, can equally be produced upon the cylinder by the revolving cutter so long as they have no pitch, and are cut as annular grooves. In all these cases the axial section of the cylinder gives the same section of the threads as is given by the square end of the slab. If we take the cylinder and now add the element of axial traverse in the cutting tool, we put pitch into our thread, and it advances continuously as a spiral. The side of the square thread annulus lay in a plane of rotation. The side of the revolving fly-cutter also moved in a plane of rotation, and therefore could coalesce with it. But the side of the square thread spiral is *a rectangular helixoid* or spiral surface, and cannot be dealt with by a plane. In short, the spiral square-thread cannot be cut by a revolving fly cutter of this shape. Now the *rectangular helixoid* is described by a line *at right angles* to the axis, uniformly rotating around the axis, and, at the same time, advancing uniformly along the axis. But the side of the angular thread is *a skew. helixoid*, and is described by a line at *an acute angle* to the axis, but rotating and advancing uniformly in the same way. The question of clearance on the part of the revolving fly-cutter is in this case a mere question of degree. It depends upon the acuteness of the angle formed by the line which describes the helixoid, the radius of the cylinder on which the thread is cut, the radius of the fly-cutter, and the amount of the pitch which is given to the thread. An angular thread of 50°, making eight or ten turns per inch upon an inch mandrel-nose, is abundantly cleared by its counterpart revolving fly-cutter, and is cut just as perfectly as by a fixed point tool in the slide-rest, even if this be kept perfectly on the line of centres, but which, as I have said before, is a very difficult thing to be sure of.

It is now fully admitted that, with the revolving fly-cutter, the height of the cutter-axis makes no difference to the outline of the groove when on a cylinder, so long as the groove is annular and the cutter revolves in a plane which is normal to the axis of the cylinder. Here, then, the revolving cutter has the advantage, inasmuch as a fixed V-point tool, equally set for its cutting face to cut a groove normal to the axis of the cylinder, does depend for the outline of its cut upon the level of the cutter face. In order to show the extent to which the angle of the groove cut by the fixed V-point tool depends upon its level, the following will be an interesting experiment. In a 2in. cylinder of boxwood turn some large V-grooves, then stand the cylinder in a 2·5in. paper tube, and fill up the intervening space with melted wax or plaster of Paris. On planing down down the cylinder parallel to its axis, the juncture of the two substances will show the angle of the groove. At first there will be two points, then a double-funnel section whose connecting channel gets cut off as the stem of the cylinder intervenes, while the angular divergence of the sides gradually increases till the axial section is exposed. By planing down in various directions such grooved or screwed cylinders, we can develop the whole stereotomy of screw threads.

In "J. K. P.'s" valuable contribution (p. 149), it is stated that "when the cylinder is stationary and the revolving cutter is placed and moved horizontally, we also get a groove which is a counterpart of the cutter." This is true only in one case—*i.e.*, when an axial plane of the cylinder bisects the angular groove which is cut. If the cutter, when placed horizontally, does not revolve in an axial plane, we cut a groove, whose sides are not both of the same height, because the bisectrix of the angle is not normal to a tangent plane of the cylinder. In this case it is not the groove or projection-form of the cutter which has been changed, but only that the full measure of both sides of the groove is not shown by reason of the fact that the groove is cut obliquely upon the tangent plane. This deformation, by reason of defect in the surface upon which the cut is projected, must be carefully separated from substitution of cosine or secant for radius as the base of the triangle, when the tool is not kept with its face normal to the line of its cut. A third morphological factor is the helicoidal character of the screw-thread. This factor is the increasing inclination of the thread as it approaches the axis of the cylinder. Every screw-thread, if cut to the axis of the cylinder, would coincide with that axis, and thus become a straight line. Hence, at the axis of the cylinder the pitch of every screw-thread is infinite, just as the tangent of every angle at 90° is infinite. This is one of the things which makes the thread "a screw-thread"; and Mr. Wenham might just as reasonably say that the three-cornered outline of a triangular groove was due to the steel being badly tempered, as that this increasing pitch of the screw-thread is due to my V-point tool being used revolving instead of fixed.

We now have before us all the factors in the form of the counterpart groove — the outline of the cutting plane of the tool, the angle which this cutting plane bears to the line of the cut, and the competency of the surface upon which the cut is projected. I assume, of course, that the base of the cutting plane will always be so shaped as to give clearance, and that, in cross cutting, the sweep of the radius of the revolving cutter will be taken into account. Therefore, for the longitudinal fluting-groove to be received upon a competent cylindrical surface, the groove must be bisected by an axial plane—i.e., the centring of the cutter, whether revolving or fixed, is of primary importance. For the annular groove, and for the annular component of the helicoidal groove, the centring is of equal importance for the V-point cutter when fixed, but of no importance when revolving, inasmuch as the cut then must finish upon the line of centres—i.e, upon the straight line between the lathe-axis and the cutter-axis. Therefore, in the helicoidal thread the necessity for attention to centring with the revolving cutter is only in proporto the longitudinal component in the thread. With a traverse of ·1in., or thereabouts, this longitudinal component is so small that one must be very careless to get the revolving cutter discoverably wrong. The threads cut by myself have been examined by Mr. Evans and other experts. Mr. Evans once said that "no one had ever before cut such perfect screwthreads," and every expert who has seen these threads has approved of them.

I regret much to have had to occupy so much space in developing this matter; but when a writer like Mr. Wenham persists in reasserting these things it is necessary to set the facts out fully. There is no literature that I am aware of which developes this subject, and as it belongs to a difficult branch of descriptive geometry which is of great practical interest to mechanics, I trust that I shall be excused if I write a few words more upon the *normal section* of the screw-thread.

If we take a helix—*i.e., a spiral line—its normal helix*, where the two curved lines intersect, gives *a point*. But our triangular screw-thread is a triangular bundle of these spiral lines, and the points at which they will be cut by a rectangular normal helixoid will lie in the surface of that helixoid, and not in a plane as when cut axially. If, having cut a perfect angular thread upon a cylinder, we could take an infinitely thin tube and sever the whole thread from its base, we might contemplate the spiral thread in one hand and the cylinder which formed its stem in the other. The axial section of this thread would obviously have a straight line for its base corresponding to the straight line which the cylinder would give if cut by an axial plane. But, the inside of the thread being a hollow cylinder, every line except the axial one would be curved, and the curved line forming the base of the normal thread-section would be one of the spiral lines of the normal rectangular helixoid. It would be the normal helix taken on the surface of the cylindrical stem. This must be what "Vulcan" saw in his mind's eye when he wrote (page 60) "the axial section would be a curved broader-based one"; but then, at page 125, "Vulcan" writes:—"I find I have misstated the nature of the deformation: the thread would be broader-topped, not broader-based—it is the cutter which should be broader based." "Vulcan" has not yet thought out this intricate stereometry. Perhaps he will develop his positions more fully. What are we writing about?

We now see that the normal section of the screw-thread is that area of the normal rectangular helixoid which intersects the screw-thread, and that the base of the normal section is a length of the normal helix taken on the surface of the cylindrical stem. In no case, except that of severance from its base by an infinitely thin tube, would the thread shear from the substance of its stem on that line. The substance of the stem at the base of the thread is, for the calculation of stress-bearing capacity, as much a part of the thread as of the cylindrical stem. I am not prepared to discuss offhand the distribution of shearing stress around the base of the normal section; but, probably, if we took the chord of the spiral base line, we should be about right. **James Edmunds.**

Grafton-street, Bond-street.

## LATHE-MATTERS.

[24173.]—IN his letter on page 173, "Vulcan" says he does not wish to "poke fun" at me; but he is a little bit in the sarcastic vein. He says that my expression, "What I know, that I know," is impressive. I only meant that it should be impressive, and I have a sort of idea that it may leave a tiny mark perhaps. I wish to say, however, that it had reference to my letter (No. 24112) and its subject, and to none other. On the very same page on which "Vulcan's" appears, I admit that I sometimes "doubt," and, without question, I am sometimes wrong—who is not? I can only say that I use my best endeavour not to render retractation a duty, and am not now quite sure that I was wrong in the matter of friction.

As to "impressiveness," I have often in vain tried to impress on three generations of Mr. Evans's family what I perhaps too fondly think I may have succeeded in proving to the present one a little while ago—viz., that it is not only possible, but easy, to make chucks interchange on mandrels of the ordinary construction, provided only that both the noses of the mandrels and the thread in the chucks are properly cut. With the tools that our forefathers had—viz., taps and hand screw tools—it was simply impossible, and they were quite right in saying so, and in telling their children so, and hence few or none of those children ever made the attempt, and were content to leave it alone as an impossibility. I had many a talk and disputation with Mr. Evans's father and grandfather on the subject, and, of course, they looked upon me in those days as a young fool for daring to dispute their accuracy. When I was talking to the present Mr. Evans about it, at the beginning of the present year, or late in the last one, and I said, "I am sure I can do it," he was polite enough not to contradict me, but turned it off by saying, "Oh, yes, you can do it, but who (or nobody, I forget which) else can?" My assertion is simply this: that with well-cut screws a chuck will go right up to the shoulder, and centre itself accurately without a cone fitting; that if either of the screws is the least bit eccentric or drunk, the presence of the cone-fitting makes it less likely that the chuck will shoulder up, and that easing the screw to allow the chuck to go up is an unmechanical artifice, as it leaves a cross-strain on the screw itself. Or, summing up the total result, the cone-fitting at best does no good, and it may even do some harm.

I have, of course, nothing to say against cone-fittings without screws; for live centres fitted into hollow mandrels, or dead centres in poppets, for which they are more suitable than screws, I cone them 1½° on each side, or total 3°. The two mandrels that on February 9th I showed Mr. Evans, screwed end on into one chuck, were my own lathe-mandrel that has run about 15 years, and that of the milling machine figured Vol. XII., p. 185, November, 1870, and had no special preparation whatever for the experiment. As nearly as I can remember dates, I have "touched" 15 different mandrels during about nine years, and there are now two within half an hour's walk that I should dearly like to "touch," if their respective owners would only let me. I have had the job of making taps for the chucks of both, and found it a most aggravating task; yet one is a really good lathe—a Londoner—and the other cost over 200 guineas from an eminent country maker. The latter has about six noses that want "touching"—viz., mandrel, eccentric chuck, oval, dome, multiple screw-thread, and geometric chucks, and perhaps others.

I have been puzzled to understand the drift of "Vulcan's" letter (24157); but it just strikes me that it is all due to his misunderstanding my expression, "It cannot be done otherwise," which merely means that a screwing lathe, or some equivalent, is essential to the correction of badly-cut screws, leaving the choice of suitable tools entirely to the judgment of the artist.

J. K. P.

### LATHE MATTERS.

[24174.]—Having been away to the north, I have not seen the last two numbers of the English Mechanic in the usual time. My challenge for the production of a screw both cut and finished by a revolving cutter and grinder has met with no response, for there is no such screw to be found that would bear the reversing and counter-test for accuracy of thread. "J. K. P." truly remarks that "a cutter made for a screw of any particular number of threads will not do for any other number." This cutter is not a practice, and never will be. With this the subject may be dismissed."

Running over Mr. Hines's letter, at page 148, No. 1047, I find it pervaded by the usual tone of self-praise and desire to place himself first in rank as a lathe-maker. Thus: "As I have already said, every reader who has a fine ornamental lathe, made either by myself or by Holtzapffel, or Evans," &c. As to the last firms, we all read their interesting writings with pleasure, and, being practical and free from the trade element, are above criticism.

With respect to myself, Mr. Hines has got into the abusive stage. I cautioned him not to allow his pen to be guided. By this he incurs a double responsibility. He, however, puts the words "dodging about," and "runs away," as applied to myself in common. These are the now well-known coarse stock phrases of another hand, who, when his lack of practical knowledge is corrected, substitutes abuse for argument. Let Mr. Hines, as a self-styled practical man, continue to be "amused" at tempered mandrel noses, and announce that he makes his own soft. This is a losing argument for him, and I am content.

I have before remarked that I do not write to the English Mechanic on technical matters unless I have either practised or seen them myself. Does Mr. Hines really assert, or has he been led to suppose, that I know of no makers of lathes who in their workshops adopt diamond turning tools for their hardened steel surfaces, and, to use his elegant phrase, that I "make a paltry excuse" instead of naming them? This is a forlorn hope for him. I do know of this practice, and the lathes of the makers who adopt it well. I invited persons to obtain their names from me privately through the medium of these pages. This has been responded to, and I have the appropriate thanks in reply. These lathes are by Continental makers; the diamond-turned mandrels are beautifully finished. In the ordinary ones the old weak back centre is discarded, yet they run remarkably light. Every lathe is supplied with a standard plug tap or hob, the exact counterpart of the mandrel screw; a running catch-plate or pulley is also sent for turning up small work accurately between fixed or dead centres, and great attention has been given to make these lathes a really useful and workable tool. They would be selected in preference to those made by one of the assumed "first rank," particularly as they are sold at nearly half the price, and I intend ordering one of them for my own use. An old engineering friend of mine procured one for his amateur workroom, and is so satisfied that he has just got another with a traversing mandrel for fine screwcutting; and thus the conservatism, or I may say the obstinacy, of some of our old makers is causing the trade in small and fine mechanism to leave this country.

The English Mechanic is a first-class medium for communicating useful knowledge to its readers. Will Mr. Hines aid in this, take the onus, and request me plainly to give the names of these manufacturers? I shall be very glad to do so if the Editor will kindly permit it.

Passing on to Mr. Hines's note at p. 173 of last issue, first (not neglecting to insinuate matters as to the antiquity and leadership of his business) he shows that he has never used the diamond turning-tool, but his examples have been "hunted up" by his father, and had been used by someone even before him; and then says that diamonds "cannot be ground down to an effective edge upon a diamond lap, as Mr. Wenham thinks." Under the circumstances, the assurance of this assertion is rather astounding. I do not merely "think" about it. I have now in my hands a diamond tool sharpened to a cutting edge by myself years ago. I take this tool and use it on the hardest and harshest piece of steel—that is, an old file with the teeth ground off; with very little pressure it cuts and ploughs up the surface as if it were copper, not by a scraping action, but by shaving off the steel in lengths. Knowing what an unassailable material hard steel is, many persons would be surprised at seeing this. Mr. Hines states without knowledge that the "carbonado" is the only kind of diamond that will not break away. On the contrary, this is just what it does do, and therefore is not the best for making a tool with a fine cutting edge; its extreme hardness and the ease with which it can be powdered in the steel mortar makes it very suitable for charging laps and slicers. Then, again, to say that when the hard outer skin is gone a diamond tool is useless is another fallacy; cut or ground up diamonds may be used for drilling rubies, cutting agates, porcelain, or other substances much harder than steel. I believe this hard "outer skin" theory to be an error, arising from the fact that at first abrasive powders will not take a bite on a polished surface—for example, as emery on glass; we might as well say that this has a hard skin.

Do those who pretend to have used diamond turning tools and condemn them know how to mount and employ them properly? I imagine not. However, this we shall see. I intended to have given the result of my experience this way this week, but, as may be seen, I have been put under the necessity of doing some weeding, which has occupied my time.

F. H. Wenham.

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[24175.]—Apropos of the discussion and correspondence on the "front slide lathe" some few months since, I have just noticed a drawing of a small bench lathe on this principle in the *American Machinist* for March 7th last, which I think would interest your numerous lathe correspondents if they have access to the journal in question; the design appears to be very neat and convenient in many respects. Two leading screws are shown, one for ordinary sliding purposes, and the other, which is of superior accuracy, but the same pitch, for screw cutting only. For some reasons this may be a better arrangement than the employment of a screw for screw cutting and a grooved feed-rod for sliding.

"B. Sc., Plymouth," 56443, should not put a round cord or gut on a flat wheel. I presume his flywheel has only one speed, in this case he can fix some wooden segments to the side of the wheel and turn V-grooves therein to suit his new three-speed V-grooved cone pulley on mandrel.

If, however, his flywheel has three flat speeds for belts, why not have a three-speeded flat cone pulley on his new mandrel?

Personally, I much prefer flat belts to cords or guts, as they can be run slacker than cords to transmit the same amount of power, and can be shifted from one speed to another far more readily.

Belts as used on foot lathes are rarely wide enough; a 5in. lathe should have a belt not less than 1¼in., and a 6in. lathe a 1¾in. belt. A narrow belt will never give satisfaction.

One great advantage of belts is that they compel the mandrel to be made of decent length. I was looking at some new light foot lathes the other day in which the distance from the end of the line centre to the middle of the collar was equal to, if not actually greater than, the distance from the tail of the mandrel to the same point.

I should mention that the centre was fitted into a chuck which screwed on the mandrel nose, an old-fashioned, abominable arrangement, of which the defects are only too obvious.

A. Myall.

### INTERCHANGEABLE MANDRELS.

[24176.]—If Dr. Edmunds's short cylinder does not act as centring agent, what use is it? And if it does, will it not drive the thread into closer contact at *one side* than at the other? I apprehend that the interchangeability would be perfect; but how would the lathe act with a stiff job and the poppet head not up?

An E.M.

### DIAMOND TOOLS.

[24177.]—In reply to A. P. Bower, I can only say that most probably if an attempt were made to abrade soft steel by a diamond charged skive or lap, the particles would leave this and get imbedded in the work. The same liability would occur in a less degree with hard steel. This cannot be effectively ground, shaped, or sliced with diamond dust. This without difficulty, will soon take a slice off a piece of hard quartz an inch in diameter, but to take a slice off the end of a hardened steel rod of this size would be an impracticable feat. The diamond particles get completely imbedded in the edge of the slicer, which also at once gets choked up by the abraded metal, and no longer cuts; but for its legitimate purpose it is not rendered inoperative by this, for now try it on the quartz with the usual lubricants. At first it is inert and quite slippery; but presently a little point catches the stone, and then the cutting action commences. The impalpable dust ground off the quartz acts by attrition on the unarmed portions of the edge of the slicer, laying bare the buried diamond, and no choking occurs, as with the hard steel. My lapidary mill or lathe is on the well-known Holtzapffel pattern, as I require the top or centres of the laps and buffs to be quite free.

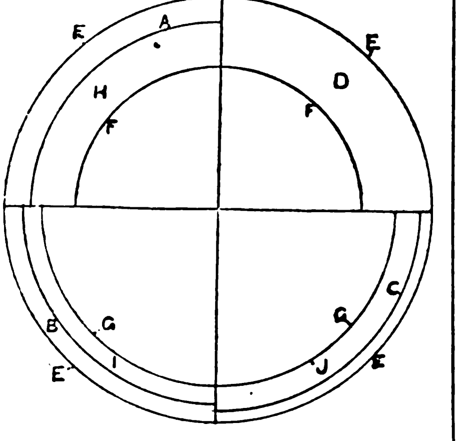
F. H. Wenham.

### HOW TO MAKE A VERY CHEAP LATHE-WHEEL.

[24178.]—Many who wish to build a cheap lathe would like to avoid paying 10s. or 12s. for a speed-wheel, when they could, by the outlay of half as many pence, and the exercise of a little skill, produce a wheel quite as heavy and almost as serviceable.

These persons, then, should take a smooth sheet of stiff, tough paper of sufficient size. Tack this by the corners to the wall, floor, dining-table, or anything you please that is flat, dear reader. Now take a beam-compass, which if you happen not to have—and this, no doubt, will generally be the case—can easily be improvised out of a square stick of wood, a bradawl, and a pencil. Bore a hole near one end, and of a size to hold the pencil tight when pushed through. The bradawl can be pushed through, at any number of inches from the pencil as may be required, to form the centre. With this describe the circle E, 13in. from the centre, and make a good clear dot on the centre. Take the paper down and cut out the centre very accurately; fold it carefully in half, exactly on the centre dot, burnish the fold well at its extreme edge, so that it shall give a well-defined and unmistakable mark when the paper is opened; but do not burnish to the extent of stretching the paper. Now open the paper, and fold it again in half, exactly on the centre dot, and so that the two halves of the first fold-mark fall exactly on each other. Rub down again, and open. Then describe semicircle F 6in., and G 9in. from centure, also A at 10in.; B at 11in., and C at 12in. respectively. Now take a sharp knife, or scissors, and cut out with great care the four pieces D, H, I, J. This is all that is wanted of the paper. Get a couple of orange, lemon, or onion cases, the ends and mid-partitions of which are made of ¾in. or ⅞in. beech or other heavy wood. Free these end pieces from nails, and see that they are not warped. Lay your paper patterns on the wood, and pencil off four pieces of each of the four shapes, D, H, I, J, 16 in all. The grain of the wood should run from end to end. Now saw them all out with as much accuracy as you possibly can. Just take half the pencil-line away with the saw. Attention to this point will save lots of trouble after in fitting. Plane up the ends of the pieces, if they need it, but recollect one end must be quite square with the other. Now draw a 26in. circle on the floor on which you intend putting the wheel together, and lay the four pieces, D, down in order with it. Drive a lot of nails round them outside (not through them), to keep them well in place. Place the four of J on these, so as to break joint; see that the inch space is equal all round. Fasten each of these pieces down with about eight 2in. French wire nails. Bore the hole carefully for each one with a gimlet or bradawl. Do not split the wood, whatever you do. If the wood is only ¾in. or ⅞in., these nails penetrate the floor a little. Never mind that; it will keep the work steady, and a little leverage will soon bring the wheel up afterwards. (The floor, of course, should be quite flat.) Now put on the pieces I, to break joint with J. Nail them on in the same manner with 2in.-nails.

The spokes must now be put in. (There is no boss or hub.) One-and-a-half inch stripes of the same lemon-case ends answer well. If four spokes be put, which is the easiest number (six would be, no doubt, better), they should be made a double thickness of the wood, well nailed together, with 1½in. left out half-way along, in one of the thicknesses in each double spoke, in order to rebate one into the other. Nail one of these first in its place in the wheel, letting its ends fall correctly on two of the joints between the pieces D, and having a regard to the future centre of your wheel. Now add the other pair of spokes. Two screws at every end would perhaps be better than nails. Now add the final pieces H, and, besides the 2in. nails, put in two wire nails to each quarter, long enough to reach right through the thickness of the wheel. Turn the wheel over, and hammer down the nail points, and put eight long nails through from the back. Bore all the holes, and do your best not to strike another nail. The hollow rim must now be packed as close as possible with pieces of old iron and dry sand and small stones, to fill the interstices. Fill one quarter of the hollow first, in doing which, of course, the wheel must be stood upright. Pack as much iron in as you can, and make the top level with the edges of the wood with old putty or paper; then well tack down a strip of tin or sheet-iron, long enough to reach from spoke to spoke, and as broad as the wheel-rim is thick, and then proceed with the other three-quarters. I have used old tin goods for packing, but they require to be cut or folded up (with hammer) in small pieces, and then packed on edge with a hammer and chisel, to get them to lie close. Now put two discs of iron-plate, 4in. or 5in. in diameter, one on each side of the wheel, to form the boss. Screw with two ¾in. screws to each spoke. If the whole has been put together with care, the spokes will cross exactly in the centre. However, find the actual centre on both sides by measuring from the outside edge of the wheel along the centre line of each spoke; mark the centre legibly, by twirling the pencil round on the point. Then take the compasses and draw a circle about this point on the spokes, a trifle larger than your iron discs, which I premise are quite circular, and have centres to them. Now screw the iron discs on so that the pencil-marks on the spokes are equidistant from edge of said discs, all round, and the centres of the discs will be the true centre of the wheel. There will now be a little "valley" left between the discs, between each pair of spokes. This may be with advantage filled with one corner of a square block of hard wood, glued (!) in with white-lead. Knock down close, and put a short screw through the disc into it from each side, and trim off the wood level with the discs. Fifteen or twenty discs of tin or sheet-iron might answer as well as iron-plate; but I have not tried this. The hole for the shaft must now be drilled, beginning on both sides, and meeting in the wood, and a key-way filed. In doing the latter, remember that one side of the wheel is probably heavier than the other. The wheel, therefore, may as well be hung, so as to avoid the crank stopping at a dead centre.



The nails and screws will be less likely to split the wood if they are made hot—just too hot to touch—before they are driven.

After the wheel is mounted, its edge may be easily trued with sharp files as it runs, and if wanted for a gut-band the V-grooves can be filed in the same manner. I will leave it to the reader to do as he likes about painting it. I do not claim for this wheel to supersede those of iron; but it will cost far less—at most only a few pence—and will weigh 45lb. to 60lb. A key-hole saw will be found convenient for sawing out the quarters. **Murano.**

## ENGINE-MAKING AT HOME.

[24179.]—In answer to "Invicta" (letter 24144, p. 169), I beg to refer to the article which he mentions for the reasons why I adopted the slide-bars in Figs. 1 and 2, in preference to those of Figs. 3 and 4. And while duly appreciating the extensive knowledge possessed by our correspondent, and the spirit in which his criticisms are offered, I still consider the guide-bars in the first figures better than the form which "Invicta" advocates. There is no special difficulty in fitting them up, and the bearing surfaces are ample. There is also the very important advantage of having the thrust of the piston rod transmitted in a direct line to the slide blocks, instead of to a point above. The consequences of a misfit are more serious in the dovetailed-shaped slides than in those which I figured, involving tipping and the wearing rounding of their faces and edges. They are quite suitable for large and slow-running engines, but not for small ones going at a high speed, and are seldom adopted for the latter. Neither is the use of a planing machine necessary to the fitting of the slide bars, as "Invicta" assumes. In the articles deposited at 332, Strand, I have endeavoured to give such instructions relative to the fitting up of the engine parts that those who are not engineers may be able to construct their models to the design of Figs. 1 and 2 without having recourse to a planing machine at all, and possessing only lathe, files, drills, &c.

An overhanging cylinder is advantageous, as keeping the moving parts low down on the bed; but I should hesitate to recommend its adoption, because, although there is less work in such a cylinder than in one with feet, the work on the bed is increased to a considerable amount, since the hooded end to which the cylinder is attached has to be cored out to form the inside of the hood, and the cylinder-cover and its stuffing-box. Not long since I made the pattern for such a bed for an engine of about 20 h.p., and in which the guide-bars were of the shape which "Invicta" advocates. A half-round print was boxed up sufficiently long to carry the core, and on this the stuff representing the thickness of metal in the hood was nailed, and its ends cut to the requisite curve. The print extended over about half the length of the guide-bar facings, so that half were on the bottom board of the box, and the other half on the pattern itself. There is no difficulty in making any of the combination beds now so much used, provided one has had an engineer's training; but they should not be attempted by amateurs. But the bed which is described on page 4 of the present volume is one which anyone could attempt and complete successfully, while its appearance is not inelegant.

If I have a preference for one guide over another, it is for that on Fig. 5; but I gave my reasons for discarding that. Still there is, I think, no better guide and slipper, especially when the latter is provided with wedge-shaped adjustment pieces. These and other things passed through my mind before I put pen to paper for the "Engine-making at Home." Out of the many types of horizontal and inverted engines I was at a loss which to select. Of course it was necessary to select some one form, and that, whatever it happened to be, would not meet with universal approbation. I have it in my mind to write at some future time a course of articles in which the history of engine development will be discussed, and the advantages of modern improvements in their various details taken up, and such a series would afford that scope for the balancing of various opinions which would be out of place in a merely practical series such as the present.

"Glatton" (letter 24145, p. 169) should know that the use of the word "eccentric" in contradistinction to "crank," is misleading. In the connection in which I employed the term "eccentric" (letter 24108, p. 147) it was perfectly legitimate, since it was used to indicate a motion not directly reciprocating. The words were—"The pistons are not moved by a directly reciprocating rod, but by an eccentric." There is essentially no difference between an eccentric and a crank: each term signifies centres of motion set eccentrically in relation to each other, the eccentricity being generally understood to be less in the case of the eccentric proper than in that of the crank, and as the throw of the connecting or piston rods in the three-cylinder engines is small, I used the term eccentric in much the same way as we employ the term in reference to the back-gear spindle of a lathe. Whether "crank" or "eccentric," I say "ditto" to "Glatton," having nothing in my mind beyond the common three-cylinder engine with the piston rods attached loosely to the crank "pin," and kept in place by means of two rings embracing their three ends. **J. H.**

## PATTERN MAKING.

[24180.]—The oblong holes for shifting the back spindle must either be enlarged, or the wheels bushed for a smaller spindle, or new wheels cast. You have no choice apart from these methods. If the metal in the lugs will permit, the holes might be enlarged, but they should be larger than the spindle to permit of the latter being fitted into a brass or steel bush at each end, the bushes forming the actual spindle bearings, and sliding on their outer or flat faces in the oblong slots in the headstock lugs. They are kept in place, when in or out of gear, by steady pins from the top. If your metal is not sufficiently thick to allow of this filing out of the holes, you had better bush the ends of the wheels with gun-metal or steel bushes, say ⅛in. thick, simply driving them in tightly with the hammer.

The size of the driving wheel may be 18in. or 20in. Say you make it 20in. on the longest speed, then your pulley being 6¾in , 5½in., and 4¼in. on its steps, the driving wheel should be 17¼in., 18¾in., and 20in., for the strap to fit on all alike.

**J. H.**

## MINERAL-OIL LAMPS.

[24181.]—I have read, with mingled feelings of interest and surprise, the remarks of P. Ward in a recent issue about the over-heating of the oil-container of the Silber lamp which he has, and of its having "blown up" several times.

Now, as manager of the Silber Light Company, I have used, experimented with, and examined a great many of the Silber lamps, and, amongst the many thousands made by the Company, I have come across a few defective ones, in which the over-heating of the oil-receptacle has occurred to a slight degree, but certainly nothing at all like that described by your correspondent.

As regards the "blowing-up" which P. Ward refers to, there is not a mineral-oil lamp in existence in which this phenomenon could not be made to occur under certain conditions, but these conditions are very abnormal indeed.

The fact of P. Ward's lamp having "blown up" several times points at once to its being a defective one, and it seems a pity that he has not acted, with regard to his lamp, as he would doubtless have done with any other defective article—i.e., returned it to the maker for rectification.

I must add, however, that the second part of your correspondent's letter reads somehow to me very much like a gratuitous advertisement of somebody's new burner. **J. Collins.**

[24182.]—The best oil is the cheapest. Common kinds give out great heat, and are dangerous. I have used a lamp with a glass receptacle for a long time without accident. Keep lamps very clean, don't carry them about, keep well filled, turn down gradually, and never blow them out. A swinging lamp is the safest, simply because it cannot be upset. A really good lamp is now to be had for about 2s. 3d. in the country; here in London we get them for 1s. 11d. The body is of white enamel with a shade of the same substance; the wick is circular. They burn but little oil, and, unlike some with this shape of wick, go out quickly on being turned down gently. I tried one after it had been burning all the evening, and found the brasswork quite cool, and even the lower part of the glass not too hot to hold. Lamps explode from the use of bad oil, accumulation of charred portions of wick, and gross carelessness generally. **R. W. J.**

## RAILWAY AXLES.

[24183.]—Since my letter upon the "Breaking of Axles" was written, the Board of Trade return, relating to the accidents during the year 1884, has been published. During that period there were 385 failures of axles, by which 24 passengers were killed, and 69 passengers and 4 servants injured. Of the 385 axles, 223 were engine axles—viz., 200 crank or driving, and 23 leading or trailing; 24 were tender axles, 6 carriage axles, 113 waggon axles; 19 axles of salt vans; 68 waggons, including the salt vans, belonged to owners other than the railway companies.

Of the 200 crank or driving axles, 138 were made of iron, and 62 of steel, the average mileage of

135 iron axles = 216,333 miles.
59 steel axles = 173,287 miles.

20th April. **Clement E. Stretton.**

## OLD LOCOMOTIVES.

[24184.]—The *Engineer* for October 10, 1879, contains a very clear engraving of the "Invicta" of 1830, copied from a photograph. The same number, in addition to a few other particulars, also contains the following information respecting it:—

The "Invicta" was exhibited during the Railway Jubilee at Darlington in 1875, when the photograph was taken. The engine was sent by Mr. Cudworth, of the South Eastern line, and was constructed by Messrs. Stephenson and Co.

In some respects it resembles the "Rocket" of 1829 celebrity: had inclined cylinders as in that engine, but these were placed at the funnel end over the front wheels, instead of at the side of the firebox as in the "Rocket." The four wheels were coupled, the trailing wheels being the drivers.

The furnace was cylindrical and placed inside, and behind the cylindrical boiler it was about 2ft. in diameter. From this furnace tubes extended (number not known) to the front, the arrangement being a cross between the old single flue and the multitubular boiler.

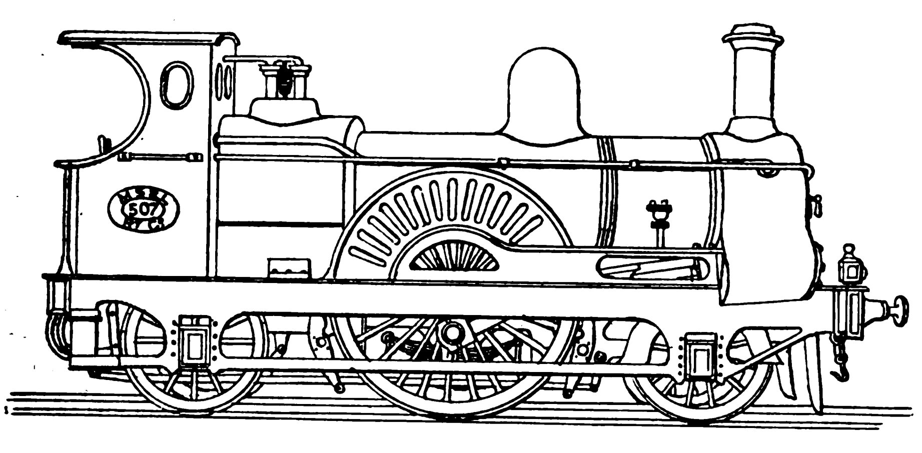
It is also stated that the existence of this engine has been passed over in silence by all historians of the locomotive.

The "Invicta" was much dismantled as exhibited at Darlington, and on account of its early date it would be extremely interesting if anyone could furnish the information as to what kind of reversing gear was fitted to it, as well as any further particulars which the dismantled remains of the engine cannot supply. **Telegraphist.**

### M. S. AND L. ENGINES.

[24185.]—Herewith I send sketch of the 7ft. 6in. single express engines on the M. S. and L. Railway, as asked for by "G. A. T." (letter 24120). These engines were designed by Mr. Charles Sacré, and commenced running in 1883. Dimensions and particulars have, I believe, been given in a previous issue; but I can forward same if required.

**W. H. Thurlow.**



### ANNEALED CASTINGS.

[24186.]—In answer to letter 24094 from Mr. Eaves, carburetted annealed cast iron is well known to those in the trade: hence my reason for advising amateurs in accordance therewith. I am aware that carburetted implies containing carbon; but it is a matter of controversy whether the malleability of the annealed cast iron is owing to the extraction of all the carbon or a molecular change within the iron itself.

The annealing of cast iron, or rendering it malleable more or less, is of much older date than is generally supposed.

Réaumer, in his work on the "Art of Converting Wrought Iron into Steel and of Softening Cast Iron" (*L'Art de Convertir le Fer Forgé Acier, et l'Art d'Adoucir le Fer Fondu*), published in 1722, gives numerous experiments by which he succeeded in producing malleable iron castings. He states, however, that these said malleable iron castings had already been made some twenty years before, but in a secret manner. Réaumer discovered that a plate of cast iron exposed for a long time to the direct action of a fire was covered with a coat of black and red oxide, and that the metal underneath had become softened (malleable). He collected this oxide for the purpose of packing with it small bars of white cast iron, and after heating them in covered crucibles he obtained a perfectly malleable iron. His other mixtures were powdered limestone and charcoal, or charcoal with calcined bone-dust. The first mixture is evidently that used at the present time; the second may be explained by the oxidising action at a certain temperature of the carbonic acid disengaged, which parts with an atom of oxygen to combine with the carbon in the cast iron, thus—$CO_2 + C = 2CO$. Or it may be that the carbon was burned out by the air of the fireplace penetrating through the interstices of the cast-iron plates forming the boxes in which the metal and the mixture were packed. The air was prevented from acting violently by the mass of bone dust and powdered charcoal with which the articles were surrounded.

It is evident that Réaumer ascertained that oxides of iron and cast iron heated together in closed vessels produced malleable iron; also that for malleable or annealed castings white is preferable to grey metal, and that castings previous to annealing should be deprived of the adhering sand, which, becoming fluxed, prevented the reaction, and that properly annealed articles may be bent, forged, welded, case-hardened, and present all the properties, and even appearance, of wrought iron.

Some authorities say that it is decarburisation by which cast iron is malleablised in this process; but Mallet doubts this, and remarks that by annealing white brittle cast iron either in hæmatite, chalk, or *even sand*, he obtains not so much a chemical change as a molecular change in its constituent particles.

Oxide of zinc has been proposed as a substitute for oxide of iron under the plea that the operation is more rapid.

The Siemens gas regenerative furnace is in use in large works. The castings are carefully packed as above, and are kept at a bright red heat for 80 to 90 hours, and allowed to cool down gradually in the furnace for about 30 hours.

More recently a patent was taken out by a Mr. Ramsden in 1881, No. 1874, for annealing, in which he states that he uses "a mixture of red ore and oxide of manganese or nitrate of potash and other materials."

If all the carbon could be extracted, the term "carburetted" as applied to annealed or malleable cast iron would be incorrect. This, however, is impossible. It should be borne in mind that the best quality of wrought iron contains carbon.

Mr. Eaves asks me what battery I used when testing the different armatures. I used a special form of Bunsen, containing sufficient liquid to do fifteen to sixteen hours' practically constant work.

**John E. Chaster.**

Talbot-street, Southport.

### LAMINATED ARMATURES.

[24187.]—Mr. F. Walker, in letter 24095, now states that 150 discs should have been 110. It would have been better if he had made this correction before. He says that he will make the 1in. of compression so clear that even I may admit the possibility, and then goes on to say that he threads the discs on to the spindle just as they come from the punching machine. I do not follow this *explanation!*

With regard to letter 24133, Mr. W. Habgood seems to have fallen by the wayside, along with Messrs. Walker, Harcourt, and Eaves, in supposing that I condemn laminated armatures for dynamos or motors. I state here most emphatically that I have never spoken or written against laminated armatures.

I merely called attention to an armature of inferior design that had been suggested for my motor during the time I was contributing the articles on electro-motor construction. This armature in question happened to be laminated, and because I condemned its use in the electro-motor, I am at once charged with having cried "Fire!" as far as laminated armatures are concerned.

If laminated armatures are so much better in these small motors, I wonder that the large makers of such who have doubtless tried them do not supply them. **John E. Chaster.**

28, Talbot-street, Southport.

### MYSTERY GOLD—USE AND TEST FOR.

[24188.]—The description recently given in the papers of this alloy, which is said to be used for making false sovereigns and jewellery, indicates that it might have a more legitimate use to replace platinum, carbon, or at all events, silver in batteries. I do not know where to obtain a sample; but if anyone can supply me with a piece I would try its suitability.

It is said to resist the usual tests for gold, and not to be attacked by acids. From its constitution I should think it might be distinguished from gold by its not being whitened by a spot of mercury, which test has, however, the disadvantage of defacing a real gold article to which it might be applied. But it appears probable that a weak solution of nitrate of silver might be a good test. Gold would not be affected unless very heavily alloyed; but I should expect to find that "mystery" would expose itself by a black mark of precipitated silver. **Sigma.**

### SEPARATE PEDAL ORGANS FOR AMERICAN ORGANS OR HARMONIUMS.

[24189.]—In my sketch, which appears on p. 171, I omitted to show the feeder spring of American organ bellows. If there is anything required to be explained with regard to the subject, I shall be pleased to answer any reasonable inquiry.

**G. Fryer.**

### MICROSCOPE CONSTRUCTION — LECLANCHE CELLS — REPAIRING BOILERS — GERMAN SILVER — CEMENT FOR KNIVES AND FORKS—FLAT EDGE LATHE WHEEL—AND RAIN-WATER PIPES.

[24190.]—I have referred to my previous communication on this subject, and fail to find therein even the ghost of the promise suggested by "Rob. Crus." But leaving mental aberration out of the question, it is only reasonable that a "Robinson Crusoe" should at times indulge in a little mild fiction. The remarks of "R. C.," and what he has accomplished, corroborate what I maintain, that any decent amateur can construct such an instrument as a microscope without a special series of papers other than what have appeared in the "E. M." Any maker of any importance has had his microscopes figured in these pages, and what more can be wanted. The glass grinding would certainly be an acquisition, as, although the subject of telescope lenses has, and is being well ventilated, we have heard little or nothing about microscope glasses, and we shall all be very glad to read what "R. C." has, to say on the matter, and to give him due credit for his doubtless original methods.

I can't say that the Leclanché cells of "Rho." are particularly cheap—batteries quite as good can be obtained from advertisers in this journal at about half the price, to say nothing of the time consumed in making them.

I wonder how "Invicta" would like to get inside a boiler with the steam just let off, as must have been the case with Lord Beresford's steamer. There are more easy ways to put a patch on a shot-hole than holding said patch up from the inside; doubtless, the engineer in question would tap holes in the shell and screw on a piece of plate. This, with some good packing, would prove equal in strength to any other portion of the boiler.

German silver *will* get tarnished (56431). I would recommend querist to try potassium cyanide. It is just possible that if the small articles were kept till wanted in petroleum oil they would retain their pristine brightness.

A mixture of powdered Bath brick and rosin is used for cementing knives and forks in their handles (56438).

I have a lathe-wheel with a flat edge on which a small round gut has been running for some years (56443), but you can't expect to get quite as much pull as the V-groove would give.

Mr. Ashworth (56446) can make an excellent joint in his rain-water pipe by getting a strip of tin plate about 2in. wide; bend this round the joint (a piece cut from an old tin can will do). This may be tied with a piece of twine or wire; now wind on some strips of canvas or calico, between the layers of which put plenty of red lead and linseed oil, and give a good coat of the same outside. This will, if done properly, last about as long as the pipe itself. Should be done in dry weather. **Os.**

### THE "CALORIE" IN FRENCH THERMAL UNITS.

[24191.]—I noticed in yours of the 27th of March last, p. 91, this was given as 22 British thermal units. Unless corrected, it may lead to errors.

The British thermal unit is 1lb. of water elevated in temperature 1° Fahr.

The French thermal unit is 1 kilogramme of water elevated in temperature 1° Centigrade.

Now the kilogramme is usually accepted as equal to 2·20462 British avoirdupois pounds, and the Centigrade thermal degree equals 1·80° Fahr. Then $2·20462 \times 1·80 = 3\ 998316$ nearly 4·00. In fact 4 may be used, as it so nearly approaches the true value, where French thermal units require to be used instead of British.

**Tubal-Kain.**

### NEW TIME.—DECIMAL TIME.

[24192.]—I have read the remarks of Mr. B. J. Hopkins on p. 151, and also those of "F. R. A. S." on p. 168, and am rather at a loss for a reply, for, as far as I can see, neither of those gentlemen has attempted to show why the change should be made, or to traverse the arguments of Sir E. Beckett. Any improvements which can be suggested in "Bradshaw's Guide" will doubtless receive attention from the publisher of that highly interesting work, which certainly is a bit of a puzzle until you get used to it, but not in connection with the times, only with the destinations and connections of the trains. I am bound to accept the statements made that people do get confused with the time tables, and so can only retort that if they make mistakes now, they may make more when the time tables are altered, which, however, is not likely.

I find that a Prof. Loudon has recently read a paper before the Canadian Institute, Toronto, Canada, in which, some time "after the fair," he suggests just exactly what "W. A. G." did on p. 341, last volume.

"The present day of 24 hours, on Prof. Loudon's system, would be divided into ten divisions, so that each hour, if we might so call it, on the new system would correspond to 2 hours 24 minutes. This hour would be again divided into 100 divisions, called minutes if necessary, each minute on the new system thus corresponding to 1·44 minute, a good fractional unit. Again, this new minute division could be subdivided for accurate measurements into 100 divisions, called seconds. The advantages arising from such a system would be: 1. The abolition of the so-called a.m. and p.m. nuisance—what has already been accomplished by the 24 hour system. 2. All the advantages to be derived from the adoption of any system based on our scale of 10—namely, the inconveniences arising from the continual use of vulgar fractions and the use of symbols for each unit in the ordinary affairs of life. 3. The fact that the time in hours and minutes (which for all practical purposes is sufficient) is indicated immediately by the clock. This is the most important advantage, because in the present system we have always to multiply by five before we know the time—thus 1 means five minutes past, 2 means ten, 11 means fifty-five past, or five to, and so on; and this would really overcome the great difficulty experienced by most children in learning to tell the time."

There are, I know, some children who are naturally obtuse, but I fancy the "great difficulty experienced by most children" is unknown to them. Some so-called teachers experience the difficulty, not the children. **Nun. Dor.**

## A NEW THEORY OF THE VOLTAIC CELL.

[24193.]—THE generally accepted theory of the galvanic battery (taking the zinc-copper cell for our example) is that the zinc decomposes the acidulated water, the hydrogen of which, by atomic substitution in the intervening molecules of $H_2O$, is transferred from the Z to the C, and there given off.

To many minds this is quite unsatisfactory, as it seems at best to be a compromise with difficulty. Why should the H atoms be given off at the copper plate instead of at the point where the O unites with the zinc?

If the theory which I shall now offer contains a germ of truth, it will blossom into fruition; if not, the world of science will be none the worse for a new thought. There is nothing so fatal to progress as a blind acquiescence in unproved theory. As examples of this mental petrification recall Helmholtz's theory as to the limits of microscopic vision, and the generally accepted hypothesis concerning the antipodal tidal wave, which any student of mechanics feels *instinctively* to be wrong.

In considering the action of a simple galvanic cell, consisting of copper-zinc excited with dilute sulphuric acid, I assume that the hydrogen arising from the decomposition of the $H_2O$ passes through the zinc (*i e.*, between its atoms) and connecting wire, and thence, when the circuit is closed, to the copper element, and is given off at its surface, which opposes the zinc. In enunciating a new hypothesis, I am aware that it must agree with observed facts.

We will first consider the spark. Considered in relation to the proposed new theory, it is caused by the partial chemical union of the fleeting H atoms with atmospheric air. Reasoning *à priori*, we should expect that a reduction of the normal pressure would enlarge the spark, and this is, of course, true. How will this hypothesis account for the phenomena of the spark in vacuum tubes?

It is very difficult to see why "energy" should expand in a vacuum; but that hydrogen atoms should conform to the law of Mariotte is a matter of course. When we consider the enormous volume of hydrogen occluded by so dense a metal as palladium, there is no difficulty in conceiving that copper and zinc may offer a path to this pigmy of the elements.

The cross section of wires of a given diameter contain a certain number of atoms peculiar to each metal. The number and shape and position of these atoms determine the resistançe to the passage of the hydrogen atoms. Each wire has its normal capacity; when this is exceeded heat is evolved. (The captious critic is requested not to inquire now what this manifestation known as heat may be—this must come later.)

How can this theory account for the decomposition of $H_2O$? It is well known that heat alone will cause the separation of this compound, and we have just seen that a conductor of insufficient capacity is rendered incandescent. So we have a perfect theory in this case. The H atoms, passing from the Z to C poles, split the $H_2O$ into its component parts, for the water being a *poor* conductor offers a great resistance to the passage of the H. atoms, and instead of being manifested as heat, it appears in the separation of the combined elements. That such separation is equivalent to the rendering latent an enormous degree of heat is evident to anyone familiar with the oxy-hydrogen blowpipe.

I will not further enlarge upon the capacity of this theory to explain known effects. My object is to give the "E. M." circle an opportunity to pursue what I believe to be a new line of thought, feeling assured that in the counsels of the many lies ultimate truth. To me there is more of probability in this new theory than in the old. I can conceive of a flashing train of atoms, potent with energy, traversing their inter-atomic path much more readily than I can assimilate the idea of *currents* of ——nothing.

I believe *all* natural phenomena capable of a mechanical solution, and that time will effect their solution on this basis. I have contributed this as a nucleus of a theory, and hope your readers will aid in adding to the structure. I am aware that a cloud of objectors will arise. I myself could easily show the weakness of many sides of the new structure; but I am more interested in building up than in throwing down at present.

**James L. Gordon.**

46 E, Brookline-street, Boston, Mass.

## PARAFFIN-OIL LAMPS.

[24194.]—I HAVE read with some interest the lecture given on this subject by Sir F. Abel as published by you on page 48; but am much surprised in regard to what was said respecting the volatile qualities of paraffin oil; and as Sir F. Abel's article is headed "Explosions in Paraffin Oil Lamps," I shall confine myself to this particular ingredient, without reference to any other of the hydrocarbons which, I admit, are far more dangerous and inflammable, but which yield no adequate return in respect to cost and safety compared with paraffin.

I have tested well-nigh a score of samples this last two years, to ascertain the volatile and other qualities of paraffin oil, and my mode of proceeding has been on so delicate a scale as to be able to tell to less than half a grain in any given time, and I find the average of the whole of the tests taken in a room of 60° temperature to be less than 1oz., or only 416 grains per square foot of surface in 24 hours, or 17·8 grains per hour per square foot of surface, and on comparing this with water in the same temperature, I find water to evaporate at nearly double the rate, or 32·9 grains per hour, or 790 grains in 24 hours. These figures, as before stated, are taken from one square foot of surface, and would have to be very materially increased before any danger could occur from paraffin. Then, again, it is not generally known that paraffin oil is not like spirits of wine, turpentine, or naphtha. You cannot set it on fire at ordinary temperature in the absence of other combustibles. A flame applied to its surface will dry it up to a kind of waxy residuum.

I don't pretend to teach those who know, nor do I write to pull to pieces what Sir F. Abel has advanced on this subject; but the general public who consume the greater part of the paraffin that is used know but very little of its nature or qualities, and my desire is that what Sir F. Abel advanced in regard to explosions in reference to paraffin lamps should not create any unnecessary fear or panic amongst those who use it, and especially the poorer class of people who, in their ignorance to the contrary, are apt to allow their fears to increase, and especially when such information comes from such high sources. I am sure no such fear need exist as to paraffin lamps exploding with anything like care. The whole surface of any lamp container is scarcely more than 1-6th of a foot, and if wholly exposed, it would require about a week of days and nights to lose 1oz. in weight. As to the higher temperature it attains while burning, the greatest danger, then, is a wick that is too narrow for the holder or casing. The container generally increases in temperature as the paraffin gets less, and especially when it is so far exhausted as to require repeated snuffing of the wick, for when this is so, the wick is little better than a dry ember lodging upon the top of the wick-holder, and it is by this cause and just at this time that so much heat is generated, that it is bound to travel downwards as well as in other directions, and should the wick at this time be too narrow for the casing, the flame will then follow the heat and creep down the wick right into the already overheated container, for the flame, if allowed, will, like ourselves, struggle hard for existence. There should be standard gauges for all wick-holders and for wicks, so that we might have them interchangeable, for I have now before me, while I write, several 1in. wicks, so-called; but there is a difference of over ⅛th of an inch between the widest and narrowest. Then, again, in the plaiting of the wicks, there should be a fixed weight per yard according to width, for the substance of the wick has much to do with the perfection of the entire lamp. A loosely plaited wick, as Sir F. Abel says, will draw up the oil to the flame more freely; but there is only a narrow limit as to looseness, for I have known loose wicks not to answer to the winding gear, and even to drop down suddenly when in use, and almost extinguish the light. A loose wick may feed the oil more regularly to the place of combustion; but there would be less than half the trouble with these lamps if the containers were recharged more often, and this also would very materially diminish the danger. When a wick requires snuffing, it shows at once that the oil has gone below the capillary powers of the wick, or, at least, below its power to raise up a sufficient supply, and the lower the oil gets, the more frequent the snuffing, and the more heat generated, and, therefore, refilling the container before this occurs would save the bulk of annoyances, and help to remove the bad repute these lamps bear. But, however well these lamps may be constructed, they are not good things to carry about, especially upstairs, or down cellars, or along draughty places unless the light is previously lowered. And now in regard to J. Hughes's letter (24023, page 82), I am surprised at his wonder at Sir F. Abel's recommending metal containers for paraffin lamps, and at his statement that it is at variance with practical experience. What are the containers used in stoves but metal, and the lights much nearer the containers than in the lamps? Then look at the optical lanterns: these, again, are all of metal, and for three years I worked optically several of the "Silber" lamps, all of brass, chimney excepted, and each lamp worked to its utmost limits and with but very little surrounding air to cool them down; in fact, I have myself been almost baked with the heat from them, and this of a cold wintry evening, and never had the slightest mishap with any of them. Then, again, there are thousands of street lamps in America consuming paraffin, and the containers to all of them are of metal. They are made by a firm which has a factory in New York and another in Chicago, and even if there were positive danger in using metal containers, the interposition of a washer of cork about ⅛in. thick between the burner and the container would prevent its descent.

I know of one firm which, even now, interposes a stratum of cork, but thinner than what I have stated; but as the connection of the burner is on the locking principle instead of screwing into the container, this cork is used to prevent the "creeping" of the paraffin through the joint. I should rather think that the makers have adopted the opal glass or earthenware containers rather for cheapness and variety, as well as profit, without any regard to the slight difference in conductivity.

Then we have letter 24127, from Mr. P. Ward, wherein he is full of the praises of "Martin's patent duplex." The lamp which I was induced to purchase of their make does not bear out what they advertise. Their circular before me states that this lamp will burn 18 hours, maintaining the same light throughout, without its being necessary to touch the wick. Now the lamp I purchased does not contain six hours' supply, and as to maintaining the same light throughout, that can never be accomplished where the supply depends entirely upon capillary attraction. J. Hughes, at page 82, says few wicks have a pull beyond 4in., and I can go further than that, and assert positively that the action, or "pull," is a declinining one in every such lamp in existence before the 4in. is reached, while in some lamps where the containers are more the shape of inverted cones, the decline begins after the first hour of lighting up. Now, I ask, How can a light maintain an equal brilliancy throughout when every half-hours' record shows a decrease in the consumption, and this is my experience with the very best made lamps. Now, Mr. J. Hughes's statement of a 4in. pull is in accord with mine, when I say that even Martin's lamp is subject to the same laws as all others, and as my lamp of their make is from 6in. to 6½in. from tip of burner to bottom of container, it exceeds the line or depth of pull by 2½in. I have tested them and a great number of others of the very best makers during the last two years—tested them for six hours at a time, and have taken a record of the consumption to the grain every half-hour, and of course those lamps which consume the most or give best or greatest light, show the greatest decline.

**G. R. Postlethwaite.**

## MUSICAL SCALE.

[24195.]—IN letter 24135, page 151, Mr. Hunt asks me to state what properties notes must possess in order to have the quality of being in tune. I answer that the properties depend on whether the notes are heard singly in succession, as in an unaccompanied air, or whether they form component parts of the chord of a harmonised piece of music. In the former case experiment shows that the notes, to be in tune, must be those of the melodic scale derived from the series of consecutive perfect fifths. In the latter, experiment equally shows that the notes must be those of the harmonic scale. Why it is that in either case these notes, and these alone, give to the musical ear the feeling of satisfaction which is expressed when we say that the notes sound in tune, is a mystery which we can no more explain than we can tell why one substance tastes sweet, another sour, another salt, or why one kind of light gives the impression of red, another of green colour. Nor have we advanced one step towards a solution when we have disconered a mathematical law regulating the external phenomena which produce the sensatory impressions. There is no *à priori* reason why a certain combination of harmonic sounds should be pleasurable rather than the reverse. We can only take note that such is the fact. It seems to me that what Mr. Hunt says about simple and complex ratios is beside the question at issue, which is one to be decided experimentally. He appeals to the experience of pianoforte tuners. That experience I claim as strongly supporting my case; for the tuner's chief difficulty is to abstain from tuning according to the natural or melodic scale, to which his musical ear constantly tends to make him revert. The pianoforte being essentially an instrument for the performance of harmonised music, the harmonic scale is the one to which it must, as nearly as possible, be tuned; therefore, in tuning each note the tuner adjusts its pitch with reference to that of certain other notes, which, for that purpose, he sounds along with it. But, in consequence of the limitation of the instrument to 12 notes per octave, he has carefully to avoid tuning to the exact harmonic intervals, and he shows his skill by giving just the necessary amount of avoidance and no more. The result is, or should be, that the piano is tuned to the scale of equal temperament, which is mostly intermediate between the harmonic and melodic scales. Of course the equal-tempered scale is not perfect, and the melodic one is positively bad for the production of good harmonies. I never asserted otherwise. But harmony in music I believe to be a comparatively modern and artificial development of the art. Melodies (and very beautiful ones, too, as, for instance, some of our old Scotch airs) were composed and became popular before the facts and laws of harmony were known—even before the melodic scale had acquired all the seven notes of our present diatonic. I am somewhat puzzled by Mr. Hunt's assertion that "no one has set any other values" on the fourth and fifth intervals than ¾ and ⅔. Even in his last letter, page 129, he implies that there must be two different values for the fifth interval D—A in the scale of C, by assigning two separate measures to the D. From D grave 0·9 to A 0·6, is, of course, a ⅔-interval; but surely from D acute 0·88 to the same A is another and a different one. But, perhaps, there is another A (omitted by Mr. Hunt) corresponding to the D acute, which will give the correct interval. The same ambiguity rests on the fourth interval D—G. Here it is the interval reckoned from D acute, which is the correct (¾) one. Are there two G's also corresponding to these two D's? Again, Mr. Elphick, page 37, expressly says that both the fourth and fifth intervals have three different values, according to the part of the scale in which they occur, and he states these values in fractions. There is another statement of Mr. Hunt's which is curious—namely, that the ear asks for a change of three notes to fit a scale for modulation into the next remove. Musicians are generally agreed that a change of one note is sufficient, except when the modulation is into the relative minor key, when two notes are changed in ascending passages. But musicians use chiefly the equal-tempered scale, and Mr. Hunt says the changeable notes are in the "composite" scale, which he has given on page 10, No. 1041; but he does not indicate the three notes in it that are to be changed for any particular modulation. Since writing the above, I have seen Mr. Elphick's reply to my correction of his mistake regarding the interval B—F. He now calls it the diminished or imperfect fifth; but as that interval is not what is known as "a fifth" either in melody or harmony, I think he might have acknowledged his error, instead of implying that in pointing out that the interval B—F is not a fifth, I am in opposition to "our good composers of the past," &c. To him, as to Mr. Hunt, I have only to say that although the harmonic or simple ratio scale is the correct one to be used in harmony, it does not give true intonation to pure melody, and that the melodic scale does. —*Proof experimental.* **W. Hardie.**

Joppa, 28th April.

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The regulations made under the Metropolis Water Act make it necessary that lead pipes should be of the following weight:—⅜in. diameter, 5lb. per lineal yard; ½in., 6lb.; ⅝in., 7½lb.; ¾in., 9lb.; 1in., 12lb.; 1¼in., 16lb.

# REPLIES TO QUERIES.

*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

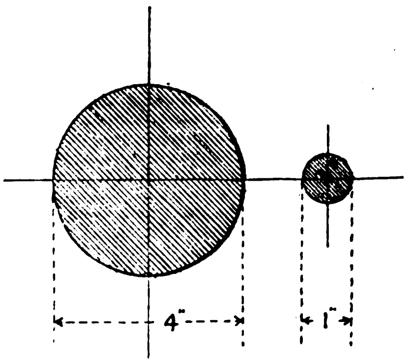
[53164.]—**3in. Spark Coil.**—I am very much obliged to Mr. Ernest Baugh for his reply, and will adopt his suggestion when I make my coil. Some time ago I thought of making one with discs of paraffiued paper; but, on testing a number of discs made in the manner directed in "ours," I found so moderate a spark would pierce them that I concluded I did not know how to make them sufficiently well to construct a coil with them, and therefore gave up the idea for the time.—B. Harcourt.

[54721.]—**Fine Adjustment for Microscope.**—On Sept. 26 I inserted a query under the above heading. This Mr. Lancaster asked me to repeat, which I did on Feb. 6. As he has not replied, will some other reader kindly help me, as I am anxious to finish the instrument?—Sempervivo.

[54825.]—**Salt, &c.**—"Dens" says "Backwoodsman" admits that wheat was choked off in the fifth season, &c. I suppose he spoke from America. As is well known, wheat is not indigeneous (native) to that country, so, of course, being merely introduced and acclimatised to America, plants native to America would, as being fittest to the surroundings, overwhelm and choke off wheat naturally. In my country, at all events, we have cereals wild in their natural state, such as wild oats and barley. Wheat is not a native of Germany, nor England, nor America; but, most probably, Africa, Asia, and Southern Europe, and if left there to itself, will propagate itself, and only deteriorate in quality. As is well known, cultivation will improve the quality, and often alter the nature of plants, trees, and animals. As to corn and baked cakes of bread having being found fossilised in the geological strata, I never heard of it before. Perhaps "Dens" can tell us when and where? I have read of fossils of bones of cave lions and hyænas, and also of stone hatchets found in river drift and caves; but never of relics of what can be called civilisation.—F. W. H.

[54825.]—**Salt.—Origin of the Cereals.**—Admitting that "Dens" may be correct in asserting that wheat will not survive one year in this country if left to itself, I would point out, that is not the question; for what we want to know is what the wheat of (blank) years ago did, and what it sprang from. "Backwoodsman's" evidence was a trifle more scientific than "Dens's" counter-assertion, and the "choking off" is exactly what one would expect, for plants developed by cultivation invariably run back when left to themselves, and are crowded out by more sturdy weeds. The origin of wheat has always been a curious subject of speculation to those who look a little deeper than the writer quoted by "Marienberg"; but the experiments of M. Fabre are generally held to afford strong evidence that wheat has been developed from a wild grass of Southern Europe and Western Asia, which the botanist calls Ægilops (see *Journal*, Royal Agricultural Society, Vol. XV.) It does not seem to have occurred to some that if a "special design" is accorded to wheat, it will be necessary to assume the same origin for rye, barley, oats, rice, maize, Eleusine, Bromus, Poa, Sorghum, Penicillaria, &c., all of which are staple food producers in different parts of the globe. It is much easier to believe that they have been developed by cultivation, just as we *know* that our modern fruits and flowers have been developed.—Nun. Dor.

[55700.]—**Strength of Shafting.**—In the "E.M." of April 24th, "Glatton," in reply to "One Ignorant," says: "The 6in. shaft comes out exactly nine times as strong as the 2in. one. I inclose a demonstration of the fact that the strength of a shaft varies as the cube of its diameter. Is not "Glatton" "at sea" here? For the assertion that he makes that a 6in. shaft is nine times as strong as a 2in. one, is not borne out by the fact that he professes to demonstrate; which demonstration he finishes up by saying: "That is, a shaft which is double the diameter of another, is four times as strong. In the same way it may be shown that a shaft three times the diameter is nine times as strong." Now, the demonstration that I inclose will, I hope, set "Glatton" right, and prove to him that the strength of shafts does vary as the cubes of their respective diameters. In the accompanying sketch, let Figs. 1 and 2 represent two shafts whose diameters are in the proportion of 4 to 1; then the strength due to the sectional areas is as 16 to 1. But the strength is increased by leverage in the proportion of 4 to 1; therefore the total relative strengths are as (4 × 16) 64 : 1, which is the proportion of the cubes of the diameters.—G. O. T.



[55700.]—**Strength of Shafting.**—Errata.—In my reply on page 174, in the last three sentences, for "four" read *eight*, and for "nine" read *twenty-seven*.—Glatton.

[55930.]—**Self-Winding Watches.**—In a memoir of M. Guinaud in the *Mechanics' Magazine* for 1825, Vol. III., p. 293, occurs the following paragraph:—"It was not until some years afterwards that an acquaintance of his, M. Recordon, having proceeded to England, where he obtained a patent for the invention of self-winding watches, which were then in great request, brought him (M. G.) from that country, some flint-glass." This visit of M. Recordon's was apparently between 1770 and 1780.—Murano.

[55957.]—**Stop Watch.**—Will "Englethwaite" please excuse delay in thanking him for reply to the above query? His idea is very ingenious, and quite applicable to the required purpose, save in one particular—viz., the reading off. As the pendulum moves with varying speed, the arc would require to have unequal divisions to indicate equal portions of time, and it is obvious that the reading could not be depended on to the required degree of accuracy if the pendulum was stopped near the limits of its swing. Can "Englethwaite" suggest any device for overcoming this difficulty?—Pendulum.

[56025.]—**Trueing Grindstone.—Patent Law.**—I reply to "Nun. Dor.," and so as to clear the ground, I give the exact words of the granting part of the patent, which is also prohibitory, and the actual words of the prohibition contained in the patent: "Know ye, therefore, that we, of our especial grace, certain knowledge, and mere motion do, by these presents for us, our heirs, and successors, give and grant unto the said patentee our especial license, full power, sole privilege, and authority that the said patentee by himself, his agents, or licensees, and no others, may at all times hereafter during the term of years herein mentioned, make, use, exercise, and vend the said invention within our United Kingdom of Great Britain and Ireland and Isle of Man, in such manner as to him or them may seem meet, and that the said patentee shall have and enjoy the whole profit and advantage from time to time accruing by reason of the said invention during the term of 14 years from the date hereunder written of these presents. And to the end that the said patentee may have and enjoy the sole use and exercise and the full benefit of the said invention, we do by these presents for us, our heirs, and successors, strictly command all our subjects whatsoever within our United Kingdom of Great Britain and Ireland and the Isle of Man, that they do not at any term during the continuance of the said term of 14 years, either directly or indirectly, make use of, or put in practice, the said invention, or any part of the same, nor in anywise imitate the same, nor make or cause to be made any addition thereto, or subtraction therefrom, whereby to pretend themselves the inventors thereof, without the consent, license, or agreement of the said patentee in writing, under his hand and seal, on pain of incurring such penalties as may be justly inflicted on such offenders for their contempt of this our Royal command, and of being answerable to the patentee according to law for his damages thereby occasioned." Now, I can assure "Nun. Dor." that the old proceedings at law used to state both the granting part and the prohibition, and the language used by the judges shows what I have said—viz., that the grant, "and none others," are words of prohibition. It has also been decided that to make a patented article for the purpose of experiment, and not for the purpose of using it for profit, is not within the grant or prohibition, and is, therefore, not an infringement. This is not a publication for a legal argument, or a reference to decided cases, but "Nun. Dor." will find that both Webster and Hindmarch's books treat the grant as a prohibition as well as the prohibitory clause itself; in fact, the words of the prohibition would not be large enough to prevent "making" or "selling"; as the words in the prohibition, as "Nun. Dor." correctly quotes them, are only "make use of," "put in practice," or "imitate." If you take the grant and prohibition together you have prohibited by exclusive "grant" and by express prohibition "making," "using," "exercising," "vending," "make use of," "put in practice," "imitate." I think I have thus shown wherein "Nun. Dor." is wrong. He ignores the prohibition in the grant that the patentee *and no others*, without license, are to "make, use, exercise, or vend."—A. P. Bower.

[56041.]—**Gun-metal.**—No, I am not inclined to split that hair about gun-metal and metal for guns; but until corrected I shall assume that gun-metal was originally the bronze used for making cannon—otherwise, whence the name? I know the gun-metal of the shops; but I doubt whether those who sell it are really acquainted with what it contains. Will some Woolwich reader tell us what is recognised there as ordinary gun-metal? I have heard that it is copper 8 or 9 to tin 1, or copper 16—18, tin 2½. In Hunt's edition of Ure's dictionary the only remarks under the head of "Gun-metal" are contained in a few lines about Aich metal, which is composed of copper 600, zinc 382, iron 88 parts. Under "Alloy," a gun-metal is mentioned composed of copper 90·300, zinc 9·670, and tin ·03; while bronze for cannon is said to be composed of copper 9, tin 1. Now, if any one likes to contend that the last is the true "gun-metal," why that settles the point so far as he is concerned; but if a carefully made specimen of good gun-metal of that brand is examined by the analyst, I believe he will find more than a trace of iron in it. For this reason, that "when bronze (*i.e.*, copper and tin) is melted in a cupola where a few fusions of cast iron have been previously made, its quality is sensibly improved. This result is due to the alloy of a small proportion of iron with the bronze." That is from Guettier's "Manufacture of Metallic Alloys," a work which, so far as I can find, never mentions gun-metal, but speaks of "bronze for cannon." In Knight's "Dictionary of Mechanics" (Cassell), there is a table of "Brasses and Bronzes containing Iron," from which I find that Stirling's gun-metal (patent 1846) contained copper 50, zinc 25, iron 1 to 8; Keir's metal (patent 1779) contained copper 100, zinc 80, iron 10; Rosthorn's gun-metal (Austrian), copper 55, tin ·83, zinc 42, iron 1·77. Knight quotes a number of analyses of ternary and quaternary alloys containing iron, and says "An English work of 1853 [slightly indefinite, that] cites the addition of one to two per cent. of iron to brass to give strength and sonorousness; and further states that large guns, large screws, propeller vanes, mill-brasses, railway bearings, bells, and other articles are made of a metal in which copper, zinc, tin, and iron all take part." In Spretson's "Casting and Founding" (Spon) gun-metal is said to be 80 to 83 parts of copper, 20 to 17 parts of tin. Overman, in his "Moulder's and Founder's Pocket Guide," says, that "if tin-plate scraps are melted in a crucible together with tin, and then this tin and iron alloy added to the melted copper, it will unite readily." Finally, from Percy's "Metallurgy: Iron and Steel" (Murray), I learn that sterro-metal was accidentally discovered in attempting to apply the ferriferous alloy of zinc, obtained in the process of galvanising iron, to the preparation of brass, and our distinguished metallurgist further gives the process of mixing the copper, zinc, tin, and iron, as supplied to him by Baron Rosthorn: "The iron, which must be malleable iron, is put at the bottom of a crucible with the copper upon it, and then exposed to a very high temperature. It is thus completely taken up by the copper, and when the whole is fused the tin is added and afterwards the zinc." Having thus occupied a good deal of space, I may perhaps be permitted to refer to the original query, p. 19, in order to show that at least one other person seems to be aware that gun-metal is not exactly a definite and invariable article of commerce, for the querist asked for the percentages of the different metals necessary to produce gun-metal that will resist the effect of a 3 per cent. solution of sulphuric acid. If anyone can answer that question, he will impart more information than I have been able to give.—Nun. Dor.

[56082.]—**Telephone Transmitters.**—Would Mr. Chaster oblige "Stubs" by giving a sketch and description of Hunning's form of transmitter mentioned by him, mentioning whether it works with Bell's telephone?—Stubs.

[56110.]—**Mill Bills.**—I have not had any experience with above; but as "Essar" seems to hold in contempt the additions of salt, &c., to the water used for tempering purposes, I should like to say a word or two. A short time since, not having a little water handy, I tempered a drill in the soldering solution, and was so much pleased with the result that I now temper all my small tools in sol. chloride zinc. I find a marked improvement in drills especially: they stand much better, and keep their edges longer. The only explanation I can arrive at is this: in pure water steam is formed at a lower temperature; the addition of a salt raises the boiling point; there must be less steam formed in a given time between the hot tool and the cold water, in consequence of which the cooling is performed more quickly. I am aware that the heat-conducting power of water is almost nil; but may not the addition of large quantities of certain metallic salts improve it? Such small quantities as 2oz. or 3oz. to 1 gallon of water must, however, be quite useless.—Zinc Sulphas.

[56140.]—**Ozone Bleach.**—Is this anything more or less than peroxide of hydrogen?—full particulars of which can be found in back volumes.—A. K. C.

[56145.]—**Wimshurst Machine.**—This query is one of that peculiar variety which appear to proceed from people who have no notion of helping themselves. The description of the "symptoms" is puzzling, to say the least of it, and it would be necessary to see the machine to give useful advice. The querist can help himself by reading up what has been written in back volumes from XXXVI. onwards. The querist constructed his machine "from descriptions given in the papers"; whether the "papers" are at fault, or his workmanship, remains to be found out.—Nemo.

[56149.]—**Calorimeter.**—This querist cannot do better than make his choice from Ganot. What does he think would answer in place of mercury?—J. C. T.

[56157.]—**Edison's Electric Pen.**—The patent was taken out in October, 1875. The £50 stamp was paid on Oct. 22nd, 1878, and the £100 stamp on Oct. 19th, 1882; so that the patent will not expire until Oct., 1889. The validity of this patent is still unchallenged. What "R. E. G." refers to I believe to be a patent of Edison's for microphones, in which he (Edison) claimed also the phonograph. This latter has been disclaimed, in order that the former may continue good.—John E. Chaster.

[56157.]—**Edison's Electric Pen.**—This query should be put to a patent agent, or to some one who can spare the time to go to the Patent Office and ascertain whether or not the patent has become void. The mention of "renewal," however, leads to the suspicion that the querist means the American patent. If so, things are dreadfully mixed, and the querist will perhaps say what it is he wishes to know. I think he will find it was the phonograph that was mixed up with the telephone.—Nun. Dor.

[56158.]—**Injector.**—I would suggest that the patentees of this injector would gladly give every information, for if it is to be fitted to a boiler by some one who does not understand it, I should not be surprised if it goes wrong.—Essar.

[56159.]—**Model Engine Boiler and Boat.**—The boiler described on page 153, in reply to query 56240, would be about right for your engines, which, by the bye, seem to me to be decidedly out of proportion as regards the height (11in.) compared to the cylinders. The boat should be about 5ft. long, 9½in. beam, and 9in. deep inside, built of XXXX tin strips about 1½in. wide, and soldered on a wire frame properly set out to the shape of the intended hull. Some builders of this description of hull strike up a wood mould and lay the strips to this, and then solder. Wooden hulls for steamers are not of much use, as they in time warp, crack, and get charred with the heating and cooling of boiler and fire. Boat-building of this description could not be gone into details without taking up a great deal of space in this paper, and I hardly think it would be of sufficient general interest to warrant such a description, or should give a description of one of the several splendid racing models I am intimately acquainted with.—S. Austel.

[56162.]—**Model Footplates.**—If I understand Mr. Shakespear, some of these are done with a file, others with a tool in the planer.—J. M.

[56164.]—**Applegarth Battery.**—In some forms of the batteries manufactured by Mr. Applegarth there is a central rod of carbon round which adheres a depolarising mixture, which I suppose to be peroxide of manganese and carbon. This is enveloped in felt and inside a cylinder of zinc, the whole being placed within a porcelain or other cell. The charging solution being a saturated or strong sol. of sal-ammoniac. If this be the form that Mr. Colley has, he should first see that the zinc is in good condition and well amalgamated, then, secondly, recharge with a fresh solution as above, having previously well washed the battery out with hot water. If this does not mend matters, he may be sure that the agglomerated block of carbon and surrounding mixture requires replacing. This can only be supplied by the maker or his agents. If, however, the battery be one of Mr. Applegarth's newer forms, in which the zinc rod is suspended from the cover, and the said zinc being within a carbon-containing vessel, forming as it does the negative pole—in this form the battery may be recharged by a saturated solution of sal-ammoniac. In this battery there is no attempt to prevent polarisation by chemical means; but owing to the very large carbon surface as compared with the zinc, this battery for ordinary bell-work, or wherever a constant current is not required for many seconds at a time, acts admirably.—John E. Chaster.

[56166.]—**Damp Workshop.**—Is this querist quite certain that the roof does "let the rain through?" What with his planking, his tar, asphalte, cement, &c., if the roof does let the rain through, he must have done the work in a very peculiar manner. Does the rain "pour" into the workshop, or is it condensed vapour which drops down from the roof?—Cyrax.

[56169.]—**Spectacle Lenses.**—The D in the formula means "dioptrics," the + convex, and − concave. The dioptric is Prof. Donders' unit—viz., a lens with a focal length of one mètre, and corresponds to the old 1-40th. Thus 4 D corresponds as nearly as possible to the 1-10th or 10 English inches. The querist will do well to take advice that in selecting spectacles it is as well to drop one's likeings, and allow an expert to settle the matter. Nowadays pebbles are only superior in that they are lighter, thinner, and harder. Pebble or rock crystal is readily distinguished from glass by its greater coldness to the tip of the tongue.—Nun. Dor.

[56172.]—**Locomotive Mechanics.**—We have any amount of interminable discussions about interchangeable mandrels, but no one seems to take notice of a really practical query like this. I have not had any experience with locomotives; but I should say that it would not be necessary to lengthen the back-gear rod when shortening the forward one—the link would make that right. What do our mechanics say, or are they frightened by the long words of the lathe-treadlers?—Centrebit.

[56173.]—**New Battery.**—If this querist will say what it is he really wishes to know, I will endeavour to help him. He appears to be acquainted with the fact that the Pabst cell is made with carbon and wrought-iron plates dipping into a solution of ferric chloride, and yet he asks "how to make."—Nun. Dor.

[56173.]—**Pabst Battery.**—To "F. Q."—This battery was patented by Dr. Pabst in England in 1883. The inventor claims: 1st. Elements of carbon and tin in a 10 per cent. ferric chloride solution or stannic chloride solution. 2nd. Elements of carbon and iron in an 8 to 14 per cent. ferric chloride solution. 3rd. Elements of carbon and iron in an 8 per cent. ferric chloride solution containing 4 per cent. of stannic chloride. To prevent polarisation, the inventor states that "This invention has for its object to employ atmospheric oxygen for the purpose, and consists in the employment as the electrolytic liquid of the aqueous solutions of the chlorides of such metals as form two compounds soluble in water corresponding to the oxide and suboxide. The higher chloride is reduced by the metallic electrode to the lower degree of oxidation, and again becomes oxidised to the higher degree by the absorption of oxygen from the atmosphere. The electrolytic liquids thus act continuously. . . . The ferric or stannic chloride solution being acted on by light, it will be preferable to blacken the glass vessel in which the element is contained." The difficulties that present themselves are first the small E.M.F., which I have seen stated as low as 0·5 volt per cell, and as high as 0·78 volt. Which is correct I cannot say; but even if the highest of the two be right, it will take 5 cells of the Pabst type to replace 2 cells of the bichromate or Bunsen type, a very serious objection when it is desired to light an incandescent lamp or run a motor. Again, the battery becomes crusted up with oxide of iron, and this oxide requires constantly to be taken out. Finally, the cells must be well protected from the light, as, if allowed out in daylight when working, a considerable amount of chlorine gas is given off, which is not, to say the least of it, very pleasant in, say, a ballroom.—John E. Chaster.

[56174.]—**Dioscope.**—Here's another! Look up the indices under Telectroscope, and search for the origin of these scientific tarradiddles somewhere in New York or New Zealand.—Nun. Dor.

[56176.]—**Patent Annealed Iron.**—Surely there is some mistake about this. Where did "Melbourne" hear anything about patent annealed iron, and annealing chilled castings?—Essar.

[56190.]—**Clark's Gas Lamps.**—Should think the best way to obtain the information desired would be to inquire of the maker.—Silica.

[56191.]—**Electrotyping.**—Does this querist want to make an electro of a wood block, or what? The usual method is to take a squeeze of the wood block in moulding compo., plumbago that carefully, and deposit a "shell" of copper. The shell is afterwards heated, tinned, and filled up with an alloy resembling type-metal.—Nun. Dor.

[56192.]—**Mineral.**—I cannot say I recognise the mineral from the description; but it may be achmite or ægerine.—G. H. B.

[56193.] — **Eccentric and Oval-Cutting Chuck.**—Does this querist really mean a "working drawing," or only a sketch which will enable him to make one? If the latter, he will find Mr. Evan's description of the oval and eccentric chuck in Nos. 850, 857; Nos. 886, 887 also contain drawings of oval chucks.—Centrebit.

[56195.]—**Consumption of Coal.**—In the last volume, it was stated that the *Oregon* consumed only 268 tons per day; other figures made it 300, but of course something depends upon the quality of the coal. As a rule, these large steamers consume 2lb. per hour per i.h.p., and, knowing that, you can readily calculate the daily consumption.—ESSAR.

[56197.]—**Rusty Water.**—This water must have been rusty indeed to quite unfit it for use. The pipes ought to be kept full of water always. You might do something by running them full with lime cream, stopping up the outlet of course, and letting the lime act for a few hours.—ESSAR.

[56199.]—**Nickel.**—According to our friend Mr. Bottone, quoted in Miller's "Chemistry," nickel is harder than either iron or copper, the figures given in Miller being nickel 1,410, iron 1,375, copper 1,360. I do not know nickel bronze; but if it is argentan, packfong, it can be made harder or softer by using differing proportions; but it is usually done by rolling and hammering to harden and by heating to soften.—NUN. DOR.

[56201.]—**Fixing Battery Plates.**—"Mikros" should use the new metallic plate connections, as manufactured by Mr. Lee, 76, High Holborn. These readily allow of the zincs being removed for amalgamation, and with the fluted carbons (giving double area), also supplied by Mr. Lee, enables one to construct a battery, the nearest approach to perfection of anything I have seen. If your battery is of the bichromate type, use the New Double Bichromate Salt, as it is cheaper than the bichromate of potash, and has many advantages. See also my reply to 55916.—JOHN E. CHASTER.

[56202.]—**Clock Gongs.**—Full directions for making and tempering clock gongs in No. 976, p. 311.—NEMO.

[56210.]—**Electro-Plating.**—To "ONE IN TROUBLE."—This is a somewhat difficult task to advise you without knowing the exact state of your bath. Dr. Gore states: "If the liquid is too dense, the articles still, and deposition is rapidly occurring, the goods are liable to become covered with vertical streaks, and to receive a much thicker deposit upon their lower parts than upon their upper ones. If the density is due to foreign salts, crystals of those salts are liable to form upon the articles in cold weather, and spoil the deposit. The specific gravity of a cyanide plating solution may vary from 1·036 to 1·116 without detriment to the quality of the deposited metal." My own experience in depositing silver is to use a somewhat dilute bath, and keep it at a temperature of about 65° Fahr. (do not let it get below this temperature). Never have too high E.M.F., and take care that the current is just enough to do the work. Don't push the electro-deposition of silver, and lastly, keep the work gently moving.—JOHN E. CHASTER.

[56215.]—**Nickel.**—I am afraid Mr. Tweedale will find this impossible. Nickel is not an easy metal to deposit nicely. In the first place, the chemical methods of applying silver to glass will not permit of nickel being substituted in place thereof. Secondly, nickel will not take kindly to silver, providing there is already a film of such metal. If the nickel were required bright, it is certain that it would never stand the polishing, as this metal is extremely hard compared with silver, and the poor hold the nickel would have, would immediately cause the metal to fly off in scales.—JOHN E. CHASTER.

[56228.]—**Storage Batteries.**—The information given by "Toby" might answer your purpose admirably; but I gather from your query that you are desirous of having a portable battery, and one that can be carried about in the pocket. If so, the single-cell battery, as described by "Toby," would not be sufficient, as you would require two such, if not three, to get the E.M.F. according to the lamp. If you would say what c.p. of lamp, and how long you require same to run at a time, I can advise you. All these pocket accumulators are, however, frightfully extravagant, in that they take three or four Bunsen cells two or three hours to charge, which will cost 1s. at the least for material consumed. The accumulator when charged will give a three c.p. light for about one hour. Why not use a pocket primary battery? Such a one is made by Mr. Lee, 76, High Holborn. This would fulfil all your requirements, and will not cost more than ½d. an hour, or twenty-four times less than an accumulator, to say nothing of trouble and temper saved.—JOHN E. CHASTER.

[56230.]—**Submarine Light.**—Living as I do by the sea, and amongst a somewhat extensive fishing industry, I know full well the advantages that a submarine light would be, especially during the autumn nights. I have never, however, heard of any such light as "Trawler" refers to. As to an electric light, I am sure an arrangement could be made that should neither be too costly nor cumbrous. I will give this matter my earnest thought, and if "Trawler" should be a near neighbour of mine, I should be ready at once to go further into the subject. Any question he might ask in "Ours" will receive my immediate attention.—JOHN E. CHASTER, 28, Talbot-street, Southport.

[56239.]—**Filtering Acids.**—Perhaps the acid, which you do not name, dissolves the cotton wool. A precipitate naturally does precipitate (else why call it a precipitate?), especially in a filter where the liquid in which it is suspended is passing downwards. The precipitate tries to go with the liquid; but as the filter stops it, what is the poor dear to do but stop on (and up) "F. G. S.'s" filter? Remedy: Could you not precipitate before filtering? I should think slagwool would answer for filter; only twopence per pound ready for use. Asbestos is, I believe, not less than one shilling, and then requires opening.—MURANO.

[56240.]—**Tug.**—I regret that in replying to this query, I accidentally left out one of the most important points in the construction of the boiler—viz., the stays for the firebox. These should be of No. 18 Stubbs W.G. copper wire, and disposed so that at least four will be on every square inch of the curved surfaces of firebox.—S. AUSTEL.

[56244.]—**Skrivanoff Battery.**—The receipt for charging this battery given by "Bobadil" is for the earlier form of battery patented by Skrivanoff, and only suited for bell work and testing. I take it that what "Accumulator" requires is the more recent patent in which chloride of silver is used as the depolariser in place of the oxide of copper of the Lalande-Chaperon cell. This cell is composed of a negative pole of silver, surrounded by chloride of silver, a zinc pole, and a 4 per cent. solution of either caustic soda or potash. The battery is well spoken of on paper, though I am of opinion that it will never come into large use. To dissolve 1lb. of zinc in the battery, there will be required 3lb. 5 z. of chloride of silver, which, at 3s. per ounce, represents a value of £7 19s. The capital required to make and maintain is decidedly against it, to say nothing of the loss of silver chloride that must be incurred in transforming the metallic silver obtained back again into the chloride.—JOHN E. CHASTER.

[56259.]—**Skrivanoff's Dry Battery.**—See reply to 56244. The dry battery is of no earthly use for your purpose. The number of cells required in series will be from three to four to light your lamp. See also reply to 56228.—JOHN E. CHASTER.

[56265.]—**Lalande-Chaperon Battery.**—A 20 candle-power lamp will require 60 watts to light it. I will assume the 20 candle-power lamp to require 45 volts; therefore you require 45 volts and 1 33 ampères. The Lalande-Chaperon battery gives, in my hands, 0·6 volt per cell; therefore, to get 45 volts, you require 75 cells in series. Now as to the size of cell. Experiment has repeatedly proved to me that not less than 40 sq. in. of zinc surface are required when the zinc is parallel to the copper or iron (as in the horizontal form), and separated from the copper or iron by a distance of not more than 1½in. To obtain 1·33 ampères, you will require 54 sq. in. of zinc surface. Therefore, if you make 75 cells each of about 8in. by 7in. and 2in. deep, and on the bottom of each cell place about 1½ to 2lb. of oxide of copper, then suspend a zinc plate so as just to go inside without touching the copper or iron, when all the 75 cells are joined in series, you ought theoretically to light your lamp; but practically you will require from five to ten more, owing to fall of potential. Use a 30 per cent. to 40 per cent. solution of caustic soda. This is made by dissolving in every 30lb. of water about 9lb. of strongest caustic soda. The whole battery should be protected from the air, as the solution of caustic soda by absorption of carbonic acid therein contained rapidly becomes carbonate of soda, and therefore useless. Any further information I shall be most happy to supply.—JOHN E. CHASTER.

[56301.]—**Flower Pots.**—To "POTTERY TECH."—Flower pots are set in the kiln in bunches; that is, one pot put in another till you come to the smallest pot, then chequered up in the kiln around and around till your kiln be full, or coupled up tops to tops and bottoms to bottoms, like stacking round blocks of wood end to end. The time of firing dedends upon the nature of the clay. If it be clay that burns red, "Pottery Tech" will have nothing to do but put a bit of glaze upon a pot on the top of kiln. When that runs freely his pots are done, which he may know by leaving a deep hole in the crown of kiln.—S. ABLIDGE.

[56331.]—**Packing Flue-Pipe Hole in Roof.**—Could you not make a gland round the pipe and pack it (i.e., stuff or ram) with asbestos or slagwool (otherwise silicate cotton) and white-lead, with a little oil? Red-lead would be better. If you care to try slagwool, I will send you sufficient (gratis) by post if you would like to have it, and will advertise your address.—MURANO.

[56335.]—**Potter's Kiln.**—I think J. Townley had better build a round kiln. Will he say the nature of the clay—whether it will stand much fire or not? Then I will try to help him.—S. ABLIDGE.

[56309.]—**Parallaxes of Stars, &c., Place of Spica A.D. O.**—To answer Mr. Arkwright's query would take up far more space than the Editor would be willing to allow. The following is a list of all the stars whose parallaxes have been found by trustworthy observers and methods to exceed 0·10″

| Star | Mag. | Parallax. |
|---|---|---|
| $\alpha$ Centauri | 1 | 0·75″ |
| $\alpha$ Tauri | 1 | 0·516 |
| Lal. 21185 | 7½ | 0·501 |
| 6 Cygni | 6 | 0·482 |
| 61 Cygni | 5½ | 0·478 |
| Sirius | 1 | 0·38 |
| $\mu$ Cassiopeiæ | 5½ | 0·342 |
| Groombridge, 1618 | 6½ | 0·32 |
| Groombridge, 34 | 8 | 0·307 |
| $\alpha$ Aurigæ | 1 | 0·305 |
| Lac. 9352 | 7½ | 0·285 |
| Lal. 21258 | 8¾ | 0·271 |
| Œltyen, 11677 | 9½ | 0·265 |
| ,, 17415 | 9 | 0·247 |
| $\delta$ Draconis | 4½ | 0·246 |
| $\varepsilon$ Indi | 5½ | 0·22 |
| Bradley, 3077 | 6 | 0·205 |
| $\Sigma$ 1516 | 7 | 0·199 |
| $\alpha$ Geminorum | 2 | 0·198 |
| $\alpha$ Lyræ | 1 | 0·179 |
| $o^2$ Eridani | 4 | 0·166 |
| 70 Ophiuchi | 4½ | 0·162 |
| $\eta$ Cassiopeiæ | 3½ | 0·154 |
| $\varepsilon$ Eridani | 4½ | 0·14 |
| $\iota$ Ursæ Majoris | 3 | 0·133 |
| $\alpha$ Boötis | 1 | 0·127 |
| $\gamma$ Draconis | 2 | 0·127 |
| $\alpha$ Canis Minoris | 1 | 0·123 |
| Groombridge, 1830 | 7 | 0·113 |
| $\alpha$ Ursæ Minoris | 2 | 0·090 |

I have included Polaris, as though the parallax is less than $\frac{1}{10}$th of a second, it is the result of a large number of different determinations. "A Fellow of the Royal Astronomical Society" has given an excellent list of the elements of some double stars on page 122. Two or three figures have dropped out from that list in printing: these Mr. Arkwright may add with his pen. They are: 6 Eridani, $a$, 3·82″; $\alpha$ Centauri $i$, 79° 24; $\xi$ Boötis $i$, 36° 55′; $\lambda$ Ophiuchi $a$, 1·19″; $\zeta$ Herculis $\pi$, 209° 30′. The elements of 42 orbits have now been calculated, in 19 of which the period of revolution is under 100 years. I do not know exactly what your querist may mean by Anno Domini "0"; but the place of Spica Virginis for B.C. 4 was XIh. 42m. 17s.; 0° 9′. I know nothing about its supposed connection with the star of the Magi. The following are the ten stars having the greatest known proper motion:

| Star | Mag. | Amount (annual) | Direction |
|---|---|---|---|
| 1830 Groombridge | 7 | 7·053″ | 144° 59′ |
| Lacaille, 9352 | 7½ | 6·957 | 79 9 |
| Cord. Zone. XXIII., 1584 | 8½ | 6·206 | 66 46 |
| 61 Cygni (mean) | 5½ | 5·220 | 52 30 |
| Lalande, 21185 | 7½ | 4·748 | 186 34 |
| $\varepsilon$ Indi | 5½ | 4·598 | 122 12 |
| Lal. 21258 | 8¾ | 4·403 | 202 22 |
| $o^2$ Eridani | 4 | 4·012 | 212 45 |
| $\mu$ Cassiopeiæ | 5½ | 3·830 | 115 0 |
| $\alpha$ Centauri | 1 | 3·625 | 282 55 |

The nearest known companion to Procyon is the small star whose angle and distance, in 1882, was 323 6° : 45 4″. The close companions, supposed to have been seen by some of the Washington observers, are probably not real, and O. Struve's was shown by its discoverer to owe its existence to an illusion. The companion predicted by Bessel has yet to be discovered.—H. SADLER.

[56349.]—**Portland Cement Concrete.**—Is not the red concrete you mean, Lascelles patent? I do not know whether it is the colour that is the subject of the patent. Neither do I know what pigment that may be. Red ochre or "raddle" either, however, would go a very long way in colouring Portland cement, and could be bought cheaply where they are found. I don't know about ground clay bricks answering, but sandy bricks certainly would. I should think any dark yellow sand would become red if burnt. Yellow ochre becomes red ochre if heated nearly to redness. There is red—nearly red—sand to be had at Reigate (Redhill), Surrey. I answer this in case no one better qualified does so.—MURANO.

[56353.]—**Planetarium.**—Search Rees's "Cyclopædia," a work far too much despised. It may be bought complete for about £4. The orrery calculations—both Jovian and Tellurian—are very full indeed. For a Saturnian orrery, there are particulars of my own in the "E. M." some four years ago, I think.—ANTARES.

[56357.]—**Telephone Switch.**—To "PHONO."—Will you kindly be a little more explicit? What is the office of the automatic switch? Does it cut in a speaking, local, or through-line circuit? I know nothing of such a switch-box, with telephone hanging to it, in use on P.O. circuits. Will you say where you saw it—were you looking at a

Blake's transmitter?—and what do you want it for?—M. L. B.

[56346.]—**Sellers' Screw-Thread.**—"Nystrom," in his pocket-book, says, William Sellers makes the angle of his thread 60°, with flat top and bottom, and of the following proportions, which are recommended by a special committee appointed by the Franklin Institute of Philadelphia. For full information see *Journal* of the Institute, May, 1864, and January, 1865.

Formulæ. All Dimensions in inches:—

$D$ = outside diameter of screw.
$d$ = diameter of root of thread, or of hole in nut.
$p$ = pitch of screw.
$t$ = number of threads per inch.
$f$ = flat top and bottom.
$o$ = outside diameter of hexagon nut, or bolt-head.
$i$ = inside diameter of hexagon, or side of square nut or bolt-head.
$s$ = diagonal of square nut or bolt-head.
$h$ = height of rough or unfinished bolt-head.

The height of finished nut or bolt-head is made equal to the diameter, D, of the screw—

$$p = \frac{\sqrt{16 \times D + 10} - 2{\cdot}909}{16{\cdot}64} \quad (1) \qquad t = \frac{1}{p} \quad (2)$$

$$s = 1{\cdot}414 + i \quad (3) \qquad d = D - \frac{1{\cdot}299}{t} \quad (4)$$

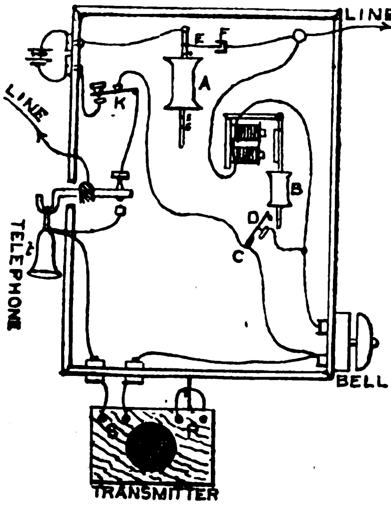
$$i = \frac{3 \times D}{2} + \tfrac{1}{8} \quad (5) \qquad o = 1{\cdot}155 \times i \quad (6)$$

$$f = \frac{p}{\ } \quad (7)$$

"Nystrom" also gives a table, with illustrations, of all the proportions, from ·25in. diameter to 6·00in. diameter. ·50in. diameter has 13 threads per inch, and 6·00in. has 2·25 threads per inch. I believe most practical men will agree that 12 threads to ·50in. diameter is too coarse for general purposes, and that 13 is far better. The table throughout is undoubtedly a modification of Whitworth's, and possibly a better one. Still, to Sir Joseph Whitworth the great credit is due, of rendering uniform and nearly universal that which was previously chaotic. Whitworth's system of screw-threads for bolts and nuts is now so firmly established that any attempt to vary would be futile.—Tubal-Kain.

[56358.]—**Chronic Cold in Head.**—Some years ago I fell into a state of health producing chronic throat and nasal catarrh, when, as a last resort, I took to Turkish baths, thanks to which, and to attention of action of the skin, I am now a quite different man. Let the querist have himself examined, and, if sound, give this a persevering trial. Locally the throat and nose may be treated daily with a gargle of sea water (easily made with Tidman's salt, say, 20 to 25 per cent. solution). For the throat use this cold, carrying the fluid well up behind soft palate; for the nose use tepid, sniffing it fearlessly out of the tumbler, held well up, and ejecting from mouth. I also call the querist's attention to what is being more and more advocated to preserve uniform warmth of the body and healthy skin action, viz., the wearing of woollen material only, avoiding linen and other vegetable fibre. On this see pamphlet published at 3, Princes-street, Oxford-street.—A. C. G.

[56361.]—**Telephone Circuit.**—I send a diagram of connections of Messrs. Brown and Saunders' individual telephone call apparatus, which, I think, is very simple. A is transmitter pendulum; B is receiving pendulum. If we fix the bob of the pendulum A at any point, it will vibrate a certain number of times in a certain time. Supposing it is set to the point marked 6, it will make the same number of vibrations as the receiving pendulum of No. 6 instrument would make in the same time. If at 5, the same number as receiving pendulum 5, &c. To call up.—The bob of pendulum A is set to the number required, key K closed, and pendulum set swinging; spring E makes an intermittent contact with F, sending intermittent currents to line. These currents pass through C and D, which short-circuit the bells, and through the receiving electro-magnet, and so on to earth. The pendulum whose time of vibration corresponds to the rate of the intermittent currents will swing, and no other pendulum on the line will move. As the receiving pendulum swings, it lifts up spring S, thus breaking contact with D, and causing the current to pass through the bell. The telephone is then lifted off the hook, and the line is open for conversation.—J. Broadbent.



[56363.]—**Pasteur's Vaccine for Splenic Fever.**—I beg to say that experiments with Pasteur's vaccine for splenic fever were undertaken at the instance of the British Government by Dr. Klein. The result was that the vaccines killed a number of the animals experimented on, and Dr. Klein concluded a report on the subject by stating, "This country is comparatively free from anthrax, and therefore the introduction and use of this so-called 'vaccine charbonneuse' seems to me most dangerous, and capable of producing incalculable mischief."—Benjn. Bryan, Secretary International Association for the Total Suppression of Vivisection. Offices: 1, Victoria-street, London, S.W.

[56365.]—**Flat Foot.**—"Pedestrian" requires a pair of boots made on lasts that are more arched in the waist than his feet are, with heels and stiffeners longer on the inside.—J. F.

[56365.]—**Flat Foot.**—First, a caution or two to a fellow sufferer. Don't pay a high price for any so-called arch-supporting boots: they simply force up the centre bones, and make a flat foot still worse. An eminent London surgeon advised me to have a strong plate of iron made into the waist. This should not be curved enough to force up the bones or be painful, but just sufficient for the arched portion of the foot to rest on. Have the boots made so that the whole of the foot stands on the sole, not a portion of it on the welt. Take particular care to leave room for the great toe to be in a straight line—not pushed toward the right on the right foot, and to the left on the left foot. The heels should not be more than ⅞in. high. They must be broad, and brought ¾in. further forward than usual. When being measured, stand on a piece of paper and let the bootmaker take an outline of the foot, leaving room for all the toes to touch the ground. The outside of the foot should be well supported. Boots so made are not ugly and clumsy-looking, and wear a long time. Thick soles do no harm. There is a valuable article on the cure of a bad case of flat foot in the *Medical Times and Gazette* of March or April, 1872. It is published at 11, New Burlington-street, London. Dr. Druitt says, "the affection depends on weakness of the muscles, especially of the *tibialis anticus* and *posticus*." He recommends that the inner edge of the heel should be thicker than the outer, and that the feet should be turned out very little in walking. He also advises that a boot with a high heel should be worn. I do not presume to differ from so eminent an authority. At one time a walk of a mile or two gave me pain. Now I can keep walking on London pavements for eight hours, and go to the top of many of the highest buildings during the time, and at the end of the day walk home without being foot-weary. I simply give my own experience as to the best cure, and hope it may be of use by saving pain to others. I adopted the flat, broad sole and low heel, but not the iron waist. Never lace boots very tight; muscles will remain weak if not exercised. R. W. J.

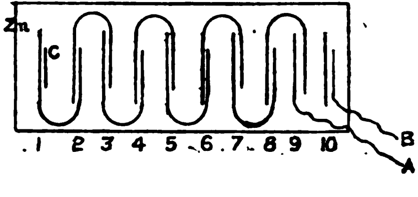
[56368.]—**Ventilator.**—If the querist will take off the elaborate top from the model referred to, and will blow at the tube, he will be surprised to find the cotton wool will be sucked up equally as well as when the top was on. A plain tube with cover to protect from rain will answer as well in most cases as fancy and expensive appliances. This was shown by experiments at Kew some years ago.—B. Boothroyd.

[56371.]—**Spoiled Negative.**—If "Sepa" moistens a piece of sponge or cotton wool with spirits of turpentine, and gently rubs over the negative, it will remove the stains easily; in fact, it will even remove gran. fog.—Photo. Publisher's Printer.

[56372.]—**Flowerpots.**—To "M. W. S."—My moulds are made of hard boxwood, attached to the lathe as a chuck, the inner mould forced along by means of the dead centre. I beg to thank "M. W. S." for his suggestion of plumbago; shall try it, and give results.—S. Arlidge.

[56379.]—**Bichromate Battery for Lighting.**—To Messrs. "Accumulator" and "Bobadil."—I am very thankful for the prompt and kind replies to my query; but I am a little perplexed to know why "Accumulator" urges the necessity of having liquid-proof separate cells (and I must say my reason dictates to me it should be so), whereas "Bobadil" appears to pass this question over as of no importance. I have now 10 earthenware jars in which I intend suspending the elements. "Accumulator" points out the necessity of having two carbons to one zinc; but does not state how much surface or solidity one should bear to the other. My zincs are $\frac{1}{10}$in. thick, 1½in. wide, and 5in. long. The carbons are $\frac{4}{10}$in. thick, 1$\frac{6}{10}$in. wide, by 6½in. long. I should wish to know whether the carbons, being larger than the zincs, are not sufficient without doubling their number; also, the quantity B. of P., and sulphuric acid and water required. After all it appears a doubtful experiment. —In the Dark.

[56379.]—**Bichromate Battery for Lighting.**—If I understand "In the Dark" aright, he has arranged and connected his battery as in the annexed diagram—A being the wire from the 9th zinc, and B the wire from the 10th carbon leading to the lamp; then what becomes of the first carbon and last zinc? Surely, "In the Dark" has not overlooked this. If this is as it should be, the total E.M.F. of the battery may be too low. A Swan lamp requires about 2·5 volts for each candle-power; a lamp of ten candle-power would, therefore, require 25 volts to work it, in addition to force required to overcome the resistance in wire, &c. Can "In the Dark" find the total E.M.F. of his battery?—he will then know if his power is enough. As a standard, I might mention that a quart Bunsen cell, with 12 parts of water to one of strong sulphuric acid in the outer cell, and strong nitric acid in the porous cell, yields an E.M.F. of 1·9 volt.—J. Kean, Northampton.



[56386.]—**Shuttles.**—Loom shuttles must be of wood tolerably heavy and very straight in grain, as they are cut away inside almost to a shell. They are tipped with steel at the points; but the friction is at the sides and bottom, where they are unprotected. The firm I am with runs about 2,000 quick calico looms, and the shuttles, some are boxwood and some ordinary teak, I think. The boxwood is best, as it wears well, and takes a fine polish with friction.—Cotton.

[56387.]—**Battery.**—This is not a battery; but only one cell. You do not say for what purpose you require to use it. Charge with a bichromate solution in the proportion of bichromate of potash, ¼lb.; sulphuric acid ¼lb., to one pint of water. You can dilute if too strong.—C. D. R.

[56389.]—**Incandescent Lamp.**—1. Electrical power is measured in watts (not volts), the product of the current in ampères by the difference of potentials in volts. 2. A comma should be inserted after "high" (third line from end), and the one after "numerically" omitted.—J. Rance.

[56391.]—**Haydon's Cutter Bar.**—I am much obliged for the replies to my query, which have greatly increased my interest in this particular cutter bar. There can be no doubt about my having a real Haydon cutter bar, because I bought it at the well-known Norwich lathe maker's. Will "J. K. P." kindly afford me the "more light" he offers. The reply of "O. J. L." is very instructive, and it is really very kind of him to take so much trouble. I should be grateful for answers to my query as to depths of cut this bar should stand under the conditions named. The shank of my cutter bar is $\frac{5}{16}$in. square, and the cutters are ¼in. square. It would be useful if the maker of this bar would make and sell a gauge, or set of gauges, for all the angles used on the cutters to facilitate correct grinding. As regards the method of grinding explained by "O. J. L.," would not the diameter of the grindstone affect the height of the grinding block and the resulting angles on the cutters? If so, some readjustment would be necessary as the stone wears.—Bellicose.

[56394.]—**Medical Battery.**—From the description, this is a Leclanché, and may have been in use several years. These small cells are very liable to get out of order in consequence of the creeping salts. If this is the case, you must clean all the connections and charge with a half-saturated solution of sal-ammoniac. If the current is still weak, the cells must be taken to pieces and fresh manganese and zincs put in.—C. D. R.

[56400.]—**Harmonium.**—You can get a full compass (5 octave) harmonium in a case 3ft. long, inside measurement, the length of a full compass keyboard (61 keys) being 33in. All the ordinary fittings can be used, saving you a great deal of trouble, making things specially, but if you only want thirty keys, your case should then be 18½in. between the cheeks: that allows you 16in. for your keyboard, and an inch and a quarter key-block each end. As regards making the reeds yourself, I should advise you not to try, as it requires great experience in making and voicing them equal, and you can get them easy and cheap.—W. H. Taplin.

[56400.]—**Harmonium.**—A compass of 30 notes is not sufficient. If the querist really wishes to make a harmonium, have, at least, four octaves, or 49 semitones. Your case being only 3ft. long, is barely large enough for 5 octaves, that is, if 3ft. is the outside measurement. A 5-octave keyboard takes up a space of 33in. in length, and a little additional space must be allowed for key-blocks, which are small pieces of wood placed at the end of each outer key. To look tidy, the space between each inside cheek should be at least 3ft. for a compass of 5 octaves. If a compass of 4 octaves is adopted, 32in. between cheeks will be quite sufficient space to allow. It is hardly worth while to make reeds, particularly as a set of 61 notes (5 octaves) can be bought for 6s. 6d., which are quite good enough for ordinary home practice. A good one-row pan can be purchased for 4s., and a passable keyboard for 12s. 6d. A person who asks, How can I tune reeds? can scarcely be considered competent to undertake the operation of tuning, and the method of flattening or sharpening the reeds has been explained more than once in the English Mechanic. "Ready made" reeds can be purchased from most musical instrument dealers; but if a few sets are required, it will be some advantage to purchase from the reed makers, who advertise in most of the musical publications. Let me advise the querist. 1st. Do not make a harmonium less than 5 octaves compass. 2nd. If you wish to economise, make all the parts that you think you can successfully accomplish, and buy all the remaining portions. 3rd. Discard the foolish idea of adopting so ridiculous a compass as 30 notes. Such a compass is not sufficient for general musical purposes with regard to keyboard instruments. 4th and last, but not least, Do not proceed further until you have acquired sufficient knowledge of the work you wish to undertake. This you can obtain from the pages of "Ours," and I am quite sure that no reasonable question with regard to the matter will remain unanswered.—G. Fryer.

[56392.]—**Cubic Feet of Air per Minute.**—

—Taking air as $\frac{1}{817}$th the weight of water, then—

$$\frac{v^2}{2g} = \frac{16\text{ft.}}{64}$$

(taking $g = 32{\cdot}5$ft.), then—

$$\frac{16{\cdot}25\text{ft.}}{65} = \frac{16\text{ft.}}{64} = 4{\cdot}0311\text{ft. per second.}$$

And air being $\frac{1}{817}$th the weight that water is, then it would require 817 × 4·0311ft. of air per sec. to maintain 3in. column of water = 3293·4087ft. The theory is that water falling from any given height would acquire a certain veloc., to be derived from the formula $\frac{v^2}{2g}$ = height named. And, therefore, if the reverse were to happen, a flow of water to be obtained by use of the same formula used in an inverse method, the height which a certain flow would maintain would be the result. If a certain flow of water maintains any ascertained head or column, then 817 times the flow of air would maintain the same head or column. 3,268ft. per sec. = ·59289 mile per sec.—G. Pinnington.

[56402.]—**Calculating Power Required.**—One would first require to learn the lengths of the lever from end to fulcrum, and from fulcrum to point of application.—G. P.

[56407.].—**Facing Stop-Valve.**—I should consider one of two causes is the reason why you are so troubled. The first is, that most probably there is a joint broken, by means of which steam escapes into the steam-chest. But another thing may, and would, cause the defect in question: did you alter the length of the starting-valve spindle? Because if you shortened it, the valve, when in the "shut" position, would still allow part of the port to be open, and through this the steam would easily keep the engine in motion. I have in practice had this occur. If you have faced the valve to its face by scraping, the leakage past should be very small indeed.—Invicta.

[56409.]—**Sulphur in Coal and Coke (Estimating).**—Powder 50 grains and put in a flask with 1oz. of concentrated nitric acid, apply heat cautiously until fumes cease, then add ½oz. more of nitric acid and boil as before, dilute result with 8oz. water and filter; add to the filtrate barium chloride in excess, collect, dry, and ignite precipitate; transfer to tube, heat with dilute HCl, recollect, wash, dry, ignite, and weigh—117 parts are equivalent to 16 parts sulphur.—B.Sc., Plymouth.

[56410.]—**Finance.**—"Sefton Park" would save £30 3s. 8d. per annum for 12 years by patching now and renewing in 6 years' time.—G. Pinnington.

[56410.]—**Finance.**—"Sefton Park" will save about four years' use of his machine by patching now. Take the position in both cases at the end of twelve years: 1, By renewing now, the total cost and interest is £1,120; 2, by patching now, and renewing in six years, patching £316; renewing £700; interest £304—total, £1,320. This exceeds the former by £200; but in the first case the machinery is done, and in the second there is presumably six years' work left.—B.Sc., Plymouth.

[56414.]—**Exhaust Pipe.**—The remedy I should apply if the exhaust be not absolutely required for forcing the draft, is to use one of two known makes of "silencing chambers." There are, in one case, an elongated box, filled with pebbles or an equivalent, so that the exhaust is checked, and passes away noiselessly. But this form, unfortunately, is dear, and produces a back pressure against the engine. The other is of a widely different construction, and is more like a circular box. No back pressure is caused by it, and I consider it superior in many respects. Both are patented. In a case where this latter apparatus was used in connection with the exhaust steam from a large beam engine which was before very noisy, the exhaust issues from the end of the pipe continuously and without noise. If our friend the querist likes to advertise his address, I will send him names and addresses of both the makers, and he can then deal with the matter with them direct, as I have no interest in the question of supply.—Invicta.

[56416.] — **Model Engines for Paddle-Boat.**—If you are contemplating a new pair of engines, and from your query on p. 178 I assume you propose to use paddles, the boat being, say, 6ft. long, the centre of the paddle-shaft should be 2ft. 9in. from the bow. Then, as to the class of engines, to save room lengthways, vertical trunks might be used; but they are not so well suited for models, because the trunk is a great source of friction, and also it is a cause of a great loss of heat on the top end stroke of cylinder. A pair of oscillators would take up, if anything, less room, and be more economical. Now if I was making such a pair of engines, I should place them diagonally, both piston rods working on to the one crank. This would mean taking up more instead of less space for the engines; but it is space well employed. The second crank is then saved, and the weights are all kept amidships. Now you might use for paddles a pair of oscillators, say, 2in. bore and 4in. stroke, with two such boilers as shown at p. 110; or you might use one such boiler, and a pair of smaller engines. The size I name will go into the boat either as verticals or diagonals. The engines should be slide-valve cylinders without eccentrics, and reverse easily as well by the movement of the one reversing lever. Crank shaft for the 2in. by 4in. cylinders should be ½in. diam. in the journals and shaft; paddle wheels 12in. diam., 5in. wide on the floats, each float being 2in. deep. Ample power also is available to work a feed pump to supply both boilers. I will be happy to give sizes for a pair of smaller engines for use with one boiler, or any additional information on any point you may desire, and I think through these pages we can put you in the way of making one of the most powerful and successful models yet afloat. At least *I* will try.—Invicta.

[56421.]—**Bichromate Cells with Hydrochloric Acid.**—I see no objection to the use of platinum instead of carbon with this solution. Probably the querist fears that platinum will be dissolved, but I do not think there is any risk of that. I do not see any advantage in the substitution however, except that platinum is more easily connected with than carbon is, and not so liable to fracture.—Sigma.

[56421.]—**Bichromate Cells with Hydrochloric Acid.**—There is no practical advantage in using platinum foil instead of carbon, let alone the cost of the former, and unless the platinum is of sufficient substance there is a positive disadvantage. The use of platinum-covered lead plates has been tried; but without any sufficient result to justify their use.—C. D. R.

[56429.]—**Mosses.**—To study these plants it is necessary to have "A Synopsis of the British Mosses," by C. P. Hobkirk (London: Reeve and Co., 1884). It is a little book, and not expensive. No plants can be easier to preserve; dry them between blotting paper under very moderate pressure, and fasten them to half-sheets of writing paper (commercial note is a convenient size). Some may be kept in small envelopes attached to the papers, the genera made up into bundles. A microscope is required to make out details of structure.—R. C. D.

[56441.]—**Sensitive Flame.**—A form of jet which I have made myself, and which in my hands succeeds well, is made as follows:—I take a piece of glass quill tube, draw it down to form a beak or jet, then cut off just above the contracted portion. Now anneal, and with a knife-edge file cut in the glass jet a V-shape. A very little does. The pressure of the gas which I use from a gas-bag under pressure has even then much to do with it. But I find the glass jets give the best result by far. They give the greatest motion, and are the most sensitive with me.—Invicta.

[56443.]—**Lathe Fly-Wheel.**—I have exactly the combination you name. The speed cone on the mandrel is made with grooves for round (or in any case V-shaped) belt. The fly-wheel is simply an ordinary shafting pulley of the right size; and I may add, it works most satisfactorily. It is, of course, not practicable to alter the speed by shifting to a smaller or larger cone on the mandrel cone pulley.—Invicta.

[56445.]—**Driving Sewing Machine.**—I should think you would most certainly find it hard work. You have neither weight enough in your fly-wheel, nor speed enough either, so that on every hand you are at a disadvantage. Your best remedy is a larger and much heavier fly-wheel; but even then the stand and parts are not suitable.—Invicta.

[56448.]—**Double Electric Bells.**—With line wire of the size named there should be no difficulty in ringing two bells well with a battery of three cells if all are in good order. As already explained in the "E. M." for Dec. 5th and Jan. 9th last, the current will in the first place elect to pass through the bell which offers least resistance, and during the interval when the circuit is broken there by the stroke of the hammer, it will pass through the other bell. The only adjustment needed is to set the bells so lightly that either will ring with one cell, or will strike instantly if a momentary contact is made through the whole circuit with two cells. You would then have ample margin with three cells to make both strike quickly enough to ring perfectly in the shorter space of time allowed to each when connected together in multiple arc. If your hammer springs are too strong to admit of such light adjustment without unduly shortening the stroke, an additional cell would probably overcome the extra tension. I have never found platinum contacts decompose by the action of the induced sparks in the manner described; even in large houses, where the batteries are usually six or eight cells, and some of the bells are large enough to give smart shocks to anyone through whom the induced current passes. But I have often met with bells presenting these appearances, and have on examination found them to be platinised with bits of German silver. In another case where platinum had been really used, it was coated with solder, which had run over it and had not been cleaned off after fixing. The contacts of the majority of French bells are made of silver, which seems to be practically as good for the purpose as platinum costing about six times as much.—R. T. Lewis.

[56450.]—**Regenerative Gas-Burners.**—I do not know the Wenham or Clark burners; but during the last few weeks I have been trying one of the Bower burners, and do not find that any shadow is cast directly under the lamp. I do not find that it heats the room more than four ordinary flat-flame burners did. It can be placed in direct communication with a ventilating tube. The light is white, perfectly steady, and gives over 6 candles per cubic foot of gas consumed. Mine burns 7½ft. per hour. I have one of Siemens' regenerative burners, but do not obtain very satisfactory results, the best regulators not supplying the quantity of gas with sufficient accuracy, and the large shadow which is cast under the burner is a very great objection. Can anyone give description of the Wenham or Clark burners?—Joseph Hall.

[56456.]—**Copper-Zinc Battery.**—The best thing the querist can do is to sell his copper plates for old metal, or, failing a market, give them away if he has no other use for them. They only waste acid and time. Let him replace them with plates of carbon, or, better still, with platinised silver. Bichromate of potash would be useless with copper plates, which are of use only in a solution of sulphate of copper in a porous jar, working as a Daniell cell. —Sigma.

[56456.]—**To Electrical Advisers.**—Get new jars and porous pots to match. Now charge as follows: In porous pots place copper and charge with sulphate of copper; fill the porous cells about three-quarters full, place zincs in outer jars, and fill both porous and jars up with water about 1in. from top; no need to use sulphuric acid. This way is best.—W. A. B.

[56456.]—**To Electrical Advisers.**—"Friar Bacon's" battery seems to be very soon polarised. He had better discard his copper plates in favour of carbon ones, which are cheap enough, and then use the ordinary bichromate solution. If he requires a powerful current for, say, an hour, let him use the battery without porous cells. If he is content to have a weaker, but more lasting current, let him use those articles to place his zincs in. The bichromate solution would destroy his copper plates. —B. Harcourt.

## UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

55927. Heating Tank, p. 549.
55937. Accumulator, 549.
55945. Lantern Condenser, 549.
55946. Electro motor, 549.
55949. Coil Shutter Springs, 549.
55952. Sheet Iron, 549.
55955. Ivory Printing or Staining, 549.
55962. Gas Reaction Wheel, 549.
55964. Circular Saw, 549.

56138. Plaster and Pipeclay, p. 67.
56141. Lobster-back Cowl, 67.
56147. Speeds, 67.
56154. Working Strain, 68.
56168. Electro-Plating, 68.
56184. Transfer Fluid for Engravings, 68.
56188. Pump, 68.
56189. Brickmaking Books, 68.
56194. Lady's Colonial Outfit, 68.
56198. Speed of Pump, 68.
56204. Calorimetry, 68.

## QUERIES.

[56460.]—**Observatory.**—I shall be obliged for some information in regard to the cylindrical-drum style of observatory. Should like to know whether it is as suitable as the hemispherical dome for a latitude where snow remains upon the ground for some time; also whether there is more danger of the drum being blown off than a dome? My observatory will go on top of the house, the telescope resting upon a chimney for a foundation. As the house will be heated by steam, and the chimney closed up, this will give a very good foundation. There is such an observatory figured in Crossley's and Gledhill's "Handbook of Double Stars," but very little description accompanies it, and I should like to know whether the sides of the drum are made of canvas, and how much pitch there should be to the roof, &c. My telescope is a 4in. equatoreal, by Cooke, with driving clock, &c., height from floor to centre of motion, about 6ft. 4in., focal length, 5ft. I thought of making the lower portion of observatory, about 10ft. square, and 5ft. high, and the drum about 9ft. diameter, and 4ft. high. Would this be the right dimensions? How does the slit in the roof work? Is there any danger of water coming down on the instruments when the slit is opened after a shower of rain?—ARLINGTON.

[56461.]—**Pressure on Sides of Tank.**—A very good and simple rule was given a short time back in the "E.M.," to find the pressure at base of any column of water, by the use of the constant 434. Would some kind friend give a simple or similar rule, to find the pressure on sides of a tank when filled with water?—J. B.

[56462.]—**Locomotive History.**—I should feel obliged if anyone could tell me what kind of valve gear was that of Messrs. J. and C. Carmichael, which was fitted to some locomotives about 1833; not being able to find it in any work on the steam engine, although it is sometimes alluded to. A diagram will not be necessary for explanation.—TELEGRAPHIST.

[56463.]—**Vertical Boiler.**—To "INVICTA."—I am making a horizontal engine with cylinder, 2in. bore, 3½in. stroke. Will you kindly help me by giving dimensions of a vertical boiler suitable for same, to make plenty of steam, and be perfectly safe?—T. H. WARD.

[56464.]—**Variable Resistance for use with Ammeter.**—In working with Ayrton and Perry's ammeter, there is considerable risk of putting the instrument out of adjustmennt, from the violent swing of the needle, if the circuit through a strong battery is abruptly closed. Can anyone suggest a simple form of apparatus by which one turn of a handle would give a resistance varying, say, from 100 ohms to nothing? I have thought of using two slender rods of gas carbon or pencil-lead, with a slider between them as in Poggendorff rheocord; but perhaps someone may know of a better arrangement.—E. R. P.

[56465.]—**Boiler Tubes.**—I want to retube a horizontal boiler with 38 2½in. tubes, 7ft. long. How far should they project in firebox and smokebox, and do they require any finishing except by the expander? Is there danger in expanding tubes too much? Should I get the tubes thicker than No. 11, B.W.G.? I have been accustomed to engineering work, but have never done anything at boiler-making, and cannot get a boiler-maker, except from a very great distance, so that any information on the above would greatly oblige.—B. P.

[56466.]—**Transit Instrument.**—I have a transit instrument, and in order to adjust it, have been endeavouring to determine time by the method of double altitudes, I should be much obliged if some one of your astronomical correspondents would inform me if the following data and calculations are right:—On p. 169 of Godfray's "Astronomy," the following formula is given for the correction to be applied for change of declination, when the sun is observed:—

$$x = \left(\frac{\tan.\ \phi}{\sin.\ t} - \frac{\cot.\ \triangle}{\tan.\ t}\right)\frac{t\ \theta}{15}$$

Where $\varphi$ = latitude = 54°3'56"
$\triangle$ = polar distance at apparent noon.
$\theta$ = small horary decrease of polar distance
T = mean of clock times.
$2t$ = elapsed time between observation.
$x$ = correction to be subtracted from T to give clock time of apparent noon.

On Oct., 3rd, 1884, observing the sun before and after noon, with a good sextant, the first contact of the real image of the sun, and that reflected in mercury, took place at 10 33 14, and the second contact at 1 27 20

$$\begin{aligned}
&\text{Hence } T = 12\text{h. } 0\text{m. } 45\text{sec.}\\
&t = 1\text{h. } 26.\ 49\tfrac{1}{2}\text{sec.} = 21^\circ\ 45'\ \text{nearly.}\\
&\theta = -\ 58.\\
&\triangle = 90 + \text{declination} = 90^\circ + 4^\circ\ 13'\ 27''\\
&\text{Cot. } (90^\circ + a) = -\ \text{tan. } a\\
&\text{log. tan. } \varphi = 10{\cdot}1398021\\
&\text{log. sin. } t \quad \underline{9{\cdot}5688555}\\
&\qquad\qquad 0{\cdot}5709466 = \text{log. } 3{\cdot}723\\
&\text{log. tan. } 4^\circ\ 13' = 8{\cdot}8676317\\
&\text{log. tan. } 21^\circ{\cdot}45' = \underline{9{\cdot}6009280}\\
&\qquad\qquad \bar{1}{\cdot}2667028 = \text{log. } 0{\cdot}1848\\
&t = -\ 87\\
&\qquad 3{\cdot}723\\
&\qquad \underline{0{\cdot}185}\\
&\qquad 3{\cdot}908\\
&\frac{3{\cdot}908 \times -\ 87}{15} = -\ 24\ 7 \text{ seconds.}
\end{aligned}$$

Hence 20·7 seconds is to be added to 12 0 45, giving 12 1 9.7, as the corrected time of apparent noon.—X. N. X.

[56467.]—**Notice to Quit.**—Could any subscriber oblige me by saying how to act in the following case: I have a person who rents a shop of me, as a monthly tenant; as I required the shop for my own use, I gave him a month's notice to quit, which expired on the 25th last, but he has not given up possession, neither has he paid the rent. Can anyone inform me how to get possession as quickly as possible, and with the least expense?—PERPLEXED.

[56468.]—**The Ochorowicz Telephone.**—Will any brother reader (or the Editor) oblige with a drawing of the above telephone? From the description given in issue of April 3rd, I really cannot make out what it is like. Perhaps someone with more intelligence has done so. I am sure this will be welcome to all telephonic readers, irrespective of—EXPERIMENTER.

[56469.]—**Skrivanoff's Dry Battery.**—To "BOBADIL."—You simply repeat "Starlight's" words of of page 119, Oct. 3rd, 84:—Boil for three hours in a glass dish, one part of oxide of mercury, and four parts of chloride of ammonia, &c. Now I think that both these substances are dry, therefore what liquid are we to boil them in, and how much of it? By so doing you may greatly oblige others as well as—EXPERIMENTER.

[56470.]—**Fitting Fusee Chain.**—I wish to fit a new chain to English bracket clock. Directions will oblige. I see nothing mentioned on this subject in last six volumes.—NOMEN.

[56471.]—**Legal.**—Having become surety by signing a promissory note, as I thought for the sum of £2, I am now summoned for the sum of £2 8s., balance of a promissory note for £4 10s., the sum of £2 2s. having been repaid. At the time of signing the promissory note, I signed my name, viz.:—"Thomas White agrees to be answerable for the sum of £2," but the money lender said it was not necessary to say that, and rubbed his hand across all but my name. Can any subscriber kindly inform me how to act. Shall I subpœna the borrower who saw me sign the promissory note?—ONE BEING IMPOSED UPON.

[56472.]—**Slide-Valve, &c.**—Will "Invicta," or any of our practical readers, please give size of slide-valve and throw of eccentric for small strong horizontal engine. I wish to cut off at quarter of stroke? Dimensions of ports:—depth, 1⅛in.; steam, $^3/_{16}$; exhaust, $^5/_{16}$in; bars, between, $^3/_{16}$in.; also say if ports are large enough, and what power it will give out with 80lb. pressure, and 800 revolutions per minute; diameter of cyl. $2^1/_{16}$in.; stroke 3¼in.?—GENERAL KOMAROFF.

[56473.]—**Corn Drill.**—Could any of our numerous readers assist me in the following difficulty?—Living in a district were there are a large quantity of allotments, we have some difficulty in getting our corn in rows, so that we can hoe it, and I should like to make a drill to take, say six rows, to be drawn by two men. Perhaps some of my fellow readers may have seen something of the kind, and would be able to help "One in a Fix." I have plenty of tools.—POSER.

[56474.]—**Training for Athletics.**—Could anyone give me any advice as to how to train for flat races, from 300yds. to one mile, which are to take place in about three weeks?—A. B. C.

[56475.]—**Nitrate of Iron.**—Will some of the readers kindly give me instructions how to make the best nitrate of iron, used by cotton dyers, and usually stands about 78 or 80 Twaddel, and is sold about 2½d. per lb. sometimes 2d., and I will give, in return, anything in my range in the chemical line?—H. H.

[56476.]—**Incandescent Lamps.**—Why is it that when an indcandescent lamp is glowing, if the glass of the lamp is broken, the influx of air into the vacuum causes the filament to be consumed almost immediately?—LIGHT.

[56477.]—**Chemical.**—Would some reader kindly inform me what is the reaction which takes place when estimating the amount of glucose by Fehling's solution? Perhaps Mr. Gray would assist me.—A. PRICE.

[56478.]—**Spectroscope.**—I have two well polished glass prisms 4in. long, and each side, 1½in. wide. Are these prisms long enough to be cut in two, to make four prisms for a spectroscope? Will any of your readers kindly inform me, and as to which is the safest way to cut them?—D. BOOTH.

[56479.]—**Surface Condenser.**—Kindly tell me if there is a rule stating how many gallons of water should pass though a surface condenser, per minute, per horse-power, and how many feet of cooling surface per horse-power in condenser?—SUBSCRIBER.

[56480.]—**Impure Iron.**—If a lot of galvanised iron and tinned iron tubing were melted down, would it make bad castings? I have always seen it so stated, but should like to know what would be the true matter with the iron.—MURANO.

[56481.]—**Diameter of Tube.**—Would some one kindly tell me, through your valuable paper, what would be the diameter of a tube made of sheet iron, about 16 W.G. in thickness, 14ft. long, to float a platform weighing about 6cwt., about 6in. or 7in. above the level of the water?—T. H. WALTON.

[56482.]—**Painting on Calico.**—I have several large calico advertising sheets to paint, but I find that capillary attraction causes the oil from the paint to spread out ⅛in. all round the letters, thus disfiguring the whole affair. Will someone tell me how to prevent this? A few hints from a practical sign painter, as to stretching and lining out large sheets of calico (say 20ft. by 12ft.) preparatory to lettering—also, the mixing of red, black and blue paint for same—would be esteemed a great favour by—AUSTRALIA.

[56483.]—**Linkwork for Slide-Valve.**—Would any reader kindly give me sketch and description of the linkwork for reversing and regulating the motion of the slide-valve in Webb's patent (L. and N.W.R.)? Can locomotives be reversed when in motion, or have they to stop before they can be reversed, for I often see the driver pull the reversing lever after engine has started—why is this?—LINKWORK.

[56484.]—**Varnished Wall-Paper.**—I have seen such paper, after having become dirty and smoky with time, restored again so as to make it look quite new. It was simply washed down with something I would like to know. Can any kind reader oblige by telling?—VIRAGO.

[56485.]—**Model Boat.**—I wish to build a model boat about 4ft. long. I intend to use the ready-cut wood used for window blinds. How broad should the boards be? How much should one board overlap the other? How are they to be fastened to the ribs and to each other? What kind of wood for ribs, and how many pairs of them should there be? An answer would greatly oblige—VIRAGO.

[56486.]—**Pressure.**—In using a hydraulic jack for compressing ensilage, can any correspondent inform me means to arrive at the amount of pressure applied at any time during the process? May add the jack I purpose using is up to six tons.—ROB. HARRIS.

[56487.]—**French Polishing.**—Will some kind readers of "Ours" give me instructions how to use French polish, and also to finish my work? I have tried many times, but I cannot succeed. I may mention that I require to polish chiefly old work; but any hints will greatly oblige—TURK.

[56488.]—**Zinc Battery.**—I am constructing some chloride of zinc batteries. Would they be much stronger if I used cylinders of zinc to go all round the porous cells instead of zinc rods?—E. A. WILLIAMS.

[56489.]—**Solar Eclipse.**—To MR. JOHN GRIGG.—Would Mr. Grigg kindly communicate full particulars, with diagrams, of his plan of photographing the sun by the aid of a 3in. telescope and ordinary plates? Was the photo. taken direct and enlarged afterwards? I feel sure that a full description would interest others besides—H. A.

[56490.]—**Wooden House.**—Will some reader kindly inform "C. G. P." if he knows of a builder of wooden houses; if they answer in this climate, and if he can see them in London or elsewhere erected and occupied?—C. G. P.

[56491.]—**Long-Distance Electro-Magnet.**—Will some practical friend kindly give me an idea how to make the above, as the ordinary electro-magnet is not strong enough for the purpose for which it is needed?—W. A. G.

[56492.]—**Jacket Pan.**—I want to work a jacket pan whose temperature in the inner pan shall range from 450deg. to 500deg. Fahr. The outer pan will be heated by a coke grate beneath it. I am anxious to learn what material is most suitable for use in the space between the two pans. I have thought chloride of calcium might answer, and also any substance (if not too expensive) driven off from tar by distillation at not below 500deg. Fahr. Will any reader be so good as to inform me whether either of the foregoing is suitable as a heat carrier from outer to inner pan, and also mention any materials that may be better adapted?—S. S.

[56493.]—**Waterproofing Tennis Racquet.**—Can any one tell me what to put on the gut of a tennis racquet to make it waterproof and last longer? I have had a racquet with black stringing which lasted tight and did not wear for years. What was put on the gut to make it so, and can it be done after the racquet is strung?—ARYAS.

[56494.]—**Soapstone Firebricks.**—On page 75, No. 965, Sept. 1883, of "Ours," it was stated that an American company had been formed for the manufacture of soapstone firebricks, for which it was claimed that they would not slag, and were superior in every way to ordinary fireclay. Can anyone oblige with any further information regarding soapstone bricks? I wish to know where the company's works are? The American Consul-General, in London, knows nothing of it. Perhaps some cousin of ours in the States does, and would oblige—MURANO.

[56495.]—**Feeding Bottle.**—Will one of your numerous readers kindly inform me how to prevent an ordinary feeding bottle from acting as a siphon, and thus causing the baby's clothes and bed to be wetted? This is a very small matter, but a very unpleasant one for persons troubled with it.—MORGAN THOMAS.

[56496.]—**Mineral Customs of Derbyshire.**—I should be glad if some one would inform me whether there is any treatise on the mineral customs of Derbyshire relative to the lead mining districts?—ANXIOUS.

[56497.]—**Sellers' Screw Thread.**—To T. L. REID, AND "ABEFES."—Will one of these correspondents kindly supplement the information given in their previous answers to this question, by explaining the principle upon which the formula for determining the relation existing between the diameter and pitch has been constructed? I should also like to know if this Americanism is supposed to possess any advantages over our ordinary Whitworth thread?—J. A. C.

[56498.]—**Linen Manufacture.**—Dr. B. W. Richardson states, on authority of Dr. Purdon, of Belfast, that in some linen factories if a girl under 18 gets a card she very rarely lives beyond 30 years, if she be constantly employed at her work, as she dies of consumption. Does this represent the facts of the case? What are the facts, as regards health, in the various departments of the linen manufacture? Can the evil effect of the dust be prevented by use of respirators? Are the high temperature and moist air injurious in practice where they exist? Does the same apply to all flax and hemp work, e.g., making of tow, canvas, thread, &c.? Will someone who knows kindly answer?—J. W. B.

[56499.]—**Electrical.**—Will you please rectify error committed in inserting my last query, two brushes being put instead of pushes? Please insert following: Will anyone tell me how I can fit two bells in one circuit, viz., one bell at each end, on one wire with two pushes one each end with battery at one end? I can do it with reversible pushes and battery at each end, but it is inconvenient? Please illustrate by diagram.—Crutesta.

[56500.]—**Gravity Leclanche.**—Mr. Preece, in his Cantor lectures, describes this battery, see Vol. XXX., "E.M." p. 160. He says, "The carbon plate is inserted in the usual mixture of crushed carbon and peroxide of manganese, passing through the zinc plate. Sal-ammoniac is placed on the zinc plate, and each cell is nearly filled with water." Can anyone give me a rough sketch of this zinc plate—it is evidently of special construction? The only weak point about the arrangement seems to me to be in the carbon passing through the zinc; of course there would be a large hole in the zinc plate so as to leave a good clear space all round, but then the battery would be short-circuited unless the carbon was well insulated. What is the best material to use for this purpose, and how far down should the insulation extend into the carbon mixture? Can anyone say from actual experience, if a cell, made as above, will last as long, and give a greater electro-motive force than one fitted with a porous cell, or is its only advantage in having the internal resistance reduced by doing away with the porous cell?—F.R.Met. Soc.

[56501.]—**Dynamo.**—*Re* letter No. 24107, of page 147, April 17. Will Mr. S. Bottone kindly answer the following queries relating to the above? Are the cogs and ring in one piece, and is the wire wound on the cogs or in the channels and thus enveloping the ring? What sort of iron (cast or wrought) are they made of? How are the sections of wire connected together, and to the commutator, and how many breaks are there in the commutator? What distance are the pole pieces apart when mounted? How would such a dynamo work if wound with No. 10 wire on field magnets and No. 12 on armature?—A. E. Slater.

[56502.]—**Faulty Dynamo.**—To Mr. Bottone.—I have put together one of Jones's 70 c.p. dynamos laminated armature, 10lb. 20 c.c. wire on magnets; 1¼lb. s.c. 20 on armature; at 2,000 revolutions it would not light two 10 c.p. lamps. I tried it in series—no better. I took off armature ¼lb. of wire, tried it again, with better results. I then took another ¼lb. off armature: it then lit up two 10 c.p. lamps properly. What was the matter that I could get no light at first? What should the resistance be between F.M.'s and armature, and how many revolutions a minute? Space for wire on F.M.'s 6 by 4; armature, 5 by 2⅜.—C. B.

[56503.]—**Motor.**—To Mr. Bottone.—By the current dividing, I mean that the armature and field-magnet were connected in parallel circuit, and this arrangement was not so good as the usual series. The former I used as a rough test only to see if the magnets were of equal power. Whether Bunsen or bichromate quart cell be used, the result is the same, viz., a good start lasting a minute or so, and then a gradual but constant slackening until almost total stoppage in five minutes, just as if the soft iron armature was polarised or its coil short-circuited.—Chingford.

[56504.]—**Hand Dynamo.**—To Mr. Bottone.—Will Mr. Bottone kindly say what sort of strap he uses for driving hand dynamos, also whether he runs it straight or across? I have made one of these machines, but find great difficulty in getting any strap to drive it. The difference between the driving and driven wheels is so great, that if the strap is run straight, only a very small part of pulley on armature is embraced by the strap; whilst, on the other hand, if run across, the wheels are so close together as to cause considerable friction at the crossing. Any information as to kind of strap used, also by what method it may best be joined, will be much esteemed by—Iota.

[56505.]—**Gas.**—To Mr. Fletcher or any of "our" Correspondents.—Will you be so kind as to tell me how to get the quantity of gas that will flow through a pipe ¼in. internal diameter at 1in. pressure, and if it would be twice as much at 2in. pressure, and so on? Hoping that some one will answer in plain figures, as I do not understand algebra.—Young Gas Man.

[56506.]—**Pattern Making.**—To "J. H."—I have got the numbers you advised me to get, and they contain the very thing I wanted, except the bracket for the half-nut for leading screw, and rack. If you would be so kind as to let me have a sketch how it is to be made, I will feel greatly obliged to you, and what number of teeth on each wheel of a train of 22 wheels, the first to have 20 teeth, as I have a lot of wheels that will do, it will only be a few I will require to get.—Busby.

**Restoring Spotty or Stained Negatives.**—This may often be satisfactorily done by converting the image into chloride, and redeveloping with oxalate developer. Belitzki dissolves one ounce of alum in a pint of water, and then adds to this 140 grains of bichromate of potassium and three fluid drachms of strong sulphuric acid. The negative is allowed to remain in this solution until it has become thoroughly yellow, after which it must be very thoroughly washed indeed. It is now exposed to a bright light for some minutes, and then immersed in the oxalate of iron developer until it is quite black. Now rinse, soak in a solution containing one part of citric acid to fifty of water, and finally wash. The point most to be noted is a thorough washing after the bichromate bath.—*Photographic News.*

# ANSWERS TO CORRESPONDENTS.

⁂ *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

## HINTS TO CORRESPONDENTS.

**1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.**

**⁂ Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.**

## BACK NUMBERS.

We receive so many queries asking for directions how to make many instruments and appliances which have been fully described in back volumes that we have compiled a list, which we shall insert in this column at intervals, of those most frequently sent, and as the numbers are still in stock, new subscribers should consult the list before sending their questions.

Batteries: Nos. 741.
Bookbinding: Nos. 613.
Copying processes: Nos. 750, 753.
Electric machines: Nos. 628, 759, 840.
Electro-magnets: Nos. 756, 772.
Lacquers: No. 866.
Pattern Making: Nos, 938, 941, 943, 945, 948, 950, 952, 954, 955, 956, 958, 959, 962, 963, 965. 969, 973, 974, 978, 981, 986, 989, 993, 995, 998, 1,000, 1,001, 1,003 1,004, 1,008, 1,009, 1,010.
Silver-plating: No. 830.
Telephones: Nos. 695, 747, 865.
Varnishes: 478, 619, 675, 691, 723, 775.

**The following are the initials, &c., of letters to hand up to Wednesday evening, April 29, and unacknowledged elsewhere:—**

Smith and Coventry.—W. Saunders.—J. L. Gallard.—H. Milnes.—W. W. Breston.—D. Allingham.—J. J. B.—F. M. Rogers.—Anxious.—J. Kean.—J. C. Barter.—E. C.—E. B. F.—Legal.—Lantern.—An Amateur.—W. J. Abel.—Vandu.—G. R.—C. L. F.—W. L. Bevins.—Box Handle.—R. Forrest.—T. O. T.—W. H. Eavis.—Harmonica.—W. H. Elphick.—E. C. Oswald.—Verax.—A. R. James.—T. H. L.—Combustion.—L. N. W.—A Fellow of the Royal Astronomical Society.—Tubal Kain.—Invicta.—S. R. Bottone.—Rev. J. L. Pearson.

Sufferer. (All that can be said is that the food should be easily digested. It will have no effect on the paralysis.)—Indigestion Pills. (Better leave them alone.)—Otter. (If you will give some reference by which we may find the statement we may be able to help you; but why not apply direct to Sir W. Thomson.)—Brumbo. (If you wish to acquire a sound knowledge of electricity, procure Mr. Sprague's work on "Electricity: its Theory, Sources, and Applications" (E. and F. N. Spon, Charing-cross). For textbooks, get Prof. Guthrie's "Electricity and Magnetism," or Prof. S. P. Thompson's "Elementary Lessons in Electricity and Magnetism" (Macmillan).—T. K. (Look through recent volumes for information about electric lighting at home. The Bunsen cells will be useful for the purpose—not the Daniells; but a little experience will send you back to gas or paraffin oil.)—P. T. (See previous answer. If the engine is only up to one horse-power, it will not light twelve 20 candle-power lamps.)—T. (See the list of Back Numbers above.)—Volunteer. (It is a petroleum or mineral oil, and of course smells like it.)—English Mechanic. (We know of nothing better than bathing in hot water, and rubbing over with alum solution. See a number of replies in Vol. XXXVII., pp. 369, 415, 440, 462, 510, 557.)—Samuel Barbour. (Surely you know that the suggestion has been put in force by Mr. Webb, the locomotive superintendent of the London and North-Western Railway. See p. 581, Vol. XXXIV., and the indices of the volumes subsequently published. The question as to the balance of advantages has not yet been definitely settled.)—Diana. (Caused by small bubbles of air. 2. We do not know of any new law. You are not permitted to make and sell patented inventions. 3. See the indices.)—Turco. (What you ask for was given so recently as p. 548, last volume. You must use discretion as to the time; but the cold sponging or spray is certainly advisable, if not absolutely necessary.)—Delta. (We have said many times that indiarubber stamps cannot be made without apparatus, and that it does not pay to buy that apparatus unless the manufacture is to be carried on commercially. Directions will be found in back volumes.)—Miner. (You will find the weight per cubic foot of metals, &c, in any of the pocket-books—*e g.*, Molesworth's. There is no rule.)—Fred Williams. (Not that we know of.)—J. K. Smythies. (We have not seen it, so far as we remember; but at any rate it could interest a few only, and they would probably prefer to wait until the paper is published in full in the *Transactions* of the Institution of Civil Engineers.)—A. G. O. S. (An electrical belt is utterly useless as a remedy for anything of the kind; but you will find directions for making one in back volumes. The use of whole-meal bread, or the taking of a glass of cold water first thing in the morning, is far more effective.)—C. Simpkins. (We do not believe there is such a book published; but there are some works of the kind. In most textbooks tables of the kind are given. You should procure the catalogues of the publishers—J. and A. Churchill, and Macmillan, for instance.)—R. J. Urquhart. (The following method of varnishing silk balloons appears on p. 247, No. 895. Wash out the oil with methylated spirit and turpentine and then varnish with 4oz. benzoline, 1oz. boiled oil, ¼oz. indiarubber. Three coats, as thin as possible, and it takes some time to dry. Other recipes will be found in back volumes.)—Alfa. (Acetic acid, nitric acid, and other chemicals are used. See pp. 195, 227, last volume.)—Tooth. (If there had been an English address we should have given it. The price is one dollar, and we suppose you will have to write to Boston for the book.)—J. C. (Celluloid is the best substitute for ivory in organ keys.)—Camera. (Search the indices of even recent back volumes, and you will not say again that there has been little about photography. You do not say what kind of camera you use, though you are very explicit about distances and exposure. Suppose you procure one of the cheap handbooks of the art, and learn the rudiments. You will then be able to put definite queries which it will be possible to answer.)—Steel Cutter. (That is the only way to soften. Try again, covering the fire thickly so as to keep the heat as long as possible.)—Stud Wheel. (See indices. There are several books of the kind, which you will find in the booksellers' lists; but we cannot say which is simple enough.)—Young Engineer. (We do not know of a work on repairing the steam-engine.)—Verax. (An advertisement in the Wanted Column would no doubt bring you a list of the principal shipbuilding firms.)—E. H. (Procure a rod of carbon and pack it in a porous jar with equal parts of crushed coke and needle manganese. Stand the porous jar in an outer vessel containing a solution of sal-ammoniac and a zinc rod. Unless you intend to make up a number of cells, it is cheaper to buy one ready fitted. To make a battery, see p. 147, No. 1049.)—Script. (Do you not see that any ink capable of withstanding that test would be sure to be patented?)—Mascheba. (Probably a vegetable wax, but you ought to be able to ascertain all about it in your city.)—S. Barnett. (No one can say without examining the antique.)—W. M. (We believe the best plan is to add "finings," and allow the matter to settle in vats; but you might try filtering through ordinary filtering paper or animal charcoal.)—Cotton. (Hydrogen and oxygen. No. See the article on superheated water and boiler explosions in No. 1032.)—D. Booth. Not a "Fixed Star," was it? We give only occultations and near approaches of fixed stars.)—Veto. (A medical man must see the case; the sooner the better, if it is ulcerated mucous membrane.)—J. B. C. Breckenfeld, San Francisco. (Thanks, we shall be glad to receive them regularly.)—Elec. Lamp. (The Bunsen, but the fumes are decidedly objectionable; hence, most experimenters use bichromate. See recent back numbers. The Daniell cell ought to work as arranged, according to your description; but it is usual to make it up in the reverse way, using the copper in the outer cell, or copper cans, and the zinc in the porous cell.)—J. W. B. (The climate of Kent would, undoubtedly, be better for you. Why not try and obtain work at the Arsenal at Woolwich.)—One Anxious to Know. (Yes; the assistance of a solicitor is not absolutely necessary, but it is desirable.)—Devoniensis. (We cannot spare more space for the first matter; queries next week.)

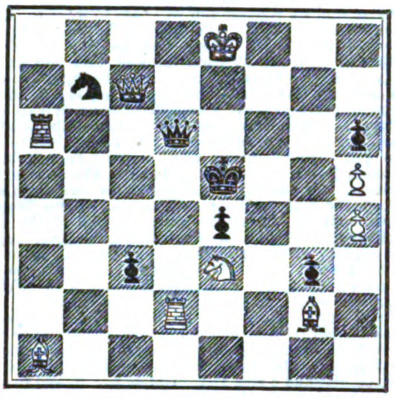
**Liquid Films.**—In a lecture recently delivered by Prof. A. W. Rücker at the Royal Institution, he said that the generally-accepted hypothesis of the nature of liquids was that they consisted of molecules held together by forces; the molecules at the surface of the liquid had these forces acting upon them from below only, instead of in all directions, so were in a different condition to those in the body of the liquid; what might be called surface films were consequently formed. A two-per-cent. solution of saponine, for instance, has a surface film which strongly resists the rotation of a needle when attracted by an adjacent magnet; but let the needle be placed less than a quarter of an inch below the surface: it will turn readily in the solution when the magnet is brought near. In a bubble of soap, or of saponine, the inner and outer strong surface films are very close together. To get durable liquid films, to keep sensibly in the same condition during experiments, the temperature must be even; this is effected by surrounding with water the glass case in which they are blown. To prevent evaporation the inside of the case must well be drenched with the liquid used for the bubbles. For the purpose of his experiments the bubbles were drawn out upon a ring of platinum above and below, so as to form a film-cylinder, which exhibited interference colours as the film thinned. In time the films became too thin at the upper part to show interference colours at all; at such parts they appeared black. As no colours then existed to afford means of measuring the thickness of the films the method was adopted of getting at it by measuring the amount of electrical current they would transmit; for this purpose two wetted gold needles were pushed into the back part of each film and the current transmitted by the part of the film between them was measured by means of a quadrant electrometer and set of resistance coils. By this means it was discovered that the coloured part of the film does not gradually thin into the black part, but that there is a hard and fast line between them; with solutions of some substances the coloured part is sixty-five times thicker than the black part. As certain technical objections could be raised to the electrical method of measurement, the plan was also adopted of putting a number of parallel black films in glass tubes; then sending a beam of light through all of them at once, and measuring their thickness by means of certain interference phenomena produced.

## CHESS.

All Communications for this department must be addressed to J. Pierce, Langley House, Dorking.

PROBLEM DCCCCXXXVII.—By "Væ Victis."

*Black.*



*White.* [9+7

White to play and mate in two moves.

Solution to 935.

| *White.* | *Black.* |
|---|---|
| 1. Q-K R sq | 1. Anything |
| 2. Q, Kt or B mates accordingly. (Six variations). | |

### NOTICES TO CORRESPONDENTS.

Correct solutions to 935 by E. S., Cheshunt (but variations not given), Brum (ditto), S. L. Chivers (ditto), W. T. Bayne (ditto), J. E. Piper (not very difficult), A. A. E. Lecluse (this little problem rather pleasing: K-Kt 6 is a strong move but Black has just one defence), V. S. Pochin (solution too palpable), Streetgate (somewhat easy for a tourney problem), R. F. Sunderland, (very easy), A. W. Orr, F. A. Vincent, Rev. W. Anderson (Old Romney), R. A. Bennett, Raymond, J. A. M. (very good), G. J. Slater (I fail to see any particular merit in this two-er), A. S. Olver, S.M. Cox.

To 934 by Raymond, J. E. Piper (very ingenious: a capital problem), A. S. Olver, Streetgate, A. A. E. Lecluse, A. W. Orr (very good), Brum, F. A. Vincent, Bronti.

To 933 by G. Stingfellow, C. Brady, J. Rayner, F. B. Webb, T. L. Robins, and J. Easton.

To 936 by J. E. Piper.

G. J. S.—You have overlooked in 934 1. B-Q B 2; you are right as to the answer if 1. B-Kt 6. Game received with thanks from F. A. Vincent.

**Separation and Determination of Methylic Alcohol in Presence of Ethylic Alcohol.**—C. De Poncy's process is based on the fact that methyl oxalate dissolves readily in water, whilst ethyl oxalate is sparingly soluble, and both oxalate form with ammonia amides perfectly insoluble in water. In 10cc. of the alcohol in question there are dissolved 10·8grm. oxalic acid, and the solution is saturated with hydrochloric acid gas. After standing for twenty-four hours in a well-stoppered bottle, 2cc. of the solution are mixed with 10cc. of water, shaken up and filtered. As methyl oxalate is completely soluble in water, there is obtained, on adding ammonia, more amide than if any equal quantity of pure ethylic alcohol had been employed. By a number of experiments we may ascertain the quantity of oxamide formed in the washing waters of the ethylic oxalates. For absolute alcohol the mean is 6·6. For methyl oxalate the mean is from 14·65, and 15 per cent. on the quantity of the methylic alcohol. If a mixture of methylic and ethylic alcohols is etherified, shaken up with water, and the filtrate mixed with ammonia to precipitate the amides, the proportion of methylic alcohol may be calculated from the quantity of oxamide obtained. For every one per cent. of methylic alcohol we obtain from 0·14 to 0·15 more than 6·6 per cent.—*Chemical News.*

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⁂ It must be borne in mind that no Displayed advertisements can appear in the "Sixpenny Sale Column." All advertisements must be prepaid; no reduction is made on repeated insertions; and in cases where the amount sent exceeds One Shilling, the publisher would be grateful if a P.O.O. could be sent, and not stamps. Stamps, however (preferably halfpenny stamps), may be sent where it is inconvenient to obtain P.O.O's.

The address is included as part of the advertisement, and charged for.

Advertisements *must* reach the office by 1 p.m. on Wednesday to insure insertion in the following Friday's number.

## NOTICE TO SUBSCRIBERS.

Subscribers receiving their copies direct from the office are requested to observe that the last number of the term for which their subscription is paid will be forwarded to them in a Pink Wrapper, as an intimation that a fresh remittance is necessary, if it is desired to continue the Subscription.

**Epps's Cocoa.**—Grateful and Comforting:—"By a thorough knowledge of the natural laws which govern the operations of digestion and nutrition, and by a careful application of the fine properties of well-selected Cocoa, Mr. Epps has provided our breakfast tables with a delicately flavoured beverage which may save us many heavy doctors' bills. It is by the judicious use of such articles of diet that a constitution may be gradually built up until strong enough to resist every tendency to disease. Hundreds of subtle maladies are floating around us ready to attack wherever there is a weak point. We may escape many a fatal shaft by keeping ourselves well fortified with pure blood and a properly nourished frame."—*Civil Service Gazette.*—Made simply with boiling water or milk, Sold only in packets, labelled—"JAMES EPPS and CO., Homœopathic Chemists London."—Also makers of Epps's Chocolate Essence

**Holloway's Ointment and Pills.** — Coughs Influenza.—The soothing properties of these medicaments render them well worthy of trial in all such diseases. In common colds and influenza the Pills taken internally and the Ointment rubbed externally are exceedingly efficacious. When influenza is epidemic this treatment is easiest, safest, and surest.—[Advt.]

## OUR EXCHANGE COLUMN.

*The charge for Exchange Notices is 3d. for the first 24 words and 3d. for every succeeding 8 words.*

**Good Value Offered** (cash or instruments) for all kinds of sound or repairable Scientific Appliances.—Caplatzi, Science Depot, Chenies-street, near British Museum. Established 1862.

Wanted, a good Collection of **Stamps**, also coins and Bric a Brac of every description, good exchange, approval required.—Address, Edward W. Drury, Hull.

"**English Mechanic**, from commencement, 40 Vols., 19 bound, all in perfect order. No reasonable offer refused, owner going abroad. Will exchange for central-fire gun.—Major Allen, Gosport, Hants.

Small Balance **Timepiece**, bronze and silvered dial, mahogany stand, glass shade. Exchange. Electric Bell and Battery wanted.—H. Leeson, Coleshill, Birmingham.

"**Engineer**," and "**English Mechanic**," volumes of, up to present date.—W. L., 61, Regency-street, Westminster, S.W.

**Nickel-plating Vat**, 9 gallons, 6 Bunsen half-gallon cells, six nickel anodes; weight, about 7lb.; 14lb. Salts of Nickel, book of instruction, scratch brush, &c., cost £8 10s.—Offers, J. Grime, Hull.

**Hot-Air Engine**, Buckett's Caloric, half h.-p., quite new, cost £62 10s. Will take exchange. Want tools or anything useful.—J. Grime, Hull.

**Tricycles**, with Dunn's patent improved power appliance, 50 per cent. increase of power. Machines bought sold, or exchanged.—222a, City-road, London, E.C.

Good **Cooking Stove**, 2 feet 9 inch by 1 foot 9 inch. Exchange for good 6in. Slide-rest, or 50in. Bicycle.—A. Hutchinson, 41, Katherine-street, North Darlington.

**Bunsen Battery**, 10 cell, 5in. carbons, $4\frac{1}{2}$in. zinc cylinders, massive clamps, complete, in thorough order. What offers to G. Heys Jones, 12, Addison-gardens, Kensington, W.

Double (walnut) **Dark Slide**, quarter-plate, nearly new. Also some Locomotive Photographs. What offers?—W. Algar, Stonard-road, Winchmore Hill, London, N.

Wanted, small **Launch Hull**, Engine, Boiler, Propeller, together or separately; also 50in. Bicycle. Exchange Double Breech-loader, Lathe, &c.—T. Carey, Foynes, Limerick.

"**Electric Lighting**," by Sawyer; "Electric Lighting," by Du Moncel; "Practical Electric Lighting," by Hedges. All half-price, or exchange for Incandescent Lamps, Saloon Pistol, or offers.—E. Rose, Regent House, Sydenham.

**Table Engine**, 4in. stroke, six turned pillars, double crank, two connecting rods, weight 35lb., mahogany stand. Exchange.—Edwin Roebuck, Stoke, Staffordshire.

Horizontal **Copper Boiler**, riveted, 15in. by 7in., manhole, steam tap, lever safety valve, gauge cocks, water gauge with 3 taps, large iron furnace and stand, about 20 firebars, funnel. Weight 35lb. Exchange.—Edwin Roebuck, Stoke, Staffordshire.

Ten-Guinea **Diamond Ring**, new, in exchange for 2ft. Locomotive with link motion. No matter if damaged. Send particulars.—W. Haughton, 138, Park-road, Liverpool.

Vols. XXXI., XXXII., and XXXIII. "**English Mechanic**"; "The Metal World," complete in 3, and "Metal," complete in 2 vols. What offers? Would exchange good Banjo. —Stemson, 4, Grove-terrace, West Kensington.

**Martini-Henry Rifle**, quite new, with cartridge and appurtenances, cost £10. Exchange for Alexandre Harmonium, Organ, or Swift's Student's Microscope.—George Elliott, New Ross.

Wanted, an **Air Engine**, in exchange for **Horizontal** Steam Engine, in very good condition, cost 25s.—H. Wilson, Rock House, Clapham-common.

"**Races of Mankind**" (Cassell's), four Vols. in two, half-calf, handsome. Exchange for Berkley's "Mosses," or Braithwaite's "Moss Flora."—Fred. Brown, Post Office, Coggeshall.

Wanted, **Lathe**, foot power, small, with rests, suitable for watchmaker; must be cheap; good exchange offered.—Hunt, Watchmaker, 88, Widnes-road, Widnes.

What offers for 22 **Books** on Military and Naval Operations, 72 numbers English Mechanic?—Address, G. W., 21, Wellington-street, Bedford.

**Violin and Bow**, in case, complete; also Concertina Patent Lever Watch, &c. What offers?—193, King Edward's-road, Birmingham.

Half-Plate **Camera and Lens**, also $\frac{1}{4}$-plate Ditto, bath and printing frame. What offers?—M. Allison, Howwood, Paisley.

Will exchange a quantity of small **Screw Plates** for anything useful. Offers requested.—Robert Gough, 19, Haggar-street, Blakenhall, Wolverhampton.

"**English Mechanic**," 44 numbers, not very dirty, unbound, for 1870. Exchange.—S. A. Clark, Croft-street, Heckmondwike, Yorks.

**Galvanic Battery**, by Halse, in perfect order, cost £10. Will exchange for 50in. Bicycle or Facile.—C. F., 19, Merrow-street, Walworth-road, S.E.

**Telescope**, $2\frac{1}{2}$in. Reflector, two Astronomical Eyepieces, fine adjustment screw, on tripod stand, in oak case. What offers?—Joe Blain, Albert-square, Carlisle.

**Medical Coil and Bichromate Battery**, in mahogany box, good condition; for Electric Scarf Pin.—Joe Blain, Albert-square, Carlisle.

**Electric Railway**, with Motor and Battery, not quite in working order; can be made right by any amateur electrician. What offers?—Joe Blain, Albert-square, Carlisle.

**Sprengel Pump**, with latest improvements, five fall tubes, and arrangement for removing air from mercury, on board, ready for fixing to wall, suitable for exhausting high vacua tubes, incandescent lamps, &c., and by which a vacuum to 1,000,000 of an atmosphere can be obtained. Exchange for Microscope, or Sale, £4 10s.—H. Newbold, 25, Calthorpe-street, W.C.

Wanted, Hall's **Type Writer**, in exchange for small Dynamo, Microscope, Telescope, Half-plate Camera, Pocket Aneroid, Medical Coil.—W. Banks.

Wanted, 8 and 10in. Sliding, Surfacing, and **Screw** Cutting Lathes, must be good quality; in exchange for a One Horse-power Otto Silent Gas Engine, new last September.—W. Banks.

What offers in exchange (or cash) for 3 Siemens **Telegraph** Instruments, 1 Government Sextant, 37ft. 4in. Belting, 1 cwt. No. 15 D. C. C. Paraffined Wire, 2 doz. Leclanche Batteries. Can be seen from 10 to 8.—H. Beer, 23, Westbourne-park-crescent, Paddington, W.

Good 6in. centre **Lathe**, double crank-shaft, counterbalanced heavy flywheel, slide-rest, hand-rest, three T rests, grindstone, and spindle, lots of tools, drivers, &c. Will exchange for Knitting Machine, Bicycle, or anything useful.—W. J. Powell, Abertillery, Newport, Mon.

**Knitting Machine**, almost new, with ribber, cost £8 10s., 80-needle Cylinder, for Sale, or exchange for Ladies' Wearing Apparel. No rubbish.—Jane Bell, Metallurgist, Bexley Heath.

Offered.—Pocket **Telescope**, with extra eyepiece, and Microscope, with achromatic triplet. Wanted, good French-English and German-English Dictionaries.—Buffham, Connaught-road, Walthamstow.

Warranted Crucible **Cast Steel**, 7-16 to $\frac{3}{8}$ diameter, 2 to 3ft. bars. Exchange for anything useful. No reasonable offer refused for 1 to 10 cwt.—Gilbert, Oxford-road, Sheffield.

**Photo. Apparatus**, consisting of $\frac{1}{4}$-plate lens and cameras, tripods, $\frac{1}{2}$-plate lens, one by Voightlander.—Day, 56, Driffield-road, Old Ford, London.

**Micro. Photo. Objectives**, by Dallmeyer; also large dishes, baths, plate boxes, pressure frames, Stanley's $\frac{1}{2}$-plate set.—Day, 56, Driffield-road, Old Ford.

**Speculum**, Silver-on-glass, good definition, 9 inches diameter, 6ft. $2\frac{1}{2}$in. focus.—Day, 56, Driffield-road, Old Ford, London.

**Sewing Machine**, Clegg and Blacklock, for back Vols. of "E.M.," bound, or 5in. slide-rest.—Day, 56, Driffield-road, Old Ford, London.

Wanted, a pair of **Circular Bellows**, about 28in., lath or fan.—J. Reside, Brighouse.

Pair of Engineer's **Tap Wrenches**, set of Lathe Carriers, spanners, yacht's compass, with transparent card, steam injector, pair powerful magnets. Offers? — Alfred Crofts, Dover.

Splendid **Model Engine**, copper boiler, with all fittings; capital printing press, for bill heads, circulars, &c.; 100 candle-power Gramme castings. Offers.—Alfred Crofts, Dover.

**Lathe**, 7in. centre, suit woodturner, also back-geared lathe heads, 7in. centre. What offer?—A. G., 16, Lesbourne-road, Reigate.

"**English Mechanic**," about 100 numbers the last two years, clean. What offer?—A. G., 16, Lesbourne-road, Reigate.

**Lathe Heads**, 4½ to 6in. centres, T and slide rests, wanted in exchange for corresponding value.—Linscott, Ramsgate.

**Photo Glass**, 7 by 5, 5 by 4, 4 by 3, 18 dozen; 8 pints silver solution, quality guaranteed. What offers?—Address above.

Five quart **Bichromates**, zincs 6 by 3. Exchange Lancaster's ¼-plate "Le Merveilleux." Conjuring Tricks. Offers. —Prof. James, 33, Pride-hill, Shrewsbury.

A few good **Conjuring Tricks** for exchange, would make a first-class entertainment at a moderate cost.—Prof. James, as above.

**Bicycles, Bicycles**.—The Dreadnought Bicycle, with hollow forks both wheels, Æolus bearings, dropped handles, Humber scroll spring, enamelled plain black; and you can have your old machine allowed for as part exchange.—Rodgers, Bermondsey-street, S.E.

**Bicycle Springs**, one dozen for exchange.—Rodgers.

**Bicycles and Tricycles**.—Offers wanted for a few, together or separately. Several are to be exchanged.—Rodgers, as above.

**Press Screw**, 3in. diameter, 14in. long, 2 threads, Quantity of American Drills. Exchange offers.—152, Bermondsey-street.

Model Vertical **Engine and Boiler**, 1½in. bore, would work sewing machine. Exchange offers.—H. R., 127, Abbey-street, Bermondsey.

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## THE SIXPENNY SALE COLUMN.

*Advertisements are inserted in this column at the rate of 6d. for the first 16 words, and 6d. for every succeeding 8 words.*

**Plating**. — Every description of Gilding, Silver Plating, Oxidising, and Bronzing, executed with very best finish. Speciality in nickel-plating. Special quotations on application. Send one stamp for price list. Small jobs attended to per return post.—Morris Cohen, 132, Kirkgate, Leeds.

**Fretwork**.—Illustrated Catalogue of every requisite and 400 miniature designs, 4 stamps.—Harger Bros., Settle, Yorks.

**Trouser Lengths**, 5s. each. Cheap Cloth for Ladies' Dresses, Mantles, Boys' Suits.—Hewitt, 37, Winfield Mount, Leeds. Patterns free.

**Electric Depot**, 10, Deansgate, Manchester.—Electric Breast Pins, 25s. Electric Bells, 4s. Induction Coils, 8s.—Millar, Proprietor.

Write for Hindle's **List** of Electrical Apparatus, free; all parts for amateur construction.—Irwell Vale, Helmshore.

A few Gramme **Dynamos** for sale, cheap.—WALKER and Olliver, 195, Severn-road, Cardiff.

**Electro-Motors** from 25s. No dead point. Battery equal Bunsen's. No fumes.—Walker and Olliver.

Leclanche **Cells**, Manganese, Sal-ammoniac, Bichromate, Bells, Wire, Pushes. Wholesale and retail.—Walker and Olliver.

**Dynamos** repaired or rewound. Advice given. Competent men sent to all parts.—Walker and Olliver.

**Microscopic**.—Good miscellaneous Slides for disposal, only 2s. 3d. dozen, post free.—Mathies, 42, McKinlay-street, Glasgow.

Shunt wound **Dynamo** and Serrin Arc Lamp, cost over £40. Will take £35 or good exchange.—John Grime, Hull.

Fletcher's **Foot Blower**, cost 35s., quite new; also large Blow Pipe and Hearth. Will take £2 10s., or offers.—J. Grime, Hull.

**Billiards**.—Great success of Thorpe's Patent Automatic Cue Tips. Cannot fly off. Cues retipped instantly.

**Billiards**.—Excellent testimonials from Roberts, jun. champion, and other professionals. £5 per week easily earned.

**Billiards**.—District Agents wanted. Send 9 stamps for particulars and sample cue end fitted with patent.

**Billiards**.—Five Shillings for sample cue, also fitted, and 3 extra tips. Thousands already in use.

**Billiards**.—Apply to sole representative for United Kingdom.—A. W. Morgan, Lancaster Avenue, Fennel-street, Manchester.

Hard **Vulcanised Fibre** for Magnet Heads.—Mosses and Mitchell, 68a, Chiswell-street, London, E.C.

Hard **Vulcanised Fibre** for all kinds of insulation. —Mosses and Mitchell, 68a, Chiswell-street, London, E.C.

Hard **Vulcanised Fibre** for carrier dry back plates. —Mosses and Mitchell, 68a, Chiswell-street, London, E.C.

Tudsbury and Sons' "High Tension" **Wimshurst** Machines, with Compound Ebonite Plates. List, one stamp.—Edwinstowe, Newark.

**Model Castings** in brass and iron, also Working Drawings for Horizontal, Vertical, Launch, and other Engines. Guaranteed best metal. Complete sets Castings from 1s. 3d.

**Separate Parts**, rough or finished. Castings from amateurs' own patterns. Catalogue, 2d. Six lithographed designs, 3d.—Hughes' "Mersey Dockyard," 17, Smith-street, Kirkdale, Liverpool.

**Castings**.—Half horse-power (Engine), Launch, Horizontal, or Vertical, ports in cylinder. Complete sets Forgings and Castings, 19s. 6d. One horse-power, 25s.—Tomlin, Highfield-terrace, Barnsley.

**Castings**.—Bench Drilling Machine Castings, 3s. 6d. Small Brass Horizontal Engine Castings, 2s. 6d. New Price-list and designs of perfect Castings post free.—I. Tomlin, Engineer, 28, Highfield-terrace, Barnsley, Yorkshire.

**French Polishing**, Staining, Painting, and Varnishing, 123 receipts or trade secrets, with full instructions and details, free 1s.—I. Tomlin, 28, Highfield-terrace, Barnsley Yorkshire.

**Cat Gut**.—Gut Hooks and Eyes for lathes and machinery.—James Bellaers. Regent-street, Leicester.

**Bellaers' Gas Stoves**, 1s. 3d., 2s. 3d., 3s. 3d., for boiling. Breakfast Stoves, 8s., 11s., 14s. 6d. Send for lists.

**Showcases** for Exhibitions, Models, Scientific Instruments. Exhibition Stands supplied and fitted.—Write, Fry and Hyatt, 90, Borough-road, London.

24 **Microscopic Slides**, in box, very cheap. List sent for stamp.—Well, Dalmain-road, Forest Hill.

Hand **Drilling Machine**, drills ⅜ holes 6 inches from edge, 25s. Photo 3 stamps.—S. Beeching, Mareham-le-Fen, Boston.

**Mica**, otherwise Talc.—RICHARD BAKER & CO., 9, Mincing-lane, London.

**Motor Castings**, materials for Electric Bells, Batteries, Galvanometers, Intensity Coils, Microphones.—King, Mendham, and Co., Bristol.

**Insulated Wire Table**, showing size, weight, resistance per foot, feet per ohm, &c., price 3d.—King, Mendham, and Co., Bristol.

**Standard Ohm**, in box, copper poles, guaranteed correct to ten thousandth of ohm, 21s.—King, Mendham, and Co., Bristol.

**Wimshurst Influence Machine**.—Sole Manufacturers of Improved Pattern. Numerous testimonials as to thorough efficiency.—King, Mendham, and Co., Bristol.

**Galvanometer Cards**, improved for tangent and ordinary combined, 2½in., 8d.; 4in., 10d.; 6in., 1s.; post free —As above.

Write for **King, Mendham, and Co.'s** large new and reduced Price List, post free 4 stamps.

**Catapults**, 7d., 1s., 1s. 2d.; elastic 2d., 3d. foot; square 1d. to 4d. yard.—Moody Bell. Cheltenham.

**Tricycle Wheels**, Bicycle Wheels, and Fittings Wonderfully cheap. Also for Safety Bicycles.—W. Gwinnett and Co., Wolverhampton.

**Edward W. Drury**, Hull, Glass Bottle and Cork Manufacturer, Importer of Chemicals, Caramel, Glucoses, Tinned Wire.

**Lathes**, Lathes. Cheapest and best. List, 2 stamps Nothing equal at price.—Robinson, Somerset-road, Sheffield.

100 **Foreign Stamps**, including Brunswick, Ceylon Tasmania, Egypt, Greece, Luxemburg, free 7d.—Hely, Foley-street, London.

Patent Spiral Grip **Letter Racks**. "An invaluable invention." Parcels post, 1s. 3d.—Iles, Highgate-street, Birmingham.

Pumphrey's **Pocket Tripod**, for cyclists, professional and amateur photographers. Perfectly rigid. May be had on approval. Illustrations and testimonials free.—Pumphrey, Stanhope-street, Birmingham.

The **Camera and Lantern**, with three instantaneous photographs; gives full instructions in their production; 6d. post.

**Camera and Lantern Apparatus**, dispenses with multiplicity of slides, 36 plates carried, changed anywhere.—Pumphrey, Birmingham.

Pumphrey's **Hydrostatic Shutter** gives instantaneous or timed exposures; 10s. Illustrations post free.—Pumphrey, Stanhope-street, Birmingham.

**Photography**. — Odd Backs, Leather and Cloth Bellows for sale.—E. Wills, 116, Rotherfield-street, N. Stamps for replies.

**Patents, Designs, and Trade Marks**. — For particulars of lowest charges, apply, G. L., Technical Bureau, 46, Queen Victoria-street, E.C.

**Battery**, for Electro-Plating, cheap in working, and will last for 200 hours without re-charging, and the consumption is almost nil when not at work. Price £25.—Britannia Co., Colchester.

**Lathe-Heads**, nearly new, 3-inch, 27s.; 3½, 53s.; 4-inch, 60s.; 5-inch, 80s. per pair, including hand rests and tees. —Britannia Company.

**Slide-Rests**, Improved Compound, several second-hand, and some nearly new. Give height of centre and section of your lathe bed.—Britannia Co.

**Cash Returned** if any article above mentioned are not approved. Similar heads and rests may be seen at our London Showroom, 99, Fenchurch-street. — All correspondence to Britannia Co., Colchester.

**Tricycle Parts**.—Complete Sets of Works for central geared, double driving, front steering, plain and ball bearings, steel tubes bent. Full instructions and working drawings. Wheels or any part finished to order.—Machines on view, and particulars of E. Edwards, 163, Kennington Park-road, London.

For sale, cheap, **Equatorial Telescope**, by Dancer, with 4-inch Wray's object glass, six eyepieces, &c., equal to new, maker's price, £90. Also an Observatory, recently erected, cost over £20.—Particulars from W. I. Chadwick, 13, Ellesmere-avenue, Eccles, near Manchester.

**New Time**.—Alter your Clocks and Watches. Twelve Sets of Figures, with instructions, 6d.—Wheeler, Preston.

**Water Motors**, for sewing machines, organettes, window advertisements, 32s., 42s. List one stamp.—Wheeler.

**Fan Castings**.—Improved Registered Designs; sets 6in., 3s.; 6in., 4s.; 8in., 5s. Drawings, 4d.—Wheeler, Engineer.

**Water Motors**.—Complete one horse-power, £9. Half, £6. Quarter, £4. Eighth, £3.—Thomas Wheeler, Preston.

Steel **Name Stamps**, 3d. per letter. Figures (set), 2s. 4d. Letters, 6s. 4d., per post.—E. F. Baldwin, Robinswood-hill, Gloucester.

**Launch Engine and Boiler**, 3in. bore, 4in. stroke, Vertical Tubular Boiler (19 tubes), 3ft. high, 1ft. 9in. diam. Price £35.—S. Smith.

**Screw Propellers** from 6in. to 30in. in stock. Improved pattern.—S. Smith, 11, West-street, Soho, W.

**Incandescent Carbon Lamps**, low resistance, 3s. each; Fairy Lamps, 3s. 6d.; Platinum Lamps, 1s. 3d., post free.—Todd, 14, Wentworth-road, Manor Park, Essex.

**Incandescent Lamp Holders**, new pattern, best in the trade, 12s. dozen; sample, post free, 1s. 3d.—Todd, as above.

**C. Pilkington**, 32, Sackville-street, Piccadilly, W., Magic Lantern Artist and Photographic Colourist.

Magic Lantern **Photograph Colouring**, finely and artistically done, 12s. per dozen. Special terms to the trade on application.—C. Pilkington, 32, Sackville-street, W.

**Violin** for sale, magnificent solo instrument, suitable for lady or gentleman, labelled "Antonius Stradvarus, Cremona, 1690," with good case and mounted bow, only 25s. Sent on approval with pleasure.—Mrs. Jones, 50, Myddelton-street, Clerkenwell.

**To Capitalists**.—An Inventor seeks a Partner to assist him in manufacturing a small article of general use by all machinery users. Very little plant required.—Apply in first instance to J. C., 3, Gladding-road, Manor Park, E.

Pair of **Bellows**, 17in., nearly new, suitable for forge or glass blowing, 15s.—H. Newbold, 25, Calthorpe-street, W.C.

Binocular **Microscope** and quantity of Apparatus, by Baker, cost £25, half-price.—S., 20, Montpelier-road, N.W.

4in. Reflecting **Telescope**, by Watson, London, with stand, cost £18 18s., price £5 5s.—S., 20, Montpelier-road, N.W.

**Revolvers**, six-chambered, rifled barrel, self-cocking, latest improvements, proof marked, only 6s. 6d. each, carriage paid. Returnable if not approved. — International Trading Company, Watchet.

Second-hand Milling or **Routing Machine**, £1 10s. Slide-rest, £1.—53, St. George's-road, Peckham, London.

Second-hand Portable **Forge**, Anvil, Tongs, £3 the lot.—53, St. George's road, Peckham, London.

**Am-Meter** to 20 ampères, accurate, 4s. 6d. Meters calibrated for amateurs.—W. A. Walton, London-road, Gloucester.

**Gas Engines**. Several good second-hand Engines for Sale.—John Middleton, 16, Hope-street, Glasgow.

Launch, Yacht, or **Tug Engine**, double, 9in. cylinders, new, for Sale.—John Middleton, 16, Hope-street, Glasgow.

**Cheap Printing**.—Bill Heads, 6s. 1,000; Memos., 5s. 6d. Business Cards, 6s. 6d., carriage paid.—Brooks and Co., Rotherham,

Universal **Cutter Frame**, slide 3in., £2. Castings 4s. 6d.—Particulars, apply, G. Allsop, Derby-road, Belper.

Screw-cutting **Lathes**, gap beds, 22 change wheels, flywheel, &c. Workmanship unexceptionable.—A. Halls, Yarmouth.

**Lathes**, complete screw-cutting, 4in. centres, 10 guineas; 3in. centres, 8 guineas.—Halls, Yarmouth.

**Launch Engine**, Boiler, and Propeller for 18ft. boat, £23. Also other sizes.—Chenhall, Eastville, Bristol.

**Mechanical Organette**, very powerful, scarcely soiled, 32 pieces music. Price £2 10s.—64, Sussex-road, Stockwell, London.

**Coca Leaves**.—The Bolivian Consul-General has sent a splendid testimonial this week in favour of their stimulating properties.

**Coca or Cuca Leaves**.—Many M.P.'s and Clergymen take them constantly. To Cyclists they are a positive necessity.

Persons afflicted with **Indigestion** should chew Coca instead of eating a hearty dinner, and they would soon be cured.

**Coca Leaves**. — Sample packet, with medical and scientific opinions, 13 stamps.—Marks and Co., 17, Newcastle-street, Farringdon-street, E.C.

Photography.—Splendid brass-bound 10 by 8 **Bellows** Camera, rack and pinion, 35s.—A. Smith, Union, Buckie.

**Engine and Boiler** combined, 6in. bore, 12in. stroke, by Green; very cheap.—Rigby Smith, Fazackerley, Chorley.

**Castings, Forgings** of a 2 by 3½ Horizontal Engine by Dorrington.—Walker, 54, Roe-lane, Southport.

**Ivory Tusk**, 2ft. 6in. long, 6in. circumference, 30s.—Mr. Lee, 3, Camden Cottages, Camden-road, N.W.

**Ivory**.—Round, 2-inch long, 1¼ thick, hollow; 6s. lb.; solid, 8s. lb.—Mr. Lee, 3, Camden Cottages, Camden-road, N.W.

**Marqueterie Panels**, Friezes, &c., high-class.—Mr. Lee, 3, Camden Cottages, Camden-road, N.W.

"**Knowledge**," to date, complete, £1. Induction Coil, ¼ inch spark, 18s.—Jas. Campbell, 158, Thomson-street, Dennistown, Glasgow.

**Contents of Amateur's Workshop**, including first-class back-geared gap bed Lathe, by Britannia Co., 3in. centres, slide-rest, scroll chuck, parallel vice, twist drills, stocks and dies, full set turning tools, &c., &c.—Apply, D. Simms, 5 Clarence-place, Belfast.

**Devonshire Cream**, delicious, by improved centrifugal process. Parcels Post, lb., 1s. 6d.—G. Bull, Manor Farm, Martock, Somerset.

**Planing**, not exceeding 10in. by 10in. by 8in.—B. W. Clegg, 18, Belinda-street, Hunslet, Leeds.

For **Model Work** (wheel-cutting in brass only); also Boring, Turning, and Screw-Cutting.—Clegg, as above.

Grant Bros.' parts of **Electrical Apparatus** of every description for amateurs; wholesale prices; full instructions free.

**Electric Bells**, Batteries, Pushes, Wire, wholesale prices; list free.—Grant Bros. and Co., 20, High Holborn.

Model **Engine Castings**.—Horizontal, Vertical, Beam, and Marine. List, 1 stamp.—Wood, Dalley-street, Broughton, Manchester.

**Dynamo**, 25 volts, 10 ampères, laminated armature, price 75s.—J., South Cottage, Thurlow Park-road, Dulwich.

**Changing Box**. Shew's, suit any ½ or ¼ camera, also Lancaster's Le Meritoire ¼-plate Lens, both in good condition.—Particulars, Braid, Livingstone, Midcalder.

Double Brass-finisher's **Lathe**, ½ H.-P. Boiler, Water Motor, Gas Bag, Marion's Cabinet Burnisher, Limelight Jet, Kettledrum, Air Gun Walking-cane, 2 Cameo Presses, Sundial. M. I. P. Bicycle Bag; must be sold.—Apply to Wm. B. Thomson, Wick, N.B.

**The Kinetic Engineering Company**, 36 and 37, Brooke-street, Holborn, London. Circulars and list post free.

**Dynamo Wire**, 1s. 2d. per lb. Line Wire, 29s. 6d. per mile. Pushes, 4s. per dozen.—Kinetic Company.

**Leclanche Cells**, best. No. 1, 16s.; No. 2, 19s.; No. 3, 22s. 6d. per dozen.—Kinetic Company.

**Electric Bells**.—Best quality, workmanship, appearance and value in market, 40s. per dozen.—Kinetic Engineering Company.

**Maiche Patent Battery**.—Best yet produced. Circulars and Scientific Reports post free.—Kinetic Engineering Company.

**Electrical Supplies**. Wholesale only.—Kinetic Engineering Company, 36 and 37, Brooke-street, Holborn. London, E.C.

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## THE INTERNATIONAL INVENTIONS EXHIBITION.

IF number and variety of objects can insure the success of the exhibition opened on Monday last at South Kensington, the Inventions will be at least as popular as the Healtheries, for since 1862 nothing like it has been seen in this country. It is well known, however, that many of the visitors are attracted by the music and by the brilliantly-illuminated gardens, which combined render the exhibition perhaps the most pleasant place in London in which to spend a few hours on a summer's evening. This year the buildings have been increased and extended; and by the formation of a subway from South Kensington Station, which enables the visitor to reach the exhibition without exposing himself to the weather, the executive council may fairly claim that they have also provided a place in which to spend a rainy day. Arrangements have also been made with the railway companies, and a useful guide enables persons residing within a radius of about 40 miles to readily ascertain the cost of a visit and the best means of making it. The exhibition is divided roughly into two divisions—Inventions and Musical Instruments; but while the former is confined to devices introduced since the Great Exhibition of 1862, the latter includes examples of a date not earlier than the beginning of the present century, though historical collections, either of instruments or drawings, are admitted. The progress of nearly a quarter of a century comes, then, under the head of inventions, and no one needs to be told that a great deal has been accomplished in that time: hence, there is in this exhibition something to interest everybody, and not a few objects which will attract the critical attention of experts. As the visitor enters by the Exhibition-road, or principal entrance, the first object that will probably attract his attention is a 12-ton 8in. breech-loading gun of steel, with the Stanhope lever arrangement for unlocking the breech, shown to illustrate the method used for working the larger guns. Close by is a trepanning bar, or boring tool, for removing the cores; of, or in other words boring out, the big guns. It is a hollow steel cylinder ¾in. thick and 16ft. long, fitted with cutting bits in its working face, which overlap each other, and provided with grooves, along which water is forced to cool the cutting edges and remove the shavings. The "tool" is fixed and the work revolves, the rate of cutting being 3in. an hour, while the solid cores which are cut out by the kerf formed by the bits are utilised in making smaller guns. The mechanic will readily compare this "tool" with the simpler lathe arrangement, which is shown in another part of the buildings, boring Lancaster gun barrels, and the novice even will readily appreciate the great advance which the 19th century has to show in machine tools. Another object which will attract attention in the War Department's exhibit is the breech of a 9·2in. gun, showing a portion of the breech end, with the Stanhope lever arrangement, and the special devices employed for working the gun in a heavy seaway or at extreme angles of elevation. There are many other objects in this exhibit which will secure attention, including the balloon equipment and the submarine mining or torpedo apparatus of the Royal Engineers. The Admiralty exhibit a number of devices used in connection with the naval service, including a Whitehead fish torpedo in full size and ditto in partial section. A number of machine guns, the Hotchkiss revolving cannon, and the new Maxim self-firing gun are also shown; but, in the last case, as the invention cannot be appreciated without seeing the gun in action, arrangements have been made for firing it in one of the iron buildings near the Queen's-gate entrance. The Maxim gun is one of the real novelties of the Exhibition, for it is a comparatively recent invention and one of the most interesting, for, once started, it will go on firing as long as cartridges are supplied to it, the force of the recoil being utilised to recharge it. If inventions for the destruction of life are numerous, it is satisfactory to find that there are many others devoted to the prevention of accidents; for besides such inventions as the Westinghouse and Vacuum brakes, there are several more or less automatic safety-couplings for railway waggons, and other devices for securing the greatest amount of protection in various dangerous employments. The Vacuum Brake Co. show their automatic arrangement as applied on the Great Northern Railway. A full-size footplate, with pipes and couplings to the vacuum and brake cylinders, has been fitted up, and a gauge indicates the degree of vacuum or the amount of pressure on the brake. The ball-valve coupling, which is arranged to separate easily if the train parts, is also fitted, and is occasionally separated to show the automatic action. A model of a G.N. 8ft. express and of the underframe of a six-wheel coach will enable the visitor to understand the arrangements. The Westinghouse Brake Co. exhibit their system as applied to a train of 15 coaches. In one corner of the stand is the air-pump and reservoir, and arranged at the back are the reservoirs and brake cylinders, all in full size, and connected so as to show the working through a train of that length. A driver's valve is placed in front, and when it is opened the rods connecting to the brakes are seen to rise simultaneously from the brake cylinders. A model of the underframe of a four-wheel coach is mounted on a short length of rail, and being fitted with the apparatus and brake blocks, the working is readily comprehended when the air-pressure is put on and taken off. The triple valve and couplings are also exhibited in full size, so that visitors can make themselves fully acquainted with the now famous brake. A specimen of Mr. Webb's compound locomotives is seen in the shape of the "Marchioness of Stafford," a brand-new engine, which forms a notable object in the Middle Court, where the majority of the exhibits connected with railways are shown. It is accompanied by a model of the "Dreadnought," a sister engine, which has already done very important work, for on March 19th, it ran from Euston to Carlisle with a load, including its own weight and that of the tender, of 207 tons, the consumption of fuel being 29·2lb. per mile, and the evaporation of water 9·49lb. per pound of coal. The distance is just a fraction over 300 miles. Mr. Webb also exhibits, in full-size, his duplex reversing gear for compound locomotives, by means of which the high and low pressure valves can be reversed together, or adjusted independently. A model six-wheel coach serves to explain Mr. Webb's method of using the air-pressure brake, and another of an eight-wheel coach exhibits his method of applying radial axle-boxes. Saxby and Farner exhibit in full size their safety lock for facing-points with duplex detector,—the signalman's cabin with fittings and the semaphore with its appurtances being also shown full size. McKenzie and Holland exhibit in full size their apparatus for working and interlocking railway points and signals at a station with level crossing, and, in model, a junction station with the method of interlocking the points and signals with the crossing gates and wickets. The Heberlein automatic friction brake is shown full size, so far as the acting parts are concerned, and there are several other brakes exhibited, possessing more or less ingenuity of construction, but which have little chance of employment in the face of the Westinghouse. Automatic and safety couplings are shown in some variety, many in large-size working models; but without drawings it is impossible to describe them. In view of the action recently taken in the United States in connection with safety couplings, it may be hoped that something will come of this public demonstration of the capabilities of some of the inventions, for the loss of life in marshalling goods trains is still deplorable. Of steam-engines there is a liberal display, many of them being utilised for driving machines, and several fitted with ropes instead of belts, while belting of various kinds is exhibited at work. Amongst the large engines under steam, a compound by the Messrs. Galloway, having the high-pressure superposed at an angle over the low-pressure cylinder, will attract attention; but the more interesting inventions in this class will be found in the new high-speed engines and in the improved valve-gears and automatic arrangements for expansion. Amongst gas engines there is one decided novelty in the shape of Atkinson's patent, exhibited by the British Gas Engine Co., while amongst those of the Otto type, shown by the Messrs. Crossley, there is one of the new two-cylinder engines, and one of the new vertical pattern. Two hot-air engines which will attract some attention, are shown respectively by Messrs. W. H. Bailey and the Britannia Company. Both are heated by gas, and while the former is at work pumping water, the latter is shown as suitable for driving a small lathe or a fret-saw. Those who are interested in agricultural machinery will find a good display in the South Court, and of machines in motion, employed in the work for which they are intended, there are enough to form a most attractive exhibition by themselves. Printing is well represented, both the *Graphic* and the *Illustrated London News* exhibiting machines producing work that is to be published, while there are many others, both litho and letterpress. In the machinery department a most interesting exhibit is that of Mr. Bell showing the methods employed in weaving and plaiting asbestos; but, perhaps, the most attractive exhibit of the class is that found in the gallery alloted to America, where the Waltham Watch Company show their wonderfully ingenious automatic machines for making the parts of watches. Amongst these is a train wheel cutter, which cuts out 40 wheels at a time; an escape wheel cutter, having two steel and four sapphire tools, which makes 50 wheels in about a quarter of an hour; a screw-making machine, which turns out finished screws at the rate of 400 an hour. Mr. S. Brooks exhibits machines for spinning and doubling cotton, including a "twist" ring spinning frame of 92 spindles, and a "weft" ring spinning frame of 84 spindles. He also exhibits the patent Ferguslie balling machine, which makes twelve balls simultaneously, containing any given length, at the rate of 250 yards a minute. Scouring, bleaching, and dyeing machinery; new laundry machines for various purposes, and others too numerous to mention here help to complete a most interesting exhibit. Of the musical instruments all that we can say here is that they form a splendid show, for while there are many, pianos for instance, exhibited only for their cases, there are several new or little-known inventions. Lovers of pipe-organs will find as many as they can properly examine in a day, though these are not all finished at present. Henry

Willis and Sons exhibit a large three-manual with pedals, without case, so that the mechanism of all parts can be inspected. Walker and Sons have a 4-manual with pneumatic, electro-pneumatic, and tubular pneumatic actions, but it is cased, as is the 3-manual instrument specially constructed by H. Jones and Sons for the Royal College of Music. We shall give the specification of this instrument, as it ought to be a typical specification for a concert organ of the size; but it may be mentioned here that it has a remarkably light touch without the use of the pneumatic action. Brindley and Foster show a model great organ of twelve speaking stops, one manual and pedal, with new tubular pneumatic action and improved pneumatic couplers; Bishop and Sons exhibit a church organ which is said to combine in one instrument the advantages of the Philharmonic and normal pitches; and Mr. Wedlake shows an organ of three manuals, with his new patent pneumatic action and improved double-action feeders. A few small chamber instruments are also exhibited; but the American organs or reed organs are almost as numerous as the pianos. Automatic instruments are shown in some variety, from the large orchestrion of Messrs. Imhof and Mukle, to one of the "perforated paper" toys, in which the working of the bellows, concertina fashion, is all that is necessary to "play any tune." Brass, string, and wood instruments are exhibited in considerable variety, and there is a considerable display of "fittings," which helps to make this part of the exhibition instructive. Of scientific apparatus and philosophical instruments there is so numerous a collection that it is almost impossible to even indicate them; but we may mention that all the recent inventions are well shown, and that M. Trouvé has intrusted to Mr. Aylmer a collection of his instruments and electrical apparatus, which will be shown in working order. The installation of the electric light will be the finest ever seen, and will include a great variety of machines and lamps, and at the same time give an opportunity for witnessing the performances of several high-speed engines, such as the Westinghouse, Armington and Sims, the Allen, the Willans, Mather and Platt, and such novelties as Goodfellow and Matthew's high-speed compound triplex, and the Tower spherical engine. "Old London" is to be lighted by arcs and glow-lamps, and with the shops occupied by weavers, makers of fancy goods, metal-workers, jewellers, lacemakers and embroiderers, engravers, &c., will form one of the most attractive sights in the Exhibition. We have endeavoured to give an idea of what is to be seen at the "Inventions," but we must obviously leave detailed explanations to future articles.

## ENGINE-MAKING AT HOME.—V.

### Miscellaneous Parts.

WITHIN the compass of this chapter I shall endeavour to embrace all that remains to be said about the construction of the engine patterns, and in succeeding articles give some hints on the fitting-up of their castings. The sketches being all dimensioned, their description will not occupy much time.

For the motion or guide bars (Figs. 51, 52), prepare the piece marked A to $\frac{7}{16}$in. thick, and cut as shown in plan, then rebate down at each end as indicated in the side view, this rebating being for the purpose of preventing the wearing of a shoulder near the ends by the slipper. Turn, and brad two circular facings, B B, on the back part, and two similar facings, C C, on the front. A curved strengthening rib D, will also be fastened on. Put a little taper in the rib, and tell the moulder to keep that in the top of the mould in order to insure sound metal in the facing.

The oil cup is made by fitting blocks E E against each side of the rib in the centre, and filling in between these and over the top of the rib with a strip of wood (Fig. 52, section). A print, F (section), is put on this, and a rectangular core box (Fig. 53) made to correspond. The same pattern will do for top and bottom motion bars without alteration, by providing a loose rib, exactly like the one on the pattern, for stopping off the oil cup by. A cover likewise (Fig. 54) to keep dust out of the cup, and a plain distance piece (Fig. 55) will be made. A special pattern will be required for the distance piece next the slide valve spindle, since that is made to take the spindle bearing (Fig. 56). The bearing piece is fitted to the distance piece, and the ribs which strengthen the casting also stiffen the pattern. It moulds with the faces A and B in top and bottom.

The cross head (Fig. 57) is proportioned for cast iron, but I should prefer to use wrought iron or gun metal on account of their superior tenacity. The pattern moulds as in plan, and is simply worked from a solid bit of mahogany, the piston rod end being turned first and the connecting rod end cut out with gouge and chisel. The slipper block (Fig. 58) consists of two pieces of wood only, and the inner or flanged portion is in the top of the mould.

The steam chest and slide valve are made like their castings. The sides and ends of the steam chest marked A, in the Fig. 59, are prepared and bradded together, and the back B fastened on, thus making a little open box. A shade of taper should be given within and without the sides. The flange C is prepared in four pieces, either mitred, or jointed with half-lap joints, or tenons at the corners, and fastened to the sides. The two strips, D D, for the valve, and those, E E, for fitting to the cylinder facing are not fastened with brads, but held loosely with skewers, which the moulder will pull out in due course. A facing, F, will be fastened to the back for the flange of the steam-pipe, and a ¾in. print—say, ½in. thick, will be fastened on the inside upon the same centre. The stuffing-box need not be made loose, provided it be cut as shown; neither will the flange be loose. The hole had better not be cored, being of small diameter.

The pattern valve (Fig. 60) is made thus: The middle block A is prepared to 2¾in. by 1⅝in. by 1⅛in., and cut without and within to the D outline (section) first. Then the outer pieces, B B, each 2¾in. by 1⅛in. by $\frac{3}{16}$in., are fastened against the sides of A, and worked to follow its outside contour. The blocks C C C are then fitted to the pattern and glued. When dry the hole D for the valve rod is cut through.

The steam chest gland (Fig. 61) consists of two pieces—one, A, cut to the oval shape; the other, B, turned and put on the flange with a stud.

Two cylinder covers (Figs. 62 and 63) are turned to the pattern dimensions out of dry, solid mahogany. The inner or cylinder faces will be turned first, the shoulders of which can be utilised for rechucking on the face plate when the outer faces are being turned. The bottom cover had better be turned to templet. The stuffing-box on the top cover should be turned separately and studded on, and its flange turned as a ring and dropped loosely over the print, as indicated in the section. The hole will be cored 1¼in. deep, leaving blank metal at the bottom, and a note to that effect must be made on the pattern for the moulder's guidance. The gland (Fig. 64) is made to dimensions given.

The piston pattern (Fig. 65) will consist of a plain disc. The recesses will be turned for the rings in the casting.

The eccentric sheave will be a solid pattern (Fig. 66), having a boss upon one side and a ¾in. print put on out of centre as shown. The grooves on the edge will be turned in the casting. The pattern of the strap (Fig. 67) will be cut out of a solid bit of mahogany, and the block A for the eccentric rod (Fig. 68) will be fitted separately, so that the one pattern (Fig. 67) will answer for the second (Fig. 68) with the addition of the block. Of the relations between the eccentric and the slide valve, I shall speak in connection with the details of fitting up.

The brasses for the connecting rod end being small (Fig. 69) are best cut from the solid, the grain running transversely to the bearing to avoid short grain in the flanges.

The pattern of the pump (Fig. 70) is turned in two portions A and B, each with its prints C, C, C. There is no need to joint so small a pattern. Make it of mahogany, the grain running longitudinally, and then the flanges may be turned out of the solid instead of going to the trouble of fitting them into recesses in the body after the fashion in larger patterns. The two portions A and B are fitted together at their junction with a gouge, glued, and allowed to set, then one fine screw on each side is put in diagonally to assist the glue. The two feet, D D, worked to the shape shown in Fig. 71, will be maintained loosely in place with a simple dowel in the centre. I should make this pump in gun metal. A core-box jointed longitudinally and dowelled will be worked out for the body core. Being small, it must be made in mahogany, marked out truly, and worked very carefully. Fig. 72 shows one-half of the box open in the joint.

In so small a pump I prefer to have the valve seatings distinct from the pump body. Fig. 73 shows a seating pattern, in section, made for bolting to the top and bottom flanges.

A plain flange (Fig. 74) will be wanted for the suction, and a flange with a short branch (Fig. 75) for the delivery. For the latter a small core box (Fig. 76) will be wanted. The small valve pattern (Fig. 77) is best turned in the cup chuck, and the wood between the feathers cut away before the pattern is detached from the chuck. The pump gland (Fig. 78) is made similarly to the other glands.

It will be observed that the glands and flanges look somewhat out of proportion to the size of the engine. But this cannot be avoided if we are to have sufficient metal to allow of screwing up without risk of fracture.

There must be no hard iron in any of these castings. Soft No. 1 Scotch, or a mixture of Scotch and scrap, both soft and tough, must be stipulated for, and the price paid. There are, I estimate, 106lb. of cast iron right through, and 18s. or £1 would not be too much for the set, provided they are good. Better pay that than 12s. or 14s. for a rough set. The brass will weigh about 6lb., not, however, including the pump, which would weigh about 1½lb, and is not, strictly speaking, brass at all, but gunmetal. This will cost 1s. a pound.

## SIMPLE EXERCISES IN TECHNICAL ANALYSIS.—VII.

By An Analytical Chemist.

### Black Paints.

(82.) THE black paints are so simple that it will not be necessary to do more than give the composition of a few average samples. Carbon black is the pigment chiefly employed; but it is not usually necessary to distinguish which kind of carbon black is used. The quality and suitability of the sample may be roughly judged by spreading a thin layer of the paint on a smooth board or a piece of paper. The loss on ignition of such paints includes both the carbon and the oil; and for ordinary purposes it is not necessary to estimate them separately.

MIXED BLACK PAINT.

(83.) *Composition*:—

| | | | | | |
|---|---|---|---|---|---|
| Oil and carbon .... | 20·50 | 21·5 | 19·6 | 21·7 | 23·4 |
| Sulphate of baryta | 28·15 | 28·1 | 31·8 | 41·4 | 38·5 |
| Oxide of iron .... | 16·25 | 14·0 | — | 9·0 | 9·5 |
| Chalk ............ | 35·10 | 36·4 | 48·6 | 27·9 | 28·6 |
| | 100 | 100 | 100 | 100 | 100 |

COMMON MIXED BLACK PAINT.

(84.) *Composition*:—

| | | | | |
|---|---|---|---|---|
| Oil and carbon ...... | 17·00 | 21·10 | 21·84 | 19·72 |
| Sulphate of baryta .. | 45·70 | 37·50 | 41·04 | 45·84 |
| Oxide of iron ........ | 7·12 | 6·83 | 4·02 | 7·28 |
| Chalk ............... | 30·18 | 34·57 | 33·10 | 27·16 |
| | 100 | 100 | 100 | 100 |

MIXED OXIDE PAINT.

(85.) *Composition*:—

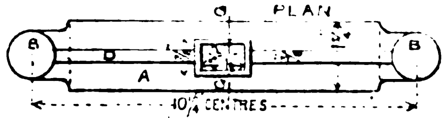
| | | | | | |
|---|---|---|---|---|---|
| Oil and carbon.... | 21·3 | 25·5 | 26 | 26·06 | 34 |
| Oxide of iron .... | 74·2 | 70·7 | 74 | 71·44 | 66 |
| Chalk............ | 4·5 | 1·2 | — | 2·50 | — |
| Sulphate of baryta | — | 2·6 | — | — | — |
| | 100 | 100 | 100 | 100 | 100 |

MIXED MAGNETIC BLACK PAINT.

(86.) *Composition*:—

| | | | | |
|---|---|---|---|---|
| Oil and carbon .... | — | 57·50 | 31·34 | — |
| Oxide of iron .... | 49·79 | 11·98 | 30·10 | 50·75 |
| Sulphate of baryta | 29·20 | 19·74 | 18·44 | 26·07 |
| Chalk............ | 21·01 | 10·78 | 19·82 | 23·18 |
| | 100 | 100 | 100 | 100 |

FIG. 50.



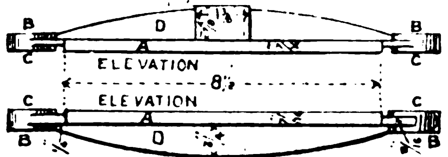


FIG. 51.

FIG. 52. SECTION G.G.

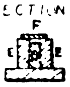
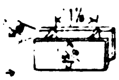


FIG. 53.



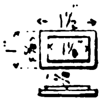


FIG. 54.

FIG. 57. SIDE VIEW PLAN

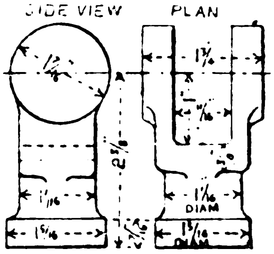


FIG. 55.

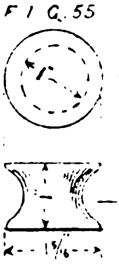


FIG. 56. PLAN, SIDE VIEW

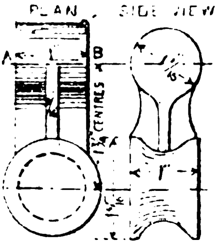


FIG. 58.

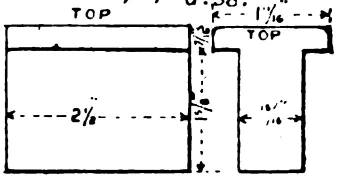
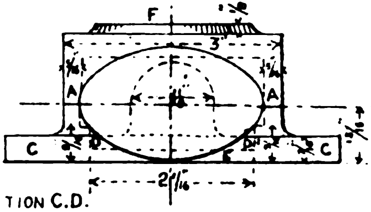


FIG. 59. END VIEW



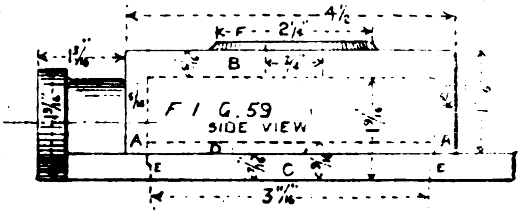
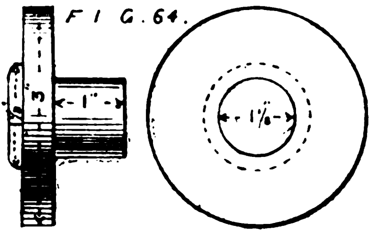


FIG. 64.



SECTION C.D.

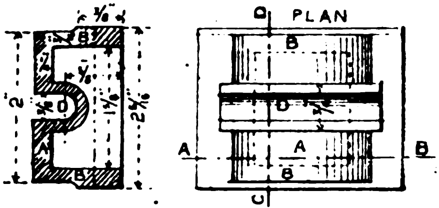
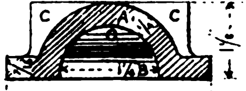


FIG. 60.



SECTION ON A.B.

FIG. 59. PLAN

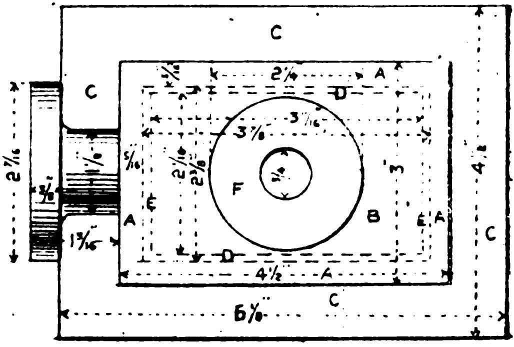


FIG. 61.

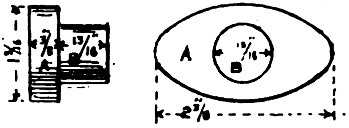


FIG. 65

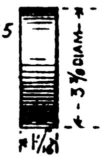


FIG. 63.

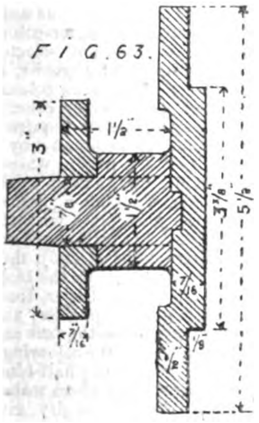


FIG. 62.

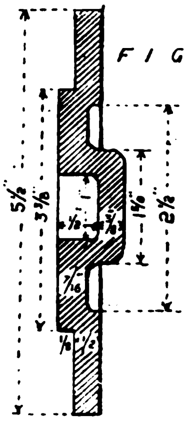


FIG. 66.

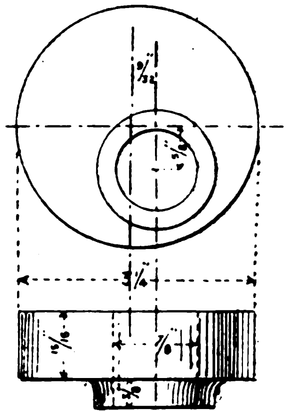


FIG. 67. FIG. 68.

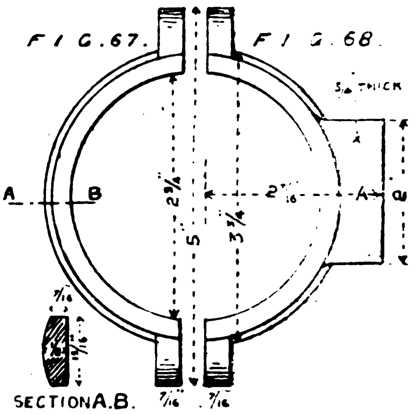


FIG. 75.

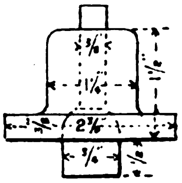


FIG. 76.

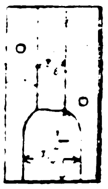
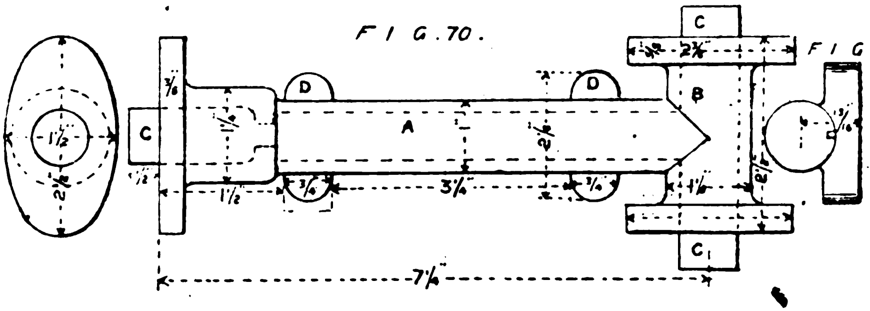


FIG. 70.



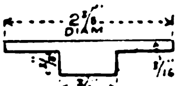


FIG. 73.

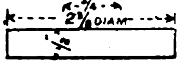


FIG. 74.

FIG. 72.

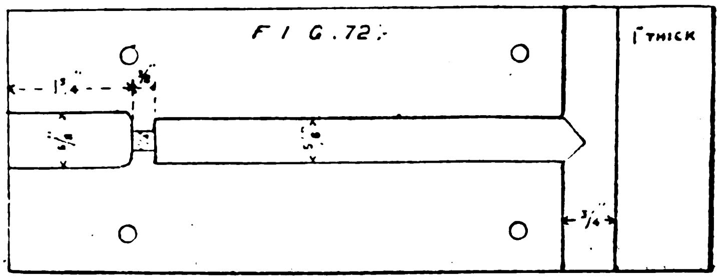
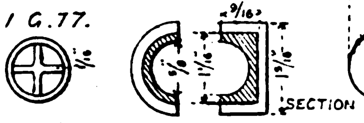


FIG. 77.



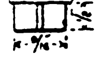
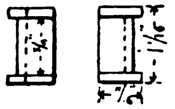


FIG. 69.



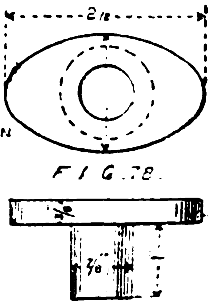


FIG. 78.

ENGINE MAKING AT HOME.

(87.) The value of this paint depends principally on the percentage of oxide of iron which it contains. A very high percentage—60 or 70—is objectionable if the paint has to be kept a long time before being used, for such paints set very hard.

### Navy Black Paint.

(88.) *Composition* :—

| | |
|---|---|
| Oil and carbon | 84·70 |
| Insoluble silicates | 5·65 |
| Oxide of iron | 4·15 |
| Chalk | 5·50 |
| | 100· |

### Black Silicate Paint.

(89.) *Composition* :—

| | | |
|---|---|---|
| Oil and carbon | 19·3 | per cent. |
| Insoluble silicates | 71·86 | ,, |
| Chalk | 8·84 | ,, |

## Brown Paints.

(90.) The analysis of these will require no special description. We shall therefore content ourselves with giving the composition of a few samples. A ferruginous earth is the pigment usually employed.

### Mixed Brown Paint.

(91.) *Composition*:—

| | | | |
|---|---|---|---|
| Oil | 17 00 | 15 75 | 17·00 |
| Oxide of iron | 6·55 | 8 45 | 6·50 |
| Sulphate of baryta | 34·45 | 24·90 | 76·50 |
| Chalk | 42·00 | 50·90 | |
| | 100 | 100 | 100 |

### Mixed Chocolate Paint.

(92.) *Composition*:—

| | | | | |
|---|---|---|---|---|
| Oil | 14·05 | 14·7 | 15·7 | 11·5 |
| Oxide of iron | 81·00 | 41·0 | 38 0 | 84·3 |
| Insoluble silicates | 4 95 | — | — | 4·2 |
| Sulphate of baryta | — | 31·1 | 35 5 | — |
| Chalk | — | 13 2 | 10 8 | — |
| | 100 | 100 | 100 | 100·0 |

### Mixed Chocolate Oxide Paint.

(93.) *Composition*:—

| | | |
|---|---|---|
| Oil | 13·4 | 13·2 |
| Oxide of iron | 86 6 | 86 8 |
| | 100 0 | 100·0 |

## Other Paints.

### Lead Colour Paint.

(94.) *Composition*:—

| | | | | | |
|---|---|---|---|---|---|
| Oil and carbon | 23·1 | 19·3 | 22·2 | 15 95 | 20·1 |
| Sulphate of baryta | 29 0 | 30·5 | — | 21·50 | — |
| Chalk | 16·5 | 39·3 | 0 5 | 26·00 | 9·1 |
| Zinc white | 31·4 | 10·9 | — | — | — |
| White lead | — | — | 77·3 | 36 55 | 70·8 |
| | 100 | 100 | 100 | 100 | 100 |

### Buff Paint.

(95.) *Composition*:—

| | | |
|---|---|---|
| Oil | 14·75 | 13 8 |
| White lead<br>Colouring matter, viz.:—<br>Chrome yellow and red lead | 58 40 | 60·9 |
| Chalk | 26 85 | 25·3 |
| | 100 | 100 |

(96.) In the analysis of buff paints it would serve no useful purpose to endeavour to estimate the white lead separately when red lead is one of the pigments used. It is sufficient, therefore, for general purposes to estimate the oil and chalk carefully and the others by difference, the analyst satisfying himself of the nature of the latter by qualitative examination.

### Anti-Corrosion Paint.

(98.) *Composition*:—

| | | | | | |
|---|---|---|---|---|---|
| Insoluble silicates | 45 60 | 50 00 | 45·56 | 46·48 | 42·60 |
| White lead | 41·60 | 41·90 | 43·98 | 38·10 | 37·80 |
| Chalk | 5 04 | 4 48 | — | (+$Fe_2O_3$)8·10 | 12 50 |
| Alkaline sulphates (soluble in water) | 3 84 | — | — | — | — |
| Moisture | 1·92 | 3 62 | — | — | — |
| Carbon | 2 00 | | — | ·40 | ·42 |
| Zinc oxide, carbon, and moisture | — | — | 10 46 | — | — |
| Loss on ignition | — | — | — | 6 92 | 6·68 |
| | 100 | 100 | 100 | 100 | 100 |

### Grey Iron Paint.

(97.) *Composition* :—

| | | | |
|---|---|---|---|
| Insoluble silicates | 7 3 | — | — |
| Carbon | 2·6 | 5·15 | 3·2 |
| White lead | 20·1 | 10·74 | 8 8 |
| Oxide of iron | 7 8 | 19 60 | 20·1 |
| Chalk | 50·4 | 6 40 | 4·8 |
| Oxide of zinc | 11·8 | 21·27 | 12·0 |
| Sulphate of baryta | — | 36 84 | 51·1 |
| | 100 | 100 | 100 |

### Anti-fouling Composition (for Ships' Bottoms.)

(99.) *Composition* :—

| | | | | | |
|---|---|---|---|---|---|
| Naphtha and volatile matter | 5·92 | 6 30 | 36 23 | 45·45 | 39·74 |
| Oil | 25·24 | 27·44 | 26·95 | 36·92 | |
| Insoluble silicates | 1·90 | 1 73 | 6·56 | 1·89 | 1·63 |
| Oxide of iron | 2·30 | 2·75 | 24 20 | 6 93 | 2·26 |
| Chalk | — | 1·89 | 6 06 | 8 81 | 1 97 |
| Oxide of zinc | 61·25 | 55·76 | — | — | 51 05 |
| White lead | — | 4·13 | — | — | 3 35 |
| Oxile of lead | 3·39 | — | — | — | — |
| | 100 | 100 | 100 | 100 | 100 |

### Liquid Iron Paint.

(100.) *Composition* :—

| | |
|---|---|
| Oil | 47 98 |
| Insoluble | 43·15 (chiefly silicates) |
| Oxides of Iron and manganese | 8·87 |
| | 100 |

### Rose Pink Paint.

(101.) *Composition*:—

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Moisture— | 13 4 | 8·75 | 20·30 | 9 60 | 26·52 | 23·40 | 24·82 |
| Organic colouring matter— | 17·5 | 9·35 | 18·70 | 18·55 | 19 08 | 14·36 | 15 50 |
| Chalk— | 60 3 | 73·55 | 55·15 | 62·35 | 45·62 | 55 84 | 52 66 |
| Alumina— | 8 8 | 8·35 | 5·85 | 9·50 | 8·78 | 6 40 | 7 02 |
| | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

## New Paints.

(102.) *Composition* :—

| | "Albissima" Paint. | "Duresco." |
|---|---|---|
| Oil and turpentine | 16·74 | 43·22 |
| Sulphate of baryta | 43 92 | 43·32 |
| Oxysulphide of zinc | 39 34 | 10 40 |
| Oxides of iron and alumina | — | 1·72 |
| Chalk | — | 1·34 |
| | 100 | 100 |

### Driers for Above.

(103.) *Composition*:—

| | | |
|---|---|---|
| Moisture | 14·68 | 99 |
| Sulphate of lime | 71·91 | |
| Borax | 11·61 | — |
| Sand | 1·80 | — |
| Sulphate of manganese | — | 1 |
| | 100 | 100 |

### Driers for Ordinary Paints.

(104.) *Composition* :—

| | | | |
|---|---|---|---|
| White Lead | 18·7 | 25 81 | 22·71 |
| Chalk | 62·5 | 48·55 | 57·00 |
| Oil | 16·0 | 16·38 | 20 29 |
| Manganese salts | 2 8 | 9·26 | traces. |
| Iron salts | | | |
| Zinc salts | — | — | |
| | 100 | 100 | 100 |

A sample of driers submitted to us was pure acetate of lead (sugar of lead).

### White Impenetrable Paint.

(105.) *Composition*:—

| | | |
|---|---|---|
| White lead | 63·27 | per cent. |
| Oil and turpentine | 36·73 | ,, |

### Sanitary White Paint.

(106.) *Composition* :—

| | | |
|---|---|---|
| Zinc white | 34·46 | per cent. |
| Sulphate of baryta | 57·35 | ,, |
| Oil | 8·19 | ,, |

### White Enamel Paint.

(107.) *Composition*:—

| | | | |
|---|---|---|---|
| No. 1. | Oil | 51·72 | per cent. |
| | Insoluble earthy matter | 1·4 | ,, |
| | Zinc white | 46·88 | ,, |
| No. 2. | Oil and Turpentine | 60·15 | ,, |
| | Zinc white | 39 85 | ,, |

### White Silicate Paint.

(108.) *Composition*:—

| | | |
|---|---|---|
| Oil | 13 22 | 11·43 |
| Insoluble (silicates, &c.) | 64·14 | 64·16 |
| Oxysulphide of Zinc | 22·64 | 24·41 |
| | 100 | 100 |

(109) The composition of the samples given above will doubtless be useful to many. Some of these paints have been recently introduced some are not very common, but all are likely to be met with in commercial analysis.

It will be seen from the figures given that some of the paints are of no special value, and are in no way superior to those ordinarily used.

*(To be continued.)*

# A SIMPLE METHOD OF COLOURING AND ENAMELLING PHOTOGRAPHS.[*]

THE following method of colouring and enamelling prints has proved in the hands of those to whom I have given instructions of very great value (commercially). Excellent results are attained at once with very little labour and the minimum of art knowledge. It is not intended to replace any of the "legitimate" methods of colouring photographs, but rather to displace the "chrystoleum." At the first glance, it will strike many as being this process; but the results are so much finer, and with this difference, that the opaque and too dark parts of the photograph are capable of being coloured. This cannot be done with the chrystoleum, it being possible only to *tint through* the very light parts of the print. The operator will, after a few trials, be able to rival many of the laboriously-stippled photographs, and never risk losing the resemblance. I am convinced, also, a much greater degree of permanence is attained in the photograph itself by the treatment it undergoes. I have subjected prints thus treated, with one-half of the face covered with opaque paper in the printing frame, to the sun for many months, and at the end of the summer it was barely possible to detect the line of exposure. This was a test sufficiently severe, and convinced me that prints with the ordinary subdued light they are always viewed in would not suffer; the margin of the white mounting board suffered more from the exposure than did the coloured print, and was considerably bleached.

The following is a list of the requirements:—Fine pumice powder, such as used by dentists; two or three sable brushes—oil sables answer quite as well, and are very much cheaper than water-colour brushes; rose madder; orange vermilion, selected on account of its body; Chinese white (moist, in bottles); Indian red (for body). These few colours are all that are necessary for flesh; other colours may be added for hair, draperies, &c., as required. A piece of thick boiler-plate iron, say about 8 by 6 inches; several sheets of blotting paper, white; solid paraffin (wax); paraffin oil; cotton-wool; gelatine, Nelson's No. 1; enamel collodion; flannel to filter. First prepare the glass plate with the enamel collodion and gelatine (those who have not previously done this, see instructions at end), then take an unmounted print, lay it down on the blotting-paper, and with the tip of the finger, freed from grease, rub with a little pumice powder, and with a circular motion, very gently on the face and hands only, to give a slight tooth for the colouring; do not abrade the surface or destroy any half-tone. Now wash the face with a brush and clean water, and pass the tongue over it. As soon as dry, give a flat wash all over the face, eyes and all, with a flesh tint of rose madder and orange vermilion. As soon as dry (which will be by the time another print is thus prepared), clean out the eyes with the brush nearly dry. Now take body colour, and colour such parts as brooches or any portion that comes too dark in the photograph, on the albumen surface, using a little of the Chinese white in the body colour, and put in all high-lights of lace, &c.; also tint the lips, which are too dark, the upper one especially, with rose madder and Indian red. All this may be done in less time than is required to write it, and is all that is required to be done on the surface.

The next proceeding is to wax and make transparent the print, which also binds the colour already on. This is effected thus: place the print face down on several thicknesses of blotting-paper placed on the heated iron plate, and with the solid block of paraffin rub over the back; if the iron be sufficiently heated, in a minute or so the wax will permeate the print and render it very transparent; let it be thoroughly saturated, and immediately with a clean cloth remove all superfluous wax from the back and front. Now take a pledget of cotton-wool, and with the paraffin oil rub lightly both sides; allow it to soak well in for two or three minutes. With clean cloth rub off all the oil, and dip it entirely in the melted gelatine (prepared as at end), and squeeze it on the glass previously prepared with the enamel collodion. Wash all gelatine off the back with a sponge and warm water; there will now be no greasiness, and the glass can be placed on a retouching desk with a sheet of white card as a reflector, and coloured at the back. The face may now have the under lip and cheeks coloured, and the hair, ribbons, &c., and can be examined for the complexion by placing a piece of white paper closely pressed behind it. It will rarely require more colour on the face than the carnations, unless the first colouring on the albumen has been too pale. The draperies and background may now have very strong colour on to tell through the tone of the photograph, but the colour on the face should be very delicate, as when finally backed up they appear much stronger. When the colour is dry again pass over the paraffin oil, this time lightly dabbing it only; allow it to remain three minutes, and as carefully dab off with clean cotton. Do not rub it, or the colour will be disturbed. The thin mounting board, such as is used for enamelled print, is now gelatinised and squeezeed to the coloured print, and left till thoroughly dry. The object of this last application of paraffin oil is to prevent the possibility of the squeezeing disturbing the colour. Do not attempt to strip it from the glass until thoroughly dry (say next morning), then mount it in the usual manner by gluing about one-eighth of an inch round the edge of the thin cardboard after trimming, then place under pressure. The following method of preparing the enamelled surface on the glass sheets will be found a simple and certain one. Procure a sheet of plate glass free from scratches. The most useful size is 12½ inches by 9; this size will take several cabinets, promenades, or cartes without waste of enamelled surface. With a file or emery cloth rough about one-eighth of an inch all round the edges, to prevent the prints leaving the glass before quite dry. Rub the glass (when new) several times with waxing solution:—

---

[*] By T. G. Whaite, in the *Photographic News*.

| | |
|---|---|
| Best yellow wax .......... | 5 grains |
| Benzole .................. | 1 ounce |

Rub it on with a pad of tissue paper, and with another pad rub off, and finally polish with the palm of the hand, removing all that is possible in this manner, or streaks in the enamelled surface will show.

A piece of new glass requires treating thus several times before it is suitable for receiving the prints; afterwards, one rubbing on and off is all that is required. The glasses must never be washed after stripping, but be kept out of the dust, and any bits of film left on the margin rubbed off before re-waxing. Now coat with the enamel collodion, either purchased or made thus:—

| | |
|---|---|
| Gun-cotton.............. | ½ ounce |
| Meth. alcohol............ | 45 ounces |
| Meth. ether.............. | 25 „ |
| And a few drops of castor oil. | |

After coating, leave in a dry place until set well, and all the ether has passed off; then pour over in the same manner the warm gelatine solution, having been previously filtered through flannel. The gelatinising solution is thus composed:—

| | |
|---|---|
| Nelson's No. 1 gelatine .. | 1 pound |
| Water .................... | 128 ounces |
| Meth. spirit.............. | 40 „ |
| Glycerine................ | 1½ „ |

Soak the gelatine first, then warm, and filter. The prints may be laid on this as soon as set if necessary, but a better surface is obtained if allowed to dry.

It is important in colouring to remember to clear out the high lights at the back from forehead, &c. This leaves only the first colouring on the albumen to tint the lights, which will be found quite sufficient, otherwise the face will have a flushed look when backed up with the cardboard. Every necessary detail is explained here, and if followed closely failure is impossible, and will be found, after one rehearsal, a rapid and extremely simple method.

## SAND SOAP AND TRANSPARENT SOAP.

ACCORDING to the *Seifensieder Zeitung*, under the name of sand soap a new detergent of peculiar appearance and composition, of English origin, has been recently placed upon the market. It is greyish white in colour, heavy as stone, and rough and sandy to the touch; on rubbing the hands with it, particles of sand adhere to the skin. It is, in fact, an intimate mixture of fine sand with ordinary soap. In order to ascertain its composition, the writer has subjected it to analysis, and finds it to contain 70 per cent. of fine sand; the saponified fat was palm oil. Experiments showed it to have no disagreeable or damaging effect on the hands when used as a detergent, and proved it, moreover, to be an excellent cleansing soap, especially suited for the use of workmen engaged in rough and dirty vocations. The author has made various experiments with a view to ascertain the maximum amount of sand which a soap of this kind can take up, and finds that 100 parts of soap can take up 200 parts of sand, but it is not advisable to add the full quantity, as the mixture will no longer lather properly. To make a good "sand soap," the author recommends the following method: 100lb. of cocoanut oil are saponified with about 200lb. of lye at 20° B. The soap is then hardened by the addition of about 8lb. salt dissolved in water to a density of 15° B., with the addition of 6lb. to 8lb. soda ash. The soap is now covered up, and the foam allowed to subside. After standing five to six hours, the fob is skimmed, and the soap is run off into the coolers. While this process has been going on the sand has been dried and sifted, and, the soap now being thoroughly crutched, the sand is sifted over it, until 100lb. to 150lb. have been added. The crutching must be continued until the mass is perfectly cooled. The soap is very firm and hard, and must be cut as soon as cooled. To perfume the mixture add of essential oil of lavender, thyme, and coriander 100 grammes each.

### Transparent Glycerine Soap.

The manufacture of transparent glycerine soap does not present any special difficulty; there are, nevertheless, points which it is essential to observe. To produce first-class soap of this kind good materials are indispensable, and the proper proportions must be strictly adhered to. Tallow and stearine are the most useful hard fats, palm oil imparts to the soap its lathering qualities, and castor oil gives transparency. Great transparency is attained by the use of spirit and of sugar-water, both of which bodies assist the normal saponification. The lye must be pure and clear as water; its proportion should not exceed 20 per cent. of lye per pound of fatty matter, for an excess of alkali would make the soap too detergent, and a considerable excess of unsaponified fat would make it too weak and greasy. In one case the soap injures the skin in use, in the other the soap would soon lose its agreeable smell, and finally become rancid. Even an excess of glycerine is to be avoided, as it renders the soap less transparent, and also too soft. No filling whatever, except sugar solution, is permissible. The following proportions are recommended:

### White Alabaster Soap.

Stearine, 13lb.; palm oil, 22lb.; glycerine, 13lb.; 38° lye, 18lb.; 96 per cent. alcohol, 26lb. The stearine and palm oil are to be heated to 65°, saponified with the lye, the alcohol added, and when the combinination, which takes place at once, is complete the glycerine is put in. When clear, the kettle is covered, and the contents are allowed to stand at 45° R. The soap is run into the moulds, and perfumed with bergamot oil, 120grm.; geranium oil, 30grm.; neroli oil, 24grm.; citron oil, 30grm. As this is a white soap, no colour is added.

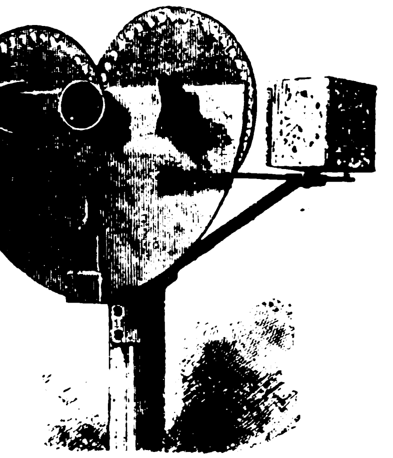
### Transparent Soap.

Tallow, 20lb.; palm oil, 12lb.; castor oil, 8lb.; 38° lye, 20lb.; spirit, 20lb.; glycerine, 20lb.; sugar dissolved in, 5lb.; water, 5lb. Process as above. Perfume with oil of bergamot, 250grm.; citron, 90grm.; lavender, 20grm.; neroli, 30grm.; rosemary, 5grm.; and a few drops of otto of roses, dissolved in 1lb. of 96° alcohol; colour with saffron substitute.

## COMPOUND OPTOMETER FOR CORRECTING ERRORS OF REFRACTION.

IN making examinations of the eye for the purpose of determining its refraction and the adaptation of spectacles to correct defects which may exist, the first part of the process is to determine visual acuteness. Letters are placed before the individual whose eye is being examined of varying sizes; some to be seen by the normal eye under a visual angle of 5' at 200ft., and from that down to the distance at which the letters are from the observer. In order that the refraction of the eye be correctly measured, it must be in a state of rest—adjusted for parallel rays; and this ophthalmologists claim can only be secured by placing objects to be observed at a distance, and 20ft. has been accepted as the distance which practically accomplishes this object. But it is claimed that the optometer herewith illustrated renders rays emanating from objects placed at 13in. from the eye parallel, and consequently measures the refraction perfectly. Lack of visual acuteness may be due to a defect in the perceptive part of the eye, the retina, or to a refractive anomaly. To determine this a concave and a convex lens, about one-thirtieth, are alternately placed before the eye, and if either improves the vision there is either myopia or hypermetropia. The number of the glass that produces the greatest visual acuteness measures the refractive error. If neither the concave nor convex lens increases the visual acuteness, the test for astigmatism is made, and when none of these tests improves vision the defect is in the retina. This is the procedure followed by occulists, and while being correct theoretically and in its practical results, it is stated to be awkward and tedious when compared with the optometer.

The optometer shown in the accompanying engraving has an upright of about 12in., upon which are mounted two circular discs, one for spherical and the other for cylindrical lenses. Each disc can be so revolved that the lenses can be brought in front of a common opening or eye tube, through which the observer sees letters. The disc containing the cylindrical lenses is attached to an arm, by which it has a movement besides the one upon its central axis, and whereby the axes of its cylindrical lenses can be placed in any degree of a circle before the eye tube. The discs are so situated that the lenses of one can be interposed with that of the other, thus combining their effect if necessary. Upon the extremity of a horizontal bar attached to the upright, about 12in. in length, rests a card rack, in which the test letters are placed 13in. from the observer's eye.



The spherical lenses are 38 in number, 19 concave and 19 convex, embracing a series from $\frac{1}{74}$ to $\frac{1}{4\cdot5}$. Intervening between either extremity of the positive and negative lenses is a plain glass. The disc containing the cylindrical lenses has the same arrangement as the one containing the spherical, as mentioned above. There is an eyepiece for the eye being examined, while the other will be deeply shaded, thus practically disposing of the inclination to convergence. The reason for this is that convergence and accommodation are co-ordinate acts, and in this case by controlling the convergence the tendency to accommodate is also greatly controlled.

At the extremity of the eye tube, and with the centre of its system, about 2in. from the cornea, as it rests in the eyepiece, is placed an objective which is a compound achromatic lens, the principal focus of which falls on the test letters on the card. This practically produces a myopia of $\frac{1}{11}$. The rays proceeding from the objective to the eye are of necessity parallel, since the test letters are at the principal focus of the objective. It is claimed that this disposes of the objection to the instrument by those who state that it will not relax accommodation. Placing the objective outside of the anterior focal distance of the dioptric media of the eye magnifies the letters to be observed, but this in no way changes the results of the test for refraction, but the letters used should be proportionately small, if a test for visual acuteness be made, else the visual angle of 5' will be changed; if the letters are magnified one-half, they should be one-half smaller.

In the construction of the system for measuring visual acuteness with this optometer, a letter is used for a basis, the measurement of whose diameters forms the base of an angle of 5", the distance from the centre of the system of the objective to the letters forming the sides of the angle. If the eye were placed at 11in. from the letters, they would be the same size as the objective renders them at 13in., so that the visual angle is measured from the centre of the system rather than from the position of the cornea. The letter, then, at 11in. should have a diameter of $\frac{11}{60}$ of a line, or for practical purposes $\frac{1}{5}$ of a line. For the purpose of keeping a record of visual acuteness, as by the method of Snellen, when the smallest letters can be read, which are $\frac{1}{5}$ of a line in diameter, it may be stated that $V = \frac{20}{20}$. When the next letters, which are one-half larger, are the smallest that can be read. V may be marked $\frac{20}{40}$, and so on up to 200ft. This optometer, which is the result of several years of careful study and experiment, has been patented, and is now manufactured, by Mr. L. A. Berteling, of 427, Kearny-street, San Francisco, Cal.—*Scientific American.*

# WHEAT-MEAL BREAD: ITS ALIMENTARY VALUE COMPARED WITH THAT OF WHITE-FLOUR BREAD.*

By Dr. Campbell Morfit, F.I.C., F.C.S.

THERE is such a diversity of chemical opinion as respects the nourishing potentiality of wheat-meal breads, that a satisfactory solution of the question by chemical analysis alone would seem to be difficult, for the present at least. But if we leave the chemists disputing amongst themselves, and pass from the domain of speculative philosophy on to the safer ground of practical science, mystification is seen to clear away at once, and there is revealed to us by the logic of facts the true state of the case, which I will now endeavour to explain.

Whole wheat-meal bread was the kind upon which the Roman army fed in the time of Julius Cœsar; and in the earlier part of this century Dr. Sylvester Graham, of New England, recommended its use in the United States, where it is now known as Graham bread, and is highly appreciated by bread consumers generally. But until I made the process for the granular form of wheat meal and gave it to the London Bread Reform League, whole meal was coarsely ground and contained its bran as dense flattened scales with sharp points and rough edges, which rendered it irritable to digestive organs the least sensitive. My improvement, which removed these defects entirely, secured for the granular meal a widespread popular favour that has not become universal only because the millers and bakers, failing to understand the philosophy of its manufacture, allow both it and its bread to degenerate into irregularities. Granular wheat meal, unlike the ordinary whole meal, not only makes more toothsome breads, but insures the maximum degree of assimilation, because it is without that mechanically stimulating effect which hurries the whole meal through the alimentary duct before it has had time to yield all its nourishing matter to absorption. Whatever small portion may be excreted has yet acted an essential part in the process of digestion at least, though we may not be able to define it at present.

There are chemists who encourage a wasteful mode of milling by repudiating the long-accepted doctrine as respects the physiological relation of the nitrogenous compounds of wheat. Their scientific contention not only splite the nitrogenous matter of food substances into divers phases with differential properties, but apportions to each a differential estimate of its nourishing capabilities. One of their tenets in this connection is that, however much nitrogenous matter may be present, only that portion of it distinguished by them as albuminoid, and which exists as protein (the basis of albumen, casein, fibrin, and the like), is potential for the nourishment of mankind. Indeed, some go so far as to suggest that even a part of the albuminoid nitrogen is of doubtful efficiency in that respect; and dividing the nitrogenous matter into two phases, one coagulable by acids and the other not, they throw out the latter as unavailable food matter. Its proportion may and does vary so widely in the same kind of food as to amount to as little as 5 per cent. in some samples of wheat, and rises to 34 per cent. in others; but these great discrepancies do not affect their judgment in the least. By this social arrangement in chemistry they ostracise nuclein, plastin, and their congeners, as dietetic pariahs; and in the case of wheat, they would relegate to the cattle-food bin all of the branny portion which, though representing about a fifth of the total nitrogen of the grain, contains most of it in other phases than the albuminoid—notwithstanding, too, that it carries with it most of the fat and phosphates, and the whole of the cerealine, the digestive ferment natural to the grain.

But while convinced by recent experiences that every part of the wheat grain is food for mankind, I know also that a portion of the branny integument, amounting to 6 per cent. of the whole grain, detracts from the toothsomeness of the baked loaf. Practically, therefore, this tough husky modicum is objectionable in a bread sense, and decortication does not remove it, nor can it be separated from the meal when the wheat grain has been ground in a steel mill. My old process conceded to the Bread Reform League, consequently, must be discarded, because it involves both decortication and the use of steel mills. I now not only make the elimination of the tough bran an incident of the grinding operation, and save any outlay for the purpose, but simultaneously render the tender portion yet more loose and soft in texture, and consequently am able to produce at the minimum of waste and cost, firstly, a standard granular meal of refined character, representing from 93 to 94 per cent. of the cleaned grain, and always uniform in quality and features; and, secondly, a pearl-white meal representing all the farina of the grain with some cerealine, or about 83 per cent. of the whole, and affording a superior material for a white loaf to excel the "household" bread of the bakers. The perfection of these meals faciliated my subsequent improvements in bread-making, and the two combined not only accomplished a saving of 10 to 13 per cent. in the milling operations, but will supply standard meals and breads at less cost than usual.

As yet the public have not had the opportunity for testing the great advantages of genuine wheat-meal breads, because bakers in this country are unable or unwilling to make them properly, and millers do not supply suitable meals. Wheat-meal bread as it should be is attractive in appearance, and very unlike the poor stuff sold as such in the London shops. Whether made by fermentation or without, its basis is granular meal free from any of the usual admixtures or substitutes of white dough or dusted bran and white flour. Its crust is tender and smoothly granular, instead of being rough and hard, and, in the case of fermentation breads, deliciously crisp. The crumb, vesiculated, light, and elastic, is never sodden or too close, becomes stale slowly, has a rich mealy taste, and when chewed excites the salivary secretion. The bran particles are invisible to the eye, even through a magnifying-glass, and, save that they impart an agreeable taste, scarcely betray their presence to the tongue. The outward features and inherent qualities of the breads of my system are characteristic and uniformly the same. Not only are they appetising, but, weight for weight, much more nourishing than white-flour breads.

In realising this standard excellence for meals and breads I employ only the usual means, but manage them in unusual ways so as to produce new and important effects. Success is obtained in my system of procedure, not by adopting the dogmas of those chemists whose cult is the aristocratic albuminoids, but by practising a rational philosophy of conflict with them. I act upon my belief that each food substance carries, naturally, an adjuvant of digestive ferments peculiar to itself, as wheat bears cerealine, which, when loosened from its bonds by compatible means, receives the impulse to co-operate in preparing its associate constituents for digestibility in the human stomach. The observance of this principle has enabled me to convert even milk into a cheese of characteristic toothsomeness and digestibility, chiefly because the latter reclaims and embodies the wealth of essentials now run to waste in the whey. Even my pearl meal, therefore, is made to retain as much as possible of the cerealine matter of the wheat; and when either it or the granular meal is mixed into dough, water is made to set free the digestive ferment for action. This done, the dough, without being touched with the hands, is partitioned in a manner to protect it against injurious influences or changes during fermentation in any weather, and to insure its perfect cooking in the oven without risk of spoiling a loaf by scorching or otherwise. The water is confined within the loaf until it has co-operated with the cerealine in developing the digestibility of the dough, and in promoting the baking or rather cooking of it into perfect bread; so that the portion necessary for its constitution remains in the loaf as a fixture, the excess passing off only when it has done its part in the cooking.

The crumb and crust of the breads made by my system contradict impressively the arguments against whole-wheat meal. But chemical analysis obtains so little interpreting assistance from physiological research in the premises, that it occurred to me to seek a fuller understanding of the subject in a way quite different from any hitherto conceived. That is, having satisfied myself, by oft-repeated practical experiments, that standard breads in every respect can be made with wheat meals, I contrived a method which, though not strictly classical, is one of practical science, for determining what modifications their material undergoes during conversion into bread to render them characteristically superior to any others of the kind. Four different typical wheats (two white and two red) having been selected and first made into three meals—viz., one crude, representing the entire grain; another, the standard granular of my system; and a third, the pearl meal or *farina consols*, also of my system, both of which have been already described—these meals were then converted severally, and according to my system, into non-ferment and fermentation breads. Scrupulous exactitude was observed as to all the weighings, dryings, and other manipulations, in order to make the results as trustworthy as possible.

The first step was to ascertain the exact proportion of total branny matter in the several meals; and for this purpose a given weight of each was carefully but thoroughly brushed upon a very fine wire cloth until all its farinaceous portion had passed through. That which remained on the sieve, being directed from the meal, was designated *proximate bran*, and it varied in proportion, according to the kind of wheat, from 16·80 to 19·30 per cent. of the crude meal, and 10·28 to 13·24 per cent. of the standard meal, or a mean of 18·23 per cent. for the former and 12·10 per cent. for the latter. Therefore, wheats generally may be said to consist of 81·72 farina and 18·28 branny matter per cent. The proximate brans of the different samples of crude and standard meals were next inclosed, separately, in very fine, white cotton cloths, and kneaded under relays of cool water until the latter ceased to become the least cloudy, and by this treatment they were reduced in weight rather more than one-half. The residue left I distinguish by the name of *absolute bran*, because it has parted with all its matter separable by the means employed. It will thus be seen that cool water alone has taken out of the proximate bran and into solution or intimate suspension upwards of 50 per cent. of its original substance. And what is no less remarkable, the ratio of absolute bran to the meal is a uniform fixed quantity for all the wheats indifferently, being 9·65 per cent. from the crude and 5·80 per cent. from the standard meal, notwithstanding that the proximate brans, whence they were derived, are variable in their quantitative relations to the meals. Therefore the total of actual bran in any wheat does not exceed 10 per cent.

Not yet satisfied that this absolute bran was exhausted, I next proceeded to ascertain if the proximate bran would yield more of its substance to artificial digestion than it does to water; and therefore it was subjected, under proper conditions, to the action of diastase, pancreatin, and pepsin consecutively. The result proved that the 9·65 per cent. of absolute bran from the crude meals had become reduced to 7·87, or 18·44 per cent.; and in like manner the 5·80 per cent. of absolute bran of the standard meals lost 21·38 per cent., having been lowered to 4·56—except for one of the red wheats, which gave rather less difference for both meals, and seemed to be erratic. As this residue could not be resolved further by any controllable means, it takes, logically, the title of *ultimate bran*; and it would represent the final state and proportion of the bran if the process of artificial digestion left it free from variable quantities of associate matter. But digestion outside of the human stomach does not correspond with that inside, however skilfully it may be imitated, for there is some force at work in the one case which cannot be commanded in the other; and probably, therefore, yet more of the bran is assimilable under more natural conditions. At the worst, the standard granular meal of my system has only 4·56 per cent. of undigestible matter. Very interesting, too, in this connection is the fact that this absolute bran not only loses density in becoming ultimate bran, but also drops as respects its mineral matter from 5·36 to 0·33 per cent. for the crude meal, and from 4·33 to 0·43 per cent. of the standard meal; or, in other words, the 2·42 and 2·36 of phosphoric acid which they represent fall nearly to zero, being drawn out by the process of digestion. Moreover, the total nitrogen, 2·17 per cent. (containing albuminoid nitrogen, 1·80), of the crude meal brans becomes 0·82 (containing albuminoid nitrogen, 0·78); and under corresponding circumstances the total nitrogen, 1·92 per cent. (containing albuminoid nitrogen, 1·86), of the standard meal brans falls to 0·80 per cent. (containing 0·80 albuminoid). Thus, although artificial digestion draws out the whole of the phosphates or mineral matter, and 60 to 70 per cent. of the nitrogenous matter, that portion of the latter which it leaves is—wonderful to be told—all or nearly all albuminoid.

Results could not be more impressive than these as to the superior nourishing value of whole wheat meal, for they prove that the separation and rejection of the bran must inevitably impoverish the residual farina or flour. This fact obtains additional confirmation in my own every-day life, for whole-meal bread, which forms four-fifths of my restricted diet, nourishes me satisfactorily; whereas any attempt to vary it in the least, with fine white flour bread, brings back bodily discomfort and debility. In the course of my laboratory work upon this subject, I also learned that, unusually fine as are the fermentation breads of my system, non-ferment breads can be made to excel them in every respect. But it is necessary to follow throughout a strictly philosophical method, and then they will require less time and labour in their manufacture, be independent of a choice of wheats, and always sweet and appetising. "Baking powders," however, must not be employed for generating the carbonic-acid gas which is to vesiculate the dough, as they leave chemical residues in the baked loaf which render it unwholesome. Nor must the carbonic-acid gas be dissolved in the water for mixing the dough and forced in mechanically, for though it will aërate the loaf, it will not produce perfect bread. To promote the hydrolysis whereby the cerealine with water replaces yeast, leaven, and fermentation, and to facilitate the osmotic action upon which the metamorphosis of dough into bread largely depends, the carbonic acid gas must be in the nascent state and generated within the dough.

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* From the *Lancet*.

# LUBRICATING OILS AND THE COEFFICIENT OF FRICTION.

AT a recent meeting of the American Association of Mechanical Engineers Dr. Arvin read a paper on the subject of lubrication, from which we extract the following:—

To a practical man who wants to know what he needs to put upon his engine, the value of "the co-efficient of friction" is extremely low. We know perfectly well that it depends upon many conditions that are difficult to maintain and to understand. Even the wisest admit that there is very little yet found out which throws a practical light upon that subject.

For instance, we know perfectly well when they decide the co-efficient of friction of paraffin oil, on two polished surfaces made to fit perfectly, we gain no light at all on what we need to use on bearings that do not fit equally well or have the same finish. If we are to decide how to construct a bearing, what its proportions should be, how large a sedgment it should cover, all of these researches would be directly in point. But if we have an engine that runs hot, or a certain construction of bearing that makes it difficult to find a suitable lubricant, these investigations afford us no light whatever, and I think that any engineer will agree with me that, crediting all possible value of researches regarding the co-efficient of friction, what we want to know is vastly beyond that.

For instance, an engineer comes to you and says: "I was using such a paraffin, and my engine ran cold; I am now using such a paraffin, and it runs hot." We find on examination that there is no practical difference between the two, but when we come to apply them to a bearing we find that for some strange reason the two oils do not work alike. When we apply them to spindles, we find that two paraffin oils often bear no relation to each other in their practical behaviour. We find that one will run at a much higher temperature, for some obscure reason. We might think it due to its viscosity, but we find by our instruments that it does not depend on that. In some instances, too, the results which we obtain are exceedingly contradictory.

The Rochester and Pittsburg Railroad Company run their cars with a bearing the surface of which is composed apparently of lead. There is a very thin film of lead—it appears to be lead—spread over the inner surface of the composition box, which looks as though it might be gun-metal. They say they will run an oil on this soft bearing that I know positively fails under similar circumstances, and on the same class of cars, on the Erie, New York Central, and Delaware and Lackawanna—just why, I cannot say for the life of me. I know that that shaft will sink down on that bearing, and yet it runs cold, and runs on a very cheap oil. One of the oil companies manufactures an oil which is composed largely of a mineral base which is united with a fatty acid. All things considered, that oil has been the most successful for running cold of any oil used on railways. And yet that fails to equal some other cheaper oils on the friction-testing machines. We have had occasion lately to make some comparative tests on fast-running spindles of the Sawyer pattern.

We have half a dozen oils from Europe, and several made in this country. Taking a spindle-frame, and adapting a dynamometer of my own, I expected to find that oils which had the best body would be the best oils for those spindles. I found I did not know anything about it. After having read many papers and listened to a great deal of talk from gentlemen who know a good deal about it, I found that the spindles did not bear out anything that I expected. Now, a spindle that was nicely fitted behaved in one way; but a spindle that was badly fitted behaved very differently. The effect of this was to establish a friction of its own in addition to the friction which we generally speak of as due to the oil itself. If we put on oil that has good body the heat increased very rapidly. Now, we should say at first that that was an objection to that oil. But we found after running them for a short time that the oils that gave us the best results in the economy of power were the ones that produced the most rapid wear. We found that after running constantly at some 6,500 revolutions a minute it had lost as much as $\frac{1}{6}$ of one gramme in actual weight. When we took another paraffin oil, the wear was not one-half of that, and there seems to be no apparent reason for it.

I have come to think lately that the question of wear on bearings, as ordinarily found, is one of vastly more importance than the cost of oil. One large mill owner came to me recently and said that he wanted an oil for his spindles. He said he did not care what it cost. He said: "After running some eleven mills for many years I have discovered that we sustain such great loss by wear due to poor lubrication as to make the mere price of the oil unimportant."

When the engines of the Brooklyn Bridge were started, the faulty construction of the bearings and journals caused rapid heating. I think it was generally believed by the engineers who examined them that the construction was faulty. The main bearings were like those drawn on the board, and the pinching on the sides appears to have been such as described. While watching those bearings quite intently one day, I happened to put my finger on the shaft (which I think measures 11in. in diameter) at a place where it showed extra pressure on the box, and I found it quite hot, while just $1\frac{1}{2}$in. from that section the shaft felt cold, showing how great and intense must be the heat generated when the conductivity of such a mass of iron failed to remove it. It seems to me that the conditions and behaviour of those journals corresponded with what Prof. Thurston has just described; and the binding in all such cases being simultaneous with an increase of temperature, I am led to wonder if it be not due to expansion by heat rather than to yield in the journal.

We generally find that where we can use oils of higher viscosity ordinary machinery bearings run colder. But in some instances of high speed and heavy pressure only thin oils answer at all, and the bearing must be flooded. I believe the engines of the Edison Electric Light Company, which run the dynamos in Pearl-street, are rated 75 horse-power, and run at the rate of 375 revolutions per minute. I am credibly informed that the oil they are using on these engines is the only sort yet found to run cold. This is an oil of about 32° Baume gravity, which is almost as light and fluid as common kerosene, and requires to be supplied constantly. I have come to think that this arranging of a steady current of thin oil is a very desirable plan wherever it can be practically carried out, as in the case of the Sawyer and Rabbeth spindles and nicely finished and fitted bearings of larger dimensions, like those in the machines these gentlemen have devised for testing oils.

With bearings nicely finished and journals carefully scraped and ground to fit, an abundant and constant supply of thin oil will give the best possible result in keeping the bearing cold and saving power. With such machines you may learn much of the proper proportions of bearings and of the conditions of friction in relation to pressure and speed, and of oils, too, under the exact conditions of these machines, but nothing of the requirements of machinery in common use. Why, these gentlemen think of a journal and bearing as two cylindrical surfaces in perfect contact. It would be more scientific and practical to regard the fit of ordinary bearings like that of a pea in a bushel basket. In many instances one point of contact would be almost too much to inspect, and the "body" or viscosity of the oil must make the fit. I know by my own observation that the results obtained in testing heavy lubricating oils on these machines do not correspond with the practical working of these oils on railway axles and other machinery, and any engineer to whom you might supply oils selected from such data would soon come back to you, as the saying is, "with tears in his fist and his eyes doubled up." We have been there—both sides.

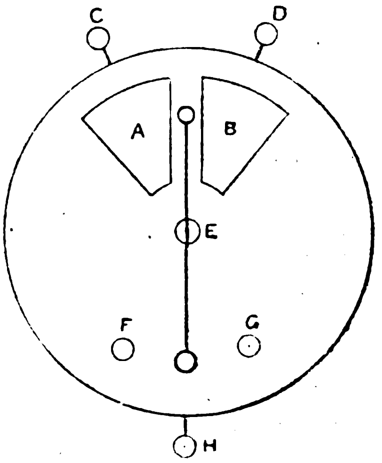
The fact is, the most important conditions under which these tests are made are the very ones that can only be maintained under special and unusual circumstances, and are never found in the great mass of machinery that must be lubricated. This makes the frictional tests by special machines worthless as a means of selecting lubricants, and a delusion to those whose opinions of oils are thus founded. I believe that the great value of these friction tests, and the machines by which they are made, lies in another direction; for we know that scientific research lies at the root of all industrial progress. But I think we must try an engine oil on an engine, a spindle oil on a spindle, and a waggon grease on a waggon, all as nearly as possible under the ordinary conditions, to learn anything of the real value of the lubricant.

While speaking of spindle oils, I should have added that I found their bearing parts did not wear bright. I considered their frosted look as indicative of a friction I saw no way of estimating, although it was attended with rapid wear. With oils of a higher viscosity and heavier gravity the bearing surfaces polish like a mirror, even though the friction, judging by the power consumed, is much greater with the more viscous oils. I infer that we cannot judge of the actual friction occasioned by the moving surfaces in contact, while we are unable to estimate separately that friction attributed to the oil itself. For using a thin oil we decrease that one friction so greatly that we cannot note any lesser increase in the other which occasions wear. If it be true that the question of wear is frequently of paramount importance in choosing special oils, then a low co-efficient of friction is no measure of value, and our frictional tests are worthless as a means of judging.

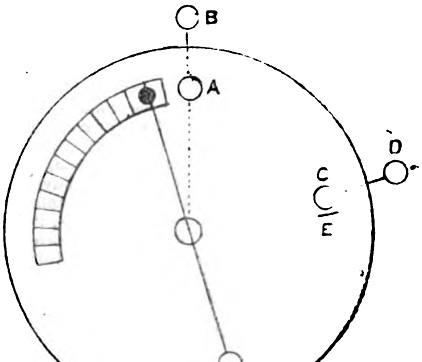
It is frequently said that we have petroleum oils which alone answer all requirements of lubrication. It is not so. I wish it was. I believe practical experience fully proves that in many instances compounded oils are best. Sometimes a thin petroleum oil, with a small portion of animal oil, gives better results. You may find instances where the best petroleum oils do not answer on an engine, when lard oil, or a mixture principally lard oil, keeps the engine cold and is every way satisfactory. This is sometimes the case whether the petroleum be of heavier or lighter gravity than the lard oil. But I am glad to say these are rare instances where petroleum oils do not answer every requirement.

## DR. MARSHALL WATTS'S ELECTROMETERS.

AT a recent meeting of the Physical Society two simple pieces of apparatus were exhibited by Dr. W. Marshall Watts. One of these instruments is a modification of the quadrant electrometer. It consists of a circular plate of ebonite, standing on feet, and covered by a glass shade. A small brass needle terminating in little brass balls is balanced on a point at the centre of the disc on an agate centre. The one end swings between two brass balls, F and G, standing up a short distance above the disc, and both connected with a ball, H, projecting from the under side of the disc. The other end of the needle moves over two plates of metal, A and B, severally connected with projecting knobs C and D. To use the instrument, a charge of known sign is communicated to the knob H, and the needle, after a few oscillations, comes to rest midway between F and G. The instrument is sufficiently delicate to give a decided deflection when C and D are connected with the plates of a small bichromate cell.



The second instrument may be regarded as a modification of Peltier's electrometer. It also consists of a disc of ebonite, having a needle point at its centre, on which turns a little needle, terminating in brass knobs; but the arms of this needle are of steel and magnetised, and the cap is metal and not agate. The directive force of the earth (or of a directing magnet, fixed on the cover of the instrument) may be made to bring one end of the needle in contact with the fixed knob A, which is in metallic connection both with the centre on which the needle turns and with a projecting knob B. When a charge is communicated to B the needle is repelled a greater or less distance, which is measured by a little graduated arc. The nature of the charge may be determined by turning the instrument round so as to bring the needle nearly into contact with a different knob at C, which is connected to a projecting knob D. The needle is prevented from coming into actual contact with C by a little ebonite stop E. If the charge is positive, the needle will then be repelled when a positively-charged body is brought near D, and if negative, then when a negatively-charged body is brought near D.



MESSRS. F. LEROY AND CO. ask us to state that they have ceased to have an office in Gateshead for the present, their agents there having left them. All orders or letters of business to be addressed to F. Leroy and Co., Gray-street, Commercial-road, London, E.

# SCIENTIFIC SOCIETIES.

## LIVERPOOL MICROSCOPICAL SOCIETY.

THE ordinary monthly meeting was held on Friday evening at the Royal Institution, the president, Mr. Chas. Botterill, F.R M.S, in the chair. Several donations of valuable slides were announced, and the thanks of the Society voted to the donors. The following ladies were elected members of the Society:—Miss Lucy E. Cradock, L K.Q C.P.I., and Miss Isabel Raleigh.

The Rev. H. H. Higgins, M.A., then made the following communication on natural vegetable mucus:—During the spring my study table has been plentifully supplied with terminal twigs of various trees and shrubs, set in water, to enable me to watch at leisure the expansion of the leaf-buds. Amongst them was the vigorous bud of a horse-chestnut, in which the gummy lacquering of the scales had set the storms of winter at defiance. Now, however, it was spring, and the bud was relaxing a little of its tight grip, whilst the bud scales were lengthening, and becoming leafy at their tips, showing that they were true leaves modified to serve a purpose. In the centre of the bud rose two little leaves, like green banners; but the petioles were flocculently woolly, after a fashion I had not noticed before. Many years ago I had found a small, bright orange fungus growing on a fallen log. The fungus was so slimy that it was difficult to take it up with the fingers, very much as an oyster out of its shell would be. A little of the transparent mucilage, magnified 400 diam., proved to be made up of monocellular trichomes, perfectly smooth and round, twisting and turning amongst each other like convoluted snakes, and forming the most perfect material for lubrication possible to be conceived. Part of the flocculent wool from the chestnut bud was collected, and, after having been wetted, was magnified. It was, as far as could be seen, identical with the mucilage from the fungus—a result which suggests that the mucilage had similar functions. When the bud expands, a forward thrust of the nascent leaves is associated with severe lateral pressure against the bud scales, causing a friction which, if the surfaces were naked, would be injurious. This very perfect lubricating material is provided by nature, and is probably found in many buds, though, when it has performed its office, the first shower washes it away. The mucus in the fungus has, I believe, been figured; though I am not aware that its function in the leaf-bud of the horse-chestnut has been noticed. Some have found a pleasure in fancying that recent science has eliminated teleology. To the theist the scope of teleology appears, on the contrary, to have become universal.

A paper was then read by Mr. Henry Kendall on "The Structure and Development of the Teeth." With the assistance of diagrams the three tissues composing the tooth were described. The dentine or ivory, traversed by numerous canaliculi, too small to admit of blood corpuscles; the enamel (the hardest substance in the human body), consisting of prismatic cells; and the *crusta petrosa*, which differs from true bone in having no haversian canals, except when hypertrophied by inflammation. In treating of the development of the teeth, it was noticed that, though they are classed with cartilaginous and osseous tissues as having conjunctive tissue for their basal substance, yet they do not form a part of the skeleton proper; they must rather be regarded as epidermic appendages, since they take their origin in papillæ formed on the *exterior* of the gums. Two methods of preparing dentary tissues for the microscope were then mentioned; the preferable one being to grind down the substance on stones of various degrees of fineness, and to polish the thin lamina thus obtained. The other process, less satisfactory, as destroying some of the characteristic features, consisting in dissolving out the calcary salts by means of acids, and cutting thin sections of the cartilaginous basis left undissolved.

## LIVERPOOL AND DISTRICT ASSOCIATION OF SCIENCE AND ART TEACHERS.

A MEETING of the Liverpool and District Association of Science and Art Teachers was held on Saturday in the Government School of Art, Mount-street, the president, Mr. Norman Tate, F.I.C., in the chair. After the reading of the minutes by Mr. Wm. Hewitt, B.Sc., hon. secretary, Mr. G. G. Tomlinson, Runcorn, was elected a member. The special committee appointed to consider a resolution moved at the last meeting by Mr. J. L. Barnes, in favour of the establishment of a museum of applied science, presented their report, which suggested an extension of the present Brown Museum by the addition of a "department of shipping and commerce," with exhibits illustrating different stages in the construction of ships, the machinery of vessels, and scientific appliances employed in navigating, lighting, and ventilating ships, together with signalling apparatus, lighthouse arrangements, life-saving apparatus, &c.; also specimens of articles imported into the country, with specimens, models, diagrams, &c., illustrating the processes of their manufacture and the practical application of their products, &c. The report was approved of, and the committee instructed to take steps towards the carrying out of the scheme. The chair was then taken by the vice-president, Mr. Edward Davies, F.I.C., F.C.S., while the president read a short paper on "The microscope as an aid in science teaching," in the course of which he referred to several important results that have already followed the use of the microscope in scientific research, the necessity of training science students in microscopical observation; the method of working which, in his opinion, was most suitable for such training, both in ordinary science classes and in laboratories of research. He laid much stress upon the reproduction of the microscopical pictures by drawing or micro-photography, and concluded by calling attention to several text-books on practical botany, botanical micro-chemistry, general biology, &c., which prescribed courses of study in which the microscope plays an important part. A short discussion ensued, in which Messrs. Davies and Marramore took part, after which much time was spent in the practical examination of microscopes, apparatus, and specimens exhibited by several of the members, and also a fine collection of slides forwarded by Messrs. Watson and Sons, of Holborn, London, and by Mr. B. Piffard, of Hemel Hempstead, and several students' microscopes and apparatus sent by Messrs. Thompson and Capper, and microscopes of various makers, and a Dallinger lamp and a lenticular prism, of his own make, from Mr. G. Wood, Lord-street, Liverpool.

# SCIENTIFIC NEWS.

THE following is the list of selected candidates recommended by the Council of the Royal Society for election to the Fellowship:—A. W. Baird, Major R.E., P. Herbert Carpenter, D.Sc., Sir Andrew Clark, M.D., Mr. A. A. Common, F.R.A.S., E. W. Creak, Staff-Commander R.N., Professor E. Divers, H. Hicks, M.D., W. M. Hicks, M.A., F. R. Japp, Ph.D., A. M. Marshall, M.D., Professor H. N. Martin, D.Sc., C. O'Sullivan, Professor J. Perry, Professor Sydney Ringer, and Sidney H. Vines, D.Sc.

The library of the Royal Society is in future to be open to Fellows, from 11 a.m. until 6 p.m., closing, however, on Saturdays at 1 p.m. In August and September the library will be closed at 4 p.m., but in July, hitherto a vacation month, the hours will be 11 to 6.

The Rev. T. E. Espin is about to publish, through Messrs. Swan Sonnenschein & Co., a series of star-maps, which will be called "The Beginner's Star Atlas."

The death is announced, at the age of 70, of Mr. William Ladd, F.R.A.S., a gentleman well known for the interest he took in the practical utilisation of many electrical inventions, and commercially as a maker of large induction coils, and the dynamo which bears his name. It was to Mr. Ladd that Reis sent his now historically famous letter describing the telephone, but the recipient does not appear to have apprehended the importance of the invention. Ladd's dynamo is well known to all science students, as it is figured in many of the text-books.

At the Royal Victoria Hall on the 12th inst. Mr. Dullinger is to lecture on "Wonderful Things we do not personally see," and on the 19th Prof. Perry will discourse on the "Spinning-tops of Japan and other countries."

A very useful railway guide and route books has been issued by the executive council of the International Inventions Exhibition. The book includes all places within a radius of about forty miles from London, and gives at a glance the number of trains daily, the times of the last, and indicates the station at which the change should be made, when that is necessary. It also gives the fares, including admission, and the average time occupied on the journey.

At a recent meeting of the Engineering Society at King's College Mr. R. B. Anderson, Stud. Inst. C.E., read a paper on "Heat in its Relation to Combustion," in which he referred to the terms used in connection with the subject. In reference to heat-units, he advocated the use of the "gram-degree," as it involved no confusion as to the thermometer scale and explained itself, but he deprecated the use of calorie, on account of the loose manner in which it is employed to represent the "gram-degree" and the "kilogram-degree." As a measure of heat, he thought it convenient to use the amount necessary to convert water at normal temperature into steam at any boiling point, which was discovered by Watt to be very nearly a constant quantity.

Mr. Stretton has issued (The *Train* offices, 280 Strand) his paper on the Leicester and Swannington Railway.

At a recent meeting of the Physical Society, a paper by Lord Rayleigh was read on "The Theory of Illumination in a Fog," which dealt with certain theoretical results based upon the assumption that the medium in which the fog is formed, and the substance composing the fog itself, are perfectly transparent. Under the title of a "Monochromatic Telescope," Lord Rayleigh also contributed a paper descriptive of a modification of Maxwell's colour-box. In this instrument light passes through a slit in the focus of a collimating lens; it traverses in succession this lens, a prism, and another lens by which it is brought to a focus upon a plane surface in which is a movable slit; the eye being placed behind which receives light approximately monochromatic. If in addition a lens be placed just behind the first slit, so as to bring some distant object into focus at a convenient distance from the eye, this object will be seen by the light that would enter the eye in the simple colour-box. Lord Rayleigh suggests the use of this instrument to compare lights of different colours, and the possibility of choosing some colour towards the middle of the spectrum at which lights might be compared for practical purposes.

The Geological Survey has issued a "memoir" descriptive of the highest and most picturesque part of the table-land of North-Eastern Yorkshire, a district composed mainly of Lias and Lower Middle Oolites, almost destitute of drift, and without signs of local glaciation. The higher ground probably formed an insular area during the Glacial period.

At a recent meeting of the Academy of Sciences of Paris some improved thermo-electric piles of Clamond and Charpentier pattern were exhibited. The couples are of iron or nickel and an alloy of antimony-zinc. One pile, consisting of twelve fsets o ten elements, exhibited an electromotive force of 8 volts and a resistance of 3·2 ohms; while another, half the size as regards number of elements, exhibited 3·6 volts and a resistance of ·65 ohm.

The Signal Engineering Co. are manufacturing an improved telephone receiver. They claim that by use of a specially designed machine for making the membrane diaphragm and other improvements in manufacture that they will work quite equal to the Bell telephone, not having the disagreeable metallic sound of the latter instrument.

At the meeting of the Leicester branch of the Amalgamated Society of Railway Servants, held last week, the debate on railway axles was closed, and a majority of the committee reported as follows:—(1) That iron axles are safer than steel axes; (2) that all cranks should have the webs hooped; (3) that as iron cranks appear to fail after running about 200,000 miles, and steel axles after 170,000, it is highly desirable that when they are known to have run these distances they should be taken out, carefully tested, and even if no flaw can be seen, they should not on any account again be used in passenger engines; (4) that crank axles properly constructed are as strong as straight axles.

In the *Lancet*, for May 2, Dr. A. de Wattville, B.Sc., has some further notes on the cure of writer's cramp, and gives in facsimile the handwriting in two cases before and after treatment by Mr. Wolff. The system adopted by the latter is a combined application of massage, gymnastics, and caligraphic exercises.

M. FLEITMANN, of Iserlohn, has shown that pure nickel and its alloys with copper, cobalt, and iron can have other metals added without their losing the property of being welded, and therefore can still be used for making plate. The metals which can be added in this way are zinc, tin, lead, cadmium, iron, and manganese up to as much as 10 per cent.; any additions, however, are not of much practical value, as the alloy of 25 parts of nickel with 75 of iron has a white colour, and resists the action of the atmosphere far better than the iron alone.

# LETTERS TO THE EDITOR.

*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

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**** In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

> "I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original."
> —*Montaigne's Essays.*

## THE SPECIAL MEETING OF THE ROYAL ASTRONOMICAL SOCIETY—SUNSPOTS AND RAIN—THE DIAMETER OF MARS—DEAN SWIFT AND THE MARTIAL SATELLITES—MOSSES—PHOTOGRAPHING THE SOLAR CORONA—THE HARVARD COLLEGE OBSERVATORY—ZETA HERCULIS—THE NEW TIME—CORRECTIONS FOR EQUAL ALTITUDES.

[24196.]—I HAVE received a circular from the Secretaries of the Royal Astronomical Society, to which, even at this eleventh hour, I would earnestly invite the attention of my brother Fellows of the Society. This official circular calls a special meeting on the night of the day on which these words will appear, to consider a proposition made under by-law 52, for alterations in two others—viz., by-laws 12 and 53 respectively: such alteration consisting in the addition to the former of the words, "Lists handed to the scrutineers of the ballot on behalf of any Fellow not present at the meeting, shall be accepted, if duly verified by the signature of the absent Fellow:" and to the latter of the words, "Fellows of the Society may vote on the business brought before annual general meetings and special general meetings, either personally or by proxy." Now, the obvious effect of these changes in our by-laws must be to enable every Fellow of the Society to exercise his personal influence, and to pronounce an opinion upon its management, whether he be resident in Chelsea, Caithness, Carrickfergus, or Candahar. We should thus secure a really representative Council, because Fellows resident at practically inaccessible distances from London would be able to vote for the men whom they considered the most fit to administer our affairs, without being dragged hundreds of miles to do so. Under existing conditions, an enormous majority of our Scotch and Irish Fellows, and the whole of our Continental ones and those serving abroad, are disfranchised. And if they have no voice in the selection of the gentlemen who so condescendingly rule over them, *a fortiori* they have less than none in the management of the Society. A Fellow may be, let us say, at Gibraltar, and may feel deeply interested in some question to be brought forward at the annual meeting. Leave, however, may be impossible to obtain, and the voyage too costly, if it were to be had; and so this man's hands are tied, while any single one of the Council is present to vote in precise opposition to his wishes and convictions. Let the man abroad, however, commit his proxy to some one whom he can trust at home, and his legitimate influence can be exercised at the meeting. Of course the select circle which dines at (and essays to direct the affairs of the Society from) Willis's Rooms, will fight tooth and nail against any alteration in a system which has made its members, so far, absolute autocrats, practically electing themselves year after year. Does any sane man believe that if the Fellows at large were in a position to exercise their franchise, the gross abuse of 25 per cent. of our Council consisting of the representatives of the Royal Observatory at Greenwich, could ever have been perpetrated? I do hope, then, earnestly and sincerely, that every Fellow of the Royal Astronomical Society, who has its independence and the best and truest interests of astronomy at heart, will, at any personal inconvenience, go to Burlington House to record his vote for the suggested changes. Depend upon it that the gentry who are quaking for their own seats at the Council Board, should any real election take place, will pack the room to the very utmost of their ability. Many a name of the hangers-on of the Brompton Ring will be inscribed in the attendance-book, which appears there but rarely indeed. There are certain faces familiar enough when any job is to be perpetrated, which are as strange as that of the Grand Llama of Thibet at our ordinary scientific meetings. Assuredly none of them will be absent. Will—or will not—Fellows anxious to restore the Society to its pristine purity of intention, play into these people's hands by absenting themselves?

From your report on page 166, it would seem that another nail was driven into the coffin of the sunspot humbug at the last meeting of the Meteorological Society, in the "Report of the Committee on Water Supply." As it is not so very long since a lecturer—who shall be nameless—so far presumed upon the ignorance of a working-class audience as to assure them that the greatest amount of rain was coincident with sun-spot maxima, and *vice-versâ*, it may not be uninstructive to compare the years of low water and of floods, as given by the Meteorological Society's Committee, with Wolf's table of sunspot phenomena. First, then, to take the years of drought:—1820 was three years, and 1821 two years before a sun-spot minimum; 1824 one year after minimum; 1835 two years after minimum; 1838, one year after a maximum; 1845, two years after minimum; 1847, one year before maximum; 1850, two years after maximum; 1854, one year before minimum; 1855, minimum; 1858, two years, and 1859, one year before maximum; 1864, three years, and 1865, two years before minimum; 1871, one year after maximum; 1875, five years after maximum; 1884, maximum. Now for the years of floods and high water: 1817, one year after maximum; 1825, two years after minimum; 1830, one year after maximum; 1836, one year before maximum; 1841, two years, and 1842, one year before minimum; 1853, two years before minimum; 1860, maximum; 1861, one year after maximum; 1866, one year before minimum; 1873, three years after maximum; 1878, minimum; 1881, three years, and 1883, one year before maximum. Let any candid and dispassionate reader study these figures, and say whether they shew that any connection whatever exists between sunspots and the quantity of rain which falls. And yet Messrs. Archibald and Co. were much shocked at the way in which I denounced that trumpery imposture, the "Solar Physical Observatory," which was *to* be established (at a cost of £*x*) to prove the dependence of one upon the other.

I doubt if a categorical answer can be given to the query with which Mr. Franks begins letter 24141 (p. 168). In the first place, the micrometrical measurement of the diameter of a planet with any very refined accuracy, is a monstrously difficult matter; and in the next a notable part of some of the metrical discordances which he tabulates has its origin in the fact that several of his authorities have employed the old solar parallax in their calculation. Sir John Herschel's figures, for example, must be diminished by one twenty-eighth part ("Outlines," page 695), and so with Arago and Mitchell's. Perhaps the best values of Mars's equatorial diameter that we at present possess are those of Schmidt, made in 1854 and 1856. He makes it 4358 6 miles: of Kaiser, who in 1864 determined the diameter to be 4256 miles: and of Engelmann, who, from measures taken during the opposition of 1873, found that Mars was 4210·4 miles in diameter at his equator. Presumably he is Webb's authority.

A good deal has been said about "Inspiration" recently in these colums; but if the fulfilment of an excessively unlikely prophecy can be (as it has been) accepted as evidence of it; then assuredly we can only regard "Gulliver's Travels" as an inspired work.

If Lovell, Reeve, and Co. still publish Stark's book on "British Mosses," Mr. Hitchcock (query 56429, p. 179) will find it the very thing he requires. He will get the "hints" he wants, as well as full and clear descriptions of all the species from it.

In a most interesting lecture delivered before the Royal Institution on February 20th, of which a reprint lies before me, that great astronomical physicist, Dr. Huggins, brings forward a considerable amount of evidence to substantiate the objective nature of the Solar Corona which he has from time to time photographed. I can hardly regard the assertion of his "friend, Mr. John Brett, A.R.A. . . . that he is able to see the Corona in a telescope of low power," however, as susceptible of inclusion among such evidence, inasmuch as it would seem to partake of that cock-and-bull character which has pre-eminently distinguished the specular reflection from Venus and cognate discoveries of the somewhat notorious observer referred to! At present, moreover, I fail to understand how any photograph of the Corona of the uneclipsed sun can possibly be obtained at all through the persistent glare of lighted haze which surrounds the sun on the very clearest days. I only know that I have utterly failed to detect Mercury at any time during the last two years. A strong point in favour of Dr. Huggins's contention is to be found in the fact that a peculiar rift which appears in one of his Coronæ photographed in May, 1883, is also visible in the negatives taken at Caroline Island at the same date during the total eclipse of the sun in that year.

From the annual report of Professor Pickering to the Visiting Committee of the Harvard College Observatory, I learn that that admirable institution worthily sustains its reputation, and continues its career of usefulness. Unfortunately, the period of temporary subscription by its friends towards the funds of the Observatory has come to an end, with the result that a reduction of its working expenses has become imperative. Its distinguished and disinterested director, however, is not the man to stand idly lamenting this, or to go whining to Congress to be "endowed" out of national funds. Perforce compelled to reduce his staff, he has manfully put his shoulder to the wheel, and there can be no doubt that his report for the current year will in no sense discredit an establishment which has heretofore maintained such eminence among the working observatories of the world.

As I, of course, never saw letter 24165, p. 187, until this (Friday) morning, the day for writing this latter half of my letter, I cannot possibly comply with "Beta's" request in time for next week's number. Burnham's own mean of his measures, by the way, in 1880·49 was 1·34″. The theoretical separating power of a 4in. object glass by Dawes's formula is 1·14″. My last volume (XL.) of the ENGLISH MECHANIC is, at this present writing, at the binder's, so I cannot refer to it; but I have an idea that some pretty recent measures of ζ Herculis were referred to in it. I may, perhaps, add that I pretty recently wholly failed to divide this star with a power of 260 on a 4¼in. Dallmeyer object-glass. I presume that it was not a bit of a diffraction-ring that your correspondent took for the *comes*?

With reference to letter 24192 (p. 193) I need only say that, as far as I am concerned, I advocate the change in the present method of reckoning time, because of the simplicity of the new mode, and the absolute immunity it affords of all confusion between a.m. and p.m. "Nun Dor." must bear in mind that, as far as astronomers are concerned, there is nothing new in it. A charming muddle we should be in truly if we tried to reckon Right Ascension in two divisions of 12 hours each! Moreover, your excellent correspondent must forgive me if I say that I am seriously puzzled "in connection with the times" on the greater main lines in "Bradshaw"; and that here I err in good company, inasmuch as the immortal discoverer of the planet Neptune has recorded how he once went down to the station at Cambridge to meet a train 12 hours after it was due! As for the crazes about decimalising our divisions of time, they stand upon an absolutely different footing, and involve an amount of learning—and unlearning—which must form an insuperable barrier in the way of their general adoption. Simply reckoning round 24 hours, however, stands, I venture to think, on entirely different ground; in fact, from long observational experience, I am convinced that a fortnight would familiarise everybody with it. Assuredly, when it was once introduced and folk had got used to it, they would wonder how they could have tolerated the cumbrousness and inartistic character of the existing method of dividing the natural day.

I fail to see how "X. N. X." (query 56466, p. 200) obtains his data. For instance, the mean of his clock times (the T of the formula)

$$\frac{10\text{h. } 33\text{m. } 14\text{s.} + 13\text{h. } 27\text{m. } 20\text{s.}}{2} = 12\text{h. } 0\text{m. } 17\text{s.},$$

and not 12h. 0m. 45s., as he has it. So, again, with his $\theta$ (the increase of N.P.D). It is true that the *hourly* increase is only 57·96″; but in 1h. 27m. 3s. this amounts to 1′ 24 09″, the quantity he must employ; so that his $\frac{t\,\theta}{15}$ will become $\frac{84\ 09''}{15}$, or 5 6. The true additive correction is 19·803s. to the mean of his two observations: i.e., 0h. 0m. 17s. + 19·8s. = 0h. 0m. 36 8s. as the observed time of apparent Noon. The working of the example seems somewhat cumbrous, too.

**A Fellow of the Royal Astronomical Society.**

## JUPITER.

[24197.]—I HAVE just come in from observing Jupiter with my 8in. reflector, and was able distinctly to recognise the transit of Satellite III. as a dark body across the disc of the planet. The satellite was immersed in the dusky northern belt, but it was nearly as dark as the shadow would have been. I watched it from 10 to 10.30 p.m., when the planet was obscured by clouds. I was able to trace the movement of the satellite from about the central meridian to nearly half-way to the western edge of the planet. I think there will be no other favourable opportunity for witnessing this phenomenon this season. There is a transit of this satellite on the 9th at 11.56 p.m.; but the planet will then be too low for observation.

I shall be glad to know if this observation is confirmed by others, and find some explanation of the phenomenon offered. I used a Browning achromatic eyepiece magnifying 144, of excellent definition. John Bone.

St. Thomas' Vicarage, Lancaster, May 2.

## JUPITER'S SATELLITES PARTIALLY OCCULTING THEIR SHADOWS.

[24198.]—THESE phenomena are not as rare as might be imagined, and many instances would soon be recorded if observers looked for them when Jupiter is near opposition. Besides the observation made by Dr. Knobel in 1872 (referred to at the last meeting of the R.A.S.), several others have been published from time to time. There is one in the ENGLISH MECHANIC, Vol. XXIII. p. 562, by Mr. G. D. Hirst, of Sydney, N.S.W., accompanied by a sketch showing the shadow of the 1st Satellite, on May, 1876, as a dark crescent breaking away from the west side of the satellite, and situated in the bright zone N. of the equatorial belts.

The recent partial obscuration of the shadow of the 1st Satellite on Feb. 18th, 1885, was casually observed here while awaiting the transit of the red spot on Jupiter, which occurred at 12h. 4m. The air was far from good; but the shadow was glimpsed as a dark crescent, exceeding a semicircle, and evidently obtruding from the W. side of the satellite, or rather, to be more accurate, from the S.W. side, for at times, when definition became tolerable, the breadth of the shadow seemed more above, and S. of the satellite.

On April 18th, 1885, at 7.37, I saw Sat. IV. skirting the N. rim of the great N. equatorial belt, as a dark brown spot. I also observed this satellite in transit on Jan. 8th, 1885, at about 15h., and on Feb. 27th, 1885, at about 13h. 25m.; but I have not seen the satellite as an intensely black spot, such as described by Mr. Spitta in the *Monthly Notices* for March, 1885, p. 344. I particularly noticed, on the early morning of Feb. 28th, when both satellite and shadow where projected on Jupiter, the unmistakably deeper tone of the shadow. Relatively to the extremely bright central regions of the planet, this satellite appears very dark indeed; but when the shadow is also present, affording the means of comparison, it is seen at once that the satellite is not absolutely black.

Bristol, April 30th. **W. F. Denning.**

## DOUBLE STARS.

[24199.]—Mr. SADLER hardly recognises the effect of his own eminence in letter 24166. I apologise if I overstated his remarks upon my supposed observation of Hyperion; but the astronomical world would look upon his statements as amounting to deciding the question against me, and I so accepted it.

With regard to his references to θ Aurigæ in "E. M." for Feb. and March, 1883, my only excuse is gross carelessness. Having come across some notices of the star in a back volume, which only had to do with mag. of θ itself, I, without looking up the references, concluded these were what Mr. Sadler meant.

I take it, the *comes* must be variable to a considerable extent, and is also closer to the large star than the distance given in "Celestial Objects."

Allow me to thank Mr. Millar (24106) for his replies *re* Spectroscope.

With regard to $a^2$ Cancri, I have the fourth edition of "Celestial Objects," and cannot find any reference to $a^2$—$a$ is in the Appendix 1, but not $a^2$. Possibly the small 2 has failed to make an impression in this copy.

Will Mr. Sadler tell me present position angles and distance of γ Leonis? I ask because, after careful measuring, I cannot make the P. A. much other than 100°, and as according to Webb, the motion is in direction of increasing position angles, and the latest measure is given as 112° in 1877, I do not see how to reconcile the measures. I tried it three times. Have I made a stupid blunder? Is there any suspicion of motion in Cor Caroli, and what is the date of measure of 54 Leonis, as given in Webb? I make this 88° or 89° now; but the weather continues so bad it is difficult to see any star long enough to get a measure.

**Edwin Holmes.**

## A CHEAP AND EASILY-CONSTRUCTED TELESCOPE STAND.

[24200.]—I SEE that in the engraving of telescope and stand on page 189, the engraver has neglected to connect the bottom of the telescope to the tube that carries it. The strap on the telescope is shown, but not attached to the tube, so that it appears as if carried only by the two straps near the middle of the telescope. The weight also near the part under the double or fast-and-loose lever, which draws the telescope after the star, is not shown. **Philip Vallance.**

## SMALL REFRACTORS AND TESTS.

[24201.]—ON Saturday, May 2nd, having read "Beta's" letter (24165), I tried my 4in. Cooke, focus 59in., on ζ Herculis, but should not have known that it was a double star with a power of 283, as its disc appeared quite round.

That evening was very steady, to which I attribute my success in seeing, for the first time, the *comes* to δ Cygni; power 288. I did not previously know the position of the comes; but after I had seen it, I checked the observation by a reference to Prebendary Webb's book.

It was a very difficult object, as the *comes* was cut through by the first diffraction ring.

I should have liked to have tried a higher power, but have not got one.

I observed the following with the 4in. Cooke:—

ι Leonis, power 70 (very well seen), *a* Lyræ, with aperture reduced to 2in., power 70 (very difficult).

ε Lyræ, Debilissimæ, full aperture, power 140 (seen immediately); Castor, power 27½ (my lowest power).

Also the following with dumpy 3in. Dallmeyer, focus 27¾in.

ι Leonis power 80 (well seen).

ξ Ursæ Majoris, power 130 (discs in contact, notch quite sharp); Castor, power 33½.

*a* Lyræ, power 46½, aperture reduced to 2in. (*comes* held steadily).

Ditto, aperture reduced to 2in. (*comes* glimpsed many times).

Would "A Fellow of the Royal Astronomical Society" kindly help me in the following difficulty?

I can see $\epsilon^1$ and $\epsilon^2$ Lyræ with my naked eye; without difficulty; distance 207". With the telescope, Castor, as above, distance 151" with 4in. Cooke, and 184" with 3in. Dallmeyer; but ξ Ursæ Maj., taking Mr. H. Sadler's distance (24166) requires, with 3in. Dall., 234". With this glass also I have frequently seen Polaris with a power of 18½; but that equals a distance of 346". ι Leonis, with the 4in. a distance of 203"; and with the 3in., a distance of 234". My difficulty is this: If you can see with the naked eye stars at a distance of 207", why should not everything else be visible with the same distance?

In other words, why did not the 3in. Dall., which showed Castor with a distance of 184", show ξ Ursæ Maj. with a similar distance? The fact being that the stars, *although quite sharply defined*, were in contact, with a distance of 234". Polaris, too, requires a distance of 346"; according to Castor, it ought to be seen with a power of 10; and according to $\epsilon^1$ and $\epsilon^2$ Lyræ, by naked eye, a power of 12; but I have tried it over and over again with a power of 13 and have not been able to see the companion.

Would it not be possible to construct a formula by which the following problems might be solved?

If a certain telescope will show a pair of 4 and 6 mag., dist. 8", with a minimum power of 22½, what is the least power the same telescope will take to show a pair 4 and 6 mag., dist. 2"? It is understood, of course, that the star mags. and distances are within the theoretical grip of the instrument.

A more complicated formula might solve the following question. With the same data, what power would the same telescope take to show a pair 3 and 9 mag., dist. 3"?

**Edward M. Nelson.**

## EVOLUTION.

[24202.]—WILL someone kindly answer the following?—not sending me to a library, to which in the country there is no access, nor to books, for the purchase of which I have no money. What reason is there to suppose that a fossil creature, half-bird and half-lizard, or other recognised intermediate link, is so in reality? Why should it not have been purposely created in that form? Suppose the seal to die out of existence, it would, I presume, be called a link between mammal and fish; ditto a whale, but in any case, why should it be considered that these were not always as now—viz., distinct creations? There was once a *bird* with a full row of teeth. I make it a link certainly by saying I do not know what the *beast* is called; but I see no reason why the *creature* should not have been so made, and I want those who do see this to open my eyes and let me see it too, if it is indeed visible.

Then again, is it not said that any special organ not used gradually decreases in size, until after many ages it becomes lost, a limb leaving a mere knot perhaps to show where it used to be. But why should any living creature cease to use such limb, and his or its descendants continue the same disuse? A parrot uses its beak in climbing, and it is a big beak and a strong one, as can be discovered by insertion of a finger. If it ceased to use it, it might grow less; but why should some insane parrot try to climb without using his beak, and teach its progeny the same difficult art? These things are mighty puzzles to **Pre-Adamite.**

## MICROSCOPICAL STAINING—MOUNTING BACTERIA.

[24203.]—As a supplement to the introductory method of sputum-mounting described by "B.Sc., Plymouth," perhaps I may be permitted to describe some other methods, with reference to sputum in particular, but also with reference to "bacteria," as they are often called, or Schizomycetes generally. (1) Cause sputum expectorated first thing in the morning to be spat into a *clean*, covered vessel, without admixture with water or with any disinfectant. The expectorated matter will consist of masses of sputum of a bluish, greenish, yellowish; or, if the sputum contains blood, reddish colour, and more or less tenacious. For the tubercle bacillus the less tenacious sputum, in the last stage of consumption, but not just before death, is the best; for the thicker sputum will probably have lain in the upper part of the windpipe before being expectorated, and before death there is a difficulty in bringing it up from the lungs. That which belongs to the same mass as a streak of blood is likely to be good. Mixed with the sputum there will be saliva, and, if the coughing has caused sickness, matters from the stomach. (2) Proceed with the subsequent processes without needless delay. Take out a little with an old teaspoon or saltspoon, which is never again to be used for its original purpose, and lay this on a sheet of newspaper or other paper, on which the whole of the appliances used should lie. (This is for the sake of cleanliness and safety; the paper must be burnt as soon as the operation is finished. The sputum most likely to be examined is that of suspected consumption, and may not improbably contain the *Bacillus tuberculosis*, the germ of consumption, scrofula, etc. It is, therefore, not a thing to play with). With the point of a scalpel, helped by an ordinary sewing needle mounted in an old penholder, transfer a little of the sputum to the centre of a ⅝in. or ¾in. No. 1 covering glass. (The scalpel, needle, forceps, scissors, slide, and whatever else has touched the sputum should be wiped with paper to be immediately burnt in the chimney, and then immersed in carbolic acid and water [one in thirty], after which they should be wiped; and, finally, thoroughly heated in a flame. The aim of this is to help to preclude possible infection. The first wiping will remove the bulk of the possibly infectious sputum. The steeping in carbolic acid and water will help to kill the germs, or, at least, to maim them. The burning in the flame may be trusted to kill them, and does not injure the instruments as much as might be expected. The flame should be that of a spirit-lamp or a Bunsen burner, since it is smokeless, and the instruments should be moved about in it to prevent all the heat falling in one place. It is well to have a scalpel, a pair of scissors, a few mounting needles, and a couple of pairs of forceps—one for taking up the sputum if needful, and the other for moving the covers from place to place—which are antiquated for other purposes, as one would not care to spoil new and good instruments by heating them almost to redness in a flame. The heat, or the carbolic acid and water, need not, of course, be applied to those parts which have not touched the sputum. Neither the sputum itself, nor anything which has touched it, ought to come in contact with the hands, which ought to be afterwards washed with Calvert's carbolic soap. If the sputum is suspected to be specially dangerous—if, for example, it is believed that the case may be one of diphtheria—remember that corrosive sublimate ($HgCl_2$, bichloride of mercury) is a much more powerful disinfectant than carbolic acid. Keep on the windward side of the material worked on. Do not leave it about, but finish it up at once, and then pour carbolic acid and water or bichloride of mercury solution (1 p.c.) over it. Take care of cuts and scratches—even the most minute—on the hands, and be careful not to be pricked by the needles, &c. Impregnate the air with chlorine where there is any suspicion of special infectiousness. This may easily be done by chloride of lime and hydrochloric acid and water; it cannot be trusted to kill germs, but helps to maim them. (I have to apologise for the length to which these remarks, thrown in between brackets, make this communication run; but they may save someone's life). If the sputum is tenacious, some of it may be taken up with a pair of blunt-edged forceps, and a string of about the size of a large pin's head snipped off with a pair of fine scissors. (It is convenient to have the cover, to which the sputum is transferred, on the corner of a slide, over which part of its edge projects a little—1-32nd of an inch. There is then something to lay hold of it by in removing it. For the same reason, when one cover is laid upon another, as presently to be described, they should not be laid quite edge to edge, or so as exactly to coincide, or it may be impossible to separate them. To lay the cover on a slide secures it a flat suface to rest on, and prevents breakage. Besides, it is cleanly, as the slide may, after use, be wiped, and immersed in carbolic acid and water as previously described. In dealing with very infectious matter, it is well to dispense with all wipings, and to transfer what has been used to a large vessel of solution of bichloride of mercury. If a piece of white paper is put beneath the slide, the light will shine up, and everything will be more visible). If, on the other hand, the sputum is very fluid, it may be taken up by dipping a glass rod into it, and thus transferring to the covering glass. Or a pipette may be used. (If there is plenty of material, it would be well, in the first instance, to try the effect of working on sputum mixed with carbolic acid or mercury solution. The risk would thus be diminished; and though the stains act sluggishly when this is done, they, as a rule, act in the long run). (3) Take another cover, and lay it on the former one, but not quite edge to edge. Press it down with a mounted needle so as to make the sputum spread, and, for the same reason, move it a little to and fro. A dozen trials will show how to diffuse a thin and delicate film over the cover. Then slide the upper cover off, pushing it to one side by applying the needle to its edge. If the needle has a little curve at its extremity, so much the better; and the film finally left will be the thicker the more obtuse the angle at which the needle is placed to the surface of the cover. More pressure has, of course, to be used for thick than for thin sputum; but the whole operation need not take more than a minute, and a few trials will teach the details. (4) Lay the covers aside out of the dust to dry quickly. They may be placed on a piece of paper under an old butter-dish cover, bell-jar, &c., and will, of course, dry more rapidly if accompanied by a little chloride of calcium in a watch glass, tooth-paste pot top, or other small receptacle. When dry, pass them quickly three or four times through a spirit-lamp flame—which has the effect of fixing the film to the glass—taking care not to use so much heat as will brown the film. This burning process seems, I admit, a barbarous one. However, the film may equally be fixed by hyperosmic acid vapour (make a 1 p.c. solution of hyperosmic acid, and put a little in a watch-glass along with the drying covers), by alcohol vapour, and also in other ways. Hyperosmic acid, first hardens, and then stains: it has quite done the first when the slightest possible brown tinge is observable on the film. Other stains will scarcely take after prolonged exposure to it. The vapour is said to be dangerous to life, and must not be breathed. Next, as to the staining of the film. This may be effected in various ways:—(1) By the ordinary old-established vegetable stains—carmine or logwood—to show the blood-corpuscles and other large cells contained in the sputum; (2) with metallic stains, as hyperosmic acid, silver, gold, &c., which stain both these and the germs; or (3) by aniline methylene dyes, &c., with the specific object of showing the germs, or some particular kind of them. (1) To stain with carmine or logwood, I tease out the sputum with needles, and, before it has become dry, float the cover with the sputum side downwards on the staining fluid. If this is gently done the film does not come off. In a series of articles in the "E.M." on Microscopic Mounting, I have described the subsequent stages of the process. They may in this case be wet mounted. (2) To stain with hyperosmic acid, all that is needed is to allow the acid to act longer and more vigorously—e.g., by floating the covers after they have been exposed to the vapour in the 1 p.c. solution, with the sputum side downward. Micrococci thus stain readily. Silver is sharper and more discriminating. Make a 10 p.c. solution of pure crystallised nitrate of silver, with a drop or two of nitric acid, and add to a little of it, which is immediately to be used for staining, as much *liquor ammoniæ* as just suffices to redissolve the precipitate at first formed—a thing to be attended to, as the alkali tends to unfix the film. Float the cover on this; do not let it sink, or the preparation will very likely be messed by a finely-granular precipitate which forms. Terchloride of gold may be used in an analogous way; and the preparation may afterwards be stained with other dyes; but these processes are more suitable to cultivations than to sputum. (3). Combinations of aniline, &c., dyes are specially used to bring out the germs. As to these stains (*a*) for the common bacillus of sputum, the *Bacillus tuberculosis*, (*b*) for this and other bacilli or micrococci, or (*c*) for whatever is in the sputum, may be desiderated. For the Bacillus tuberculosis Heneage Gibbes's method is the best, and is as follows:—1. Take a given quantity—say a fluid drachm and a half—of aniline or aniline oil. This is a clear fluid, with a smell like that of gas, but sweetish; it dissolves slightly in water, but is apparently miscible in any proportions with alcohol. Dissolve it in six times its bulk (nine fluid drachms) of absolute alcohol, or in nearly seven times its bulk (ten fluid drachms) of good rectified spirits of wine to which a little alcohol has been added. Procure also some magenta, say, ½oz. Magenta is acetate, or hydrochlorate, of rosaniline, and there are, I am informed, about two dozen kinds of it in the market, passing by various names and prepared in different ways. It is a green, non-deliquescent, semicrystalline substance, in lumps, with a metallic lustre, dissolving in water, spirit, or acetic acid, without sediment, and forming a red solution. All the kinds are not equally proper: it is safest to procure it from Hopkins and Williams, through the local chemist, at the same time asking that it be stated that the dye is wanted for tubercle bacilli. In this way a definite substance will be procured; and this is of the greatest importance on account of the multitudinous varieties of aniline dyes, magenta-coloured and otherwise, which have been introduced for commercial purposes. With a vague magenta, methylene blue, or whatever it may be, procured anywhere, one does not know what one is using or what to expect. Weigh out two-thirds of a part (i.e., a drachm) of this and transfer it, e.g., to an ounce measure glass, having at hand a 4oz. stoppered bottle for the reception of the stain. Pour on it a little of the spirit with the aniline, rub up the crystals with a glass rod (which is easily made from a bit of tubing), and pour off into the bottle the deep red-coloured liquid. Treat the sediment with more of the spirit and aniline, and so on till the whole is used up. Then measure out ten fluid drachms of distilled water, if rectified spirit was made use of, or a proportionately larger quantity if absolute alcohol was employed; rinse out the measure glass with it, and pour it into the bottle little by little, shaking as you pour. Label "Heneage Gibbes' Magenta Stain." It is a very deep and strong stain, and should it touch the fingers, the colour may be removed by sulphuric acid and water. (2) To use it, pour a little into a tooth-paste pot top, or some such thing, either floating the covers on it film side downwards, or arranging them on the bottom film side upwards and dropping the liquid over them; the first course being most cleanly, and the second most efficacious. To prevent evaporation, cover the whole up with a glass circle, smearing the edges of the pot top with vaseline or vaseline and paraffin. Leave the covers to stain for six hours or more, in a warm place; and before taking them out, let them be heated to between 90° and 100°. If the heat is much more than this, the magenta will blacken; if it is much less, the bacilli cannot be trusted to stain. The bacilli of tuberculosis and also those of leprosy have this peculiarity, that stains find an exceptional difficulty in getting into them—a difficulty, however, which may be overcome by the use of aniline as above, or by that of carbolic acid or of several other substances; and, once in, they also have a difficulty in getting out. The next point, then, is to wash the magenta out of the other constituents of the sputum without removing them from the tubercle bacilli; and this may be done by the use of any strongish acid (picric, formic, oxalic, &c.), of which nitric is usually preferred. The acid has, of course, again to be washed out, and this is done with *distilled* water. Consequently (3), take up cover by the edge with a forceps, and wave it once or twice in ordinary water. This to take off the thick of the stain and to spare the acid. Then with a tube brought to a narrow end, but not to a capillary point, take up a few drops of nitric acid and water (commercial nitric acid, a fluid drachm and a half, filled up to six fluid drachms with *distilled* water), and drop a little on the wrong side of the cover, i.e., on that on which the film is not. This will clear away from that side any stain which may have got on it, which would otherwise prevent the process of decoloration being followed; for in all spirit solutions the covers are apt to sink in the staining fluid, even though they should originally have been laid evenly on the top. Then drop the acid on the right side of the cover till the red has disappeared. Then with another tube drop on distilled water till the acid is presumably quite washed away; proceed to the next cover, and so on till the whole are finished. Of course the covers must be held over a separate vessel, for if the droppings fell into the acid it would become full of magenta, and if those from the washing away of the acid fell into the distilled water, it would become acidulous. When the distilled water is applied, a slight redness will reappear. This is of no consequence; it is, indeed, inevitable when there are many tubercle bacilli in the sputum; and if the washing is carried too far, it will take the colour out of the tubercle bacilli as well as out of everything else. But if the red is at all pronounced—if it is more than a slight pinkness—return and use a little more acid, for it is then probable that the magenta is not entirely removed from the other constituents of the sputum. (4) Make, say, 2oz. of a saturated solution of methylene blue in distilled water—i.e., add the blue till some of it remains permanently undissolved at the bottom; put in a crystal or two of thymol to prevent mouldiness. It is well to do this with all aqueous non-mineral staining fluids. There is the same difficulty with methylene blue as with magenta; I get mine from Hopkins and Williams. I *believe* what is called BBBBB methylene blue is the best. Leave the covers in or on a little of this for not less than five minutes. If they are laid on the bottom, a little dot of vaseline applied to the under side of each cover will prevent them from rising when the fluid is gently poured in. In all these operations it is needful to remember on which side the film is, and not to let the cover drop any distance, as it would then turn over and over. It is well, therefore, to hold the covers, in washing, quite close over shallow vessels, and to get into the way of holding them in the forceps in a determinate manner—e.g., with the film toward the thumb. But should the right side be forgotten, scratching the surface near the edge with a needle will show which it is. These may seem very minute details; but it is by such little things that one is chiefly puzzled when one is working by oneself. Besides, the same points occur in dealing with other Schizomycetes. (5) Take up the covers one by one (lifting them up gently with the forceps if they are floating, or sucking up the fluid with a tube or a syringe if they are lying at the bottom), and wash them with distilled water, as described above, for taking out the acid, till the water comes off very slightly tinted. Drain off the water by putting the cover on its edge on a bit of blotting-paper, preferably damped, or by rolling it on its edge like a wheel on the back of the hand. Then put it for two or three minutes into absolute alcohol (in a tooth-paste pot, paint-dish, watch-glass, &c.). Drain off the alcohol in like manner, and place the cover under a bell glass to dry. If the blue of the first cover tried washes out too much by the distilled water and alcohol, return it for a while to the stain. (6) Supposing the covers duly stained, the mounting had better not be delayed, so as to avoid action of the air on the film. Take some Canada balsam, say, ½oz. by guess, and heat it in an evaporating dish on a sandbath over a Bunsen burner, or in some equivalent way. Vapours will be given off, which must not be allowed to come in contact with a flame, and the balsam must not be permitted to do more than simmer. It must be watched, and when it has begun to give off a thick, white smoke, and is on the point of turning brown—it will then be tenacious in spite of the heat—pour it, when cooling, into a wide-mouthed stoppered bottle previously heated to prevent cracking, and let it become cold. A safer but more tedious plan is to let it harden gradually in a warm place; in either case it must be protected from the dust. Procure some xylol (a limpid, colourless, fragrant, very volatile liquid), say, 1oz., in a stoppered bottle, and add to the Canada balsam (which will be a dry mass like hard resin) as much of this as nearly suffices to bring it to its original bulk; and with time and occasional agitation the balsam will be redissolved. The mounting fluid thus prepared has the advantages of drying very rapidly and not causing the stains to fade to any appreciable extent. It should be about of the consistency of sweet oil, and to thin it down to this it may be necessary to add a little more xylol, the exact amount depending on the thickness or fluidity of the original Canada balsam. The xylol must contain no water. A mixture of ether (*Æther methylatum lotum* or *Æther lotum*) may be used instead. (7) The mounting itself is very simply accomplished: by placing a small drop of this fluid on the centre of the cover, applying it to an ordinary, but thin, glass slip, and persuading the superfluous balsam to depart by pressure with a spring clip. By this method of staining the tubercle bacilli show out red on a blue ground, looking like little red worms. Sometimes other red particles make their appearance; but they have not the shape of the bacilli, and the method is a perfectly trustworthy one, though a failure or two must be expected at first in the course of overcoming the initial difficulties of manipulation. The bacilli will not fail to be shown, *if* they are present. But they may *not* be present, even if the sputum is from a consumptive person; for even if the lump of sputum contains them, there may not have chanced to be any in the particle mounted on a given slide, and the sputum of a consumptive person will contain them only if it has come from an ulcer or cavity where they were actually being set free, and not if it proceeds merely from some region where mucus was being poured out on account of inflammation of the chest. When, on account of irritation in the chest, whether produced by a cold, by bronchitis, by tubercular consumption, or in any other way, the air tubes contain an exceptional quantity of viscid fluid; it is to be expected, and it is the fact, that it will contain other organisms besides tubercle bacilli. These other organisms—micrococci, bacteria, and bacilli of various kinds, enter with the breath, fall on the viscid matter and into the cells or cavities of the lungs, and, not being expelled at once on account of the passages being clogged, live and cultivate there, and come away with the sputum. They will very likely show blue by the above method; but the stain may be washed out by them, so that they may be faint and inconspicuous; and a better way of demonstrating them is by the use of Gram's double stain (which contrasts them with the non-schizomycetous constituents of the sputum) as follows:—Make saturated solutions of gentian violet in alcohol, and of aniline (i.e., the oil itself) in water; and for use mix a little of the first with nine times as much of the second. Place the covers on this for a few minutes; it will stain them violet. Dissolve twenty grains of iodide of potassium in fifty fluid drachms (rather more than four fluid ounces) of distilled water; and after dipping the covers in water so as to get rid of floating purple stain, wash them with and immerse them in this second fluid, which, in a minute or two, will take the colour out of everything but the air organisms mentioned above. Place them next (after a dip in water as before) in absolute alcohol, which completes the decoloration. Make a saturated watery solution of Vesuvin, or of Bismarck brown (boiling, in distilled water), and in this place the covers till they receive the stain, which they will very speedily do. Place in absolute alcohol to remove surplus stain, and mount as above. The air germs will be stained bluish-purple, and the other constituents of the sputum yellowish-brown — except the tubercle bacilli, which will be invisible, or almost so, not being stained at all. But they come out with great distinctness of detail if the first fluid is used as indicated for the magenta fluid described above, though they cannot then be distinguished by their colour, as they receive the same purple as the other bacilli, &c. If, however, the magenta is used first, and, after the covers have been washed with acid rather less vigorously than usual, the Gram purple is used for a few minutes, the *B. tuberculosis* comes out red and the others purple; but the contrast is not a good one. And, finally, if the Gram purple is lightly used, or the iodine and subsequent brown stain well applied, some bacteria, &c., come out purple, and others yellowish-brown. The sputum, however, had to pass through the mouth, and thus there will probably be in it, or, at least, in the saliva surrounding it, other organisms from the mouth or teeth. These may be examined separately by spreading a little saliva, not containing sputum, on a cover, as above, and staining. Saliva and other thin fluids may also be spread by a mounted needle held close to and parallel with the face of the cover; and greasiness of the covers may be got rid of by the use of *liquor potassæ* and water to wash them with before using. The best saliva is that procured in the morning after waking, before cleaning the mouth. The contained micrococci, bacteria, &c., may be stained *red*, with the magenta solution diluted and not afterwards washed out with water; *blue*, with the methylene blue solution; *purple*, by the first fluid of the Gram, without using the second; or *yellow* or *yellowish-brown*, by the Vesuvin or the Bismarck brown solutions. There is thus choice of stains; and which is to be taken is a matter chiefly of convenience, taste, and familiarity. The disadvantage of magenta is its liability to fade, which exceeds that of these dyes as a whole; but they are less likely to become bleached the smaller the amount of organic matter—very small in these organisms—with which they are conjoined, especially if kept in the dark. They last worst in wet mountings, and in imperfectly hardened objects—for micrococci, &c., *may* be mounted in glycerine or glycerine and water, which shows up their envelopes well. If it is desired to stain *red* with magenta, it is advisable to use a fluid more easily prepared than that given above—e.g., (1) Magenta five parts, dissolved in rectified spirit 100 parts, to which 100 parts of distilled water are added; (2) magenta in acetic acid and water (acid "fuchsin," as this stain is also called fuchsin in Germany, from its fuchsia-like colour); (3) saturated alcoholic solution of magenta one part, saturated watery solution of aniline nine parts (this may also be used for tubercle bacilli). Magenta, on account of its rapid action, is chiefly employed for staining for immediate examination. For more bulky objects than bacteria, a weaker solution may be employed, made by diluting any of the above with water, or (4) magenta one part, distilled water 1,600 parts; add 10 parts alcohol. Many metallic salts—e.g., corrosive sublimate—curdle magenta, and other aniline dyes. Methylene *blue* is, in many ways, a very remarkable stain, and shows up well the interior details of many of these minute organisms, as the spores. Of *purples*, aniline purple, dahlia, and Spiller's purple, have been employed as well as gentian violet, and an excellent purple, methylene violet, which is the basis of the French purple inks, does not seem so well known in this country as it deserves to be, and is very durable. Saturated alcoholic solution of methylene violet one part, water nine parts, wash with one per cent. solution of acetic acid, and dip for a moment in alcohol. For *yellow*, iodine may also be employed, both for immediate examination, and if the objects are to be mounted in glycerine. (1) A saturated solution of iodide of potassium in water, saturated with iodine; (2) a saturated solution of chloride of zinc in water, also saturated with iodine; or (3) tincture of iodine, strengthened if need be. The first will need to be diluted with water (Lugol's solution); the second can be used only for immediate examination; and the third will sometimes work when neither of the others will do so. The other constituents of sputum are (1) Mucus—filmy streaks, faintly stained. (2) Debris of food from the mouth, and, in cases of lung disease, of debris from the lung. These may be of different kind, and I cannot attempt to enumerate them. (3) Epithelial or skin-cells from the mouth, flat, irregularly oval, large, with or without nuclei. They may easily be obtained in saliva by rubbing the tongue firmly against the roof of the mouth, and may afterwards be identified elsewhere. (4) Salivary and mucus corpuscles, smaller, globular, also in healthy saliva. (5) Blood constituents (*a*), red blood corpuscles more or less degenerated, and (*b*) "leucocytes" or white corpuscles, larger and irregular shape. These may be seen in fresh blood drawn by a needle-prick from the finger; the red are very much more numerous, and look like plates. (6) Bodies resembling white blood corpuscles, but with many nuclei, which are well brought out by logwood. These, more or less degenerated, and granular in decay, form the bulk of the sputum.

F. Grant.

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## THE MICRO-OBJECTIVE.

[24204.]—MY labours have been in a direction differing from those from whom I have learned much in our pages, for while they have been setting forth the most perfect mode of producing the most perfect o.g.'s, my experiments have been made to discover some more simple plan by which the amateur optician might produce a fair combination.

I will now state briefly the steps which led to my success as it now stands.

The objects to be attained in a good micro o.g. are threefold—viz. (*a*) elimination of the spherical aberration and distortion; (*b*) to counteract or unde the dispersion; (*c*) to obtain greater angular aperture, as compared with a simple lens.

1st. Let this simple lens be a plano-convex, and it will be an improvement upon a bi-convex of same focus; suppose 1in. then.

2nd. Let two plano's, of 2in. focus each, be used in contact, and there will be a further correction of all the errors.

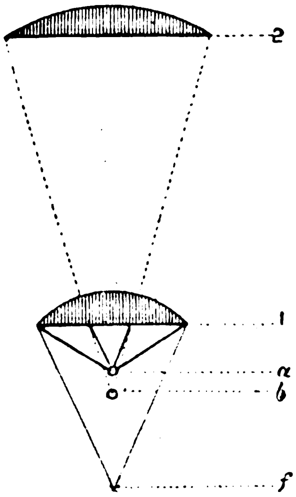
3rd. Separate the lenses increasingly, and the spherical error decreases, as also does the magnifying power; but the spherical error vanishes long before the magnifying power.

4th. Let the focal length of the posterior lens be varied, and it will be found possible to still further improve the general conditions.

These four statements constitute data on which to work.

Now let two plano-convex lenses be placed at a distance apart, equal to half the sum of their focal lenths, and the spherical error will vanish, especially when the shorter focus lens is a thick one. All things considered, too, the best focii for the lenses is the ratio 2 : 1.

A consideration of this fact, by help of a diagram, will be helpful. Herein (2) is a 2in. plano-convex, (1) is a 1in. p.c., placed with planes to object, and 1½in. apart.



The focus of (1) is at (*f*), but the object to be in the focus of the doublet must be at (*a*), when the rays of light from the object, instead of being parallel on emergence from (1), are so arranged that they impinge upon (2), as if they came from a focal point at (*b*), and also as though they came from a concave object of such concavity that every part of it is in the curved focal area of (2). Consequently, the back lens is able to give a view of the object under view as clear and flat as though it had no spherical aberration.

We now have as perfect an o.g. as two positive lenses can make, with perfectly central light (especially of a parallel or slightly convergent beam) the definition of thin objects—fly's wing, moth scales, &c.—is very little troubled with colour, and not at all distorted; neither does the field of view come into focus gradually, nor part at a time; but the whole at once and promptly, even with a large diaphragm aperture to eyepiece.

It is very plain, now, that if the back lens could have a little over correction with regard to colour, that our o.g. would be a perfect thing—at least, so I thought, and so have I also proved in practice with a little modification, which we will consider next week.

Rob. Crus.

## LATHE MATTERS.

[24205.]—I MUST again protest against Mr. Wenham's random statements. He may not intend to mislead our amateur readers; but, if not, he allows his imagination to run away with him, and he has not the courage to set himself right. I again say that of the hundreds of ornamental lathes which are in the possession of the readers of the ENGLISH MECHANIC, and whether made by myself or by Messrs. Holtzapffel or Evans, there will not be found a single mandrel-nose which is hard. Neither Mr. Holtzapffel, nor Mr. Evans, Dr. Edmunds, "J. K. P.," or any other authority will contradict this; and as any reader can test his mandrel-nose by touching it with the point of a penknife without injury, this reply must be final so far as I vindicate the practice of my own workshop.

Whether fine mandrel heads should in future be left hard or soft is a question that should be discussed apart from personalities. Mr. Wenham has taken this idea from Dr. Edmunds's paper, which says:

"The face and nose of the mandrel to be finished as hard as may be without risk of chipping or fracture, so as to secure permanent exactitude in the form of those surfaces upon which the fit of the chuck depends. . . . The nose to be tempered down to blue, and the mandrel-face at its periphery down to straw colour. The face, the cylinder-base, and the thread to be finished off with emery or diamond-dust glazers, so as to leave the surfaces true and accurately gauged. . . . The screw should be well fitted, but so easy as to allow the cylinder and mandrel-face to determine the seat of the chuck."—(*Journal* A.M S., pages 46-47.)

Mr. Wenham has appropriated the above most excellent suggestion without a word as to where he got the idea. In my opinion fine lathe-noses ought to be left of a spring temper, and brought to that state by the hardening process. In this state steel possesses the strongest endurance and the greatest possible strength, but they must be of somewhat larger dimensions than the present ornamental lathe-nose. Unless we adopt Dr. Edmunds's inch nose, such hardened noses would be liable to break off.

I am now making for clients two lathes with the Edmunds' model of mandrel-head, and left as hard as he suggests. Mr. Wenham's assault, therefore, falls idly upon my back; but it is necessary for the protection of provincial makers that such assaults should be fully exposed when insinuated into the columns of the ENGLISH MECHANIC. It is a common trick to take a third-grade article by some provincial maker, get it dirty and damaged, and keep it for exhibition by the side of newly lacquered work for which thrice the price is charged, as a sample of the difference between the work of makers in the country and in London. It is a mean trick, and does not deceive people who can compare prices as well as work. But many amateurs are gentlemen unsuspicious of such tricks, and they are often quite put out of conceit of a country maker's work by misrepresentations made behind his back. The innuendo that any one who is "knowing enough to test a lathe-nose with the corner of a file will not be taken in" is a good exemplification of the illusions to which gentlemen are treated in certain quarters. It never occurs to gentlemen to test in the same way a lathe by Whitworth, or Muir, or the other makers whose work Mr. Wenham eulogises for the moment, just for the purpose of throwing mud at me. Neither of these gentlemen will thank Mr. Wenham for the compliments which he offers them in order to disparage me, and I am certain that they will be ready to admit that, price for price, my goods will bear comparison with theirs.

As to the diamond tools for turning up hard steel lathe mandrels, Mr. Wenham (page 560, line 80), writes, "some of our best lathe makers." I denied this, and asked for names. Mr. Wenham then pretended to be reluctant to advertise his friends, and, on my calling this a paltry excuse, he says, "these lathes are by Continental makers"; and he tries to frighten English makers with the dreadful consequences of publishing Continental names in so widely-circulated a paper as the ENGLISH MECHANIC. Now, if we English makers cannot compete with Continental ones, the sooner we learn to compete, or shut up shop, the better. I therefore again challenge Mr. Wenham to publish the names of makers who really "true up their hardened steel mandrels by a diamond turning tool," and if, as I said, and he now admits, there are no such English makers, I ask for the names and addresses of the Continental makers.

English makers will be delighted to recognise good work, and some of the best French steel work is very fine; but this is also very expensive, and *price for price* we more than hold our own in the quality of our tools. I referred to the old diamond tools used by my great uncle to prove the antiquity of the method which Mr. Wenham stated was so modern. Engineers all over the world now use diamond tools for truing up emery wheels, grindstones, &c.—this is the *modern* practice. My showing this was the cause of Mr. Wenham's desire to traduce my tools; but I will challenge him for a £1,000 to finish and accurately fit a 6in. centre hard cast steel traversing mandril into its bearings by my method, as described in former letters, in one quarter the time, and far more accurately, taking the cylinder-base and shoulder-face into the bargain, than he can with the celebrated sharpened-up diamond tool he possesses, although I have not personally done such a job for 10 years or more.

It will take Mr. Wenham all his time to answer Dr. Edmunds's last letter (24172), and until he either answers the questions, or has the courage to set himself right, I shall not feel it necessary to take any further notice of his letters; but practical workers like myself often learn much from the suggestions made in the ENGLISH MECHANIC by scientific men, and we are always glad to reciprocate by explaining such matters as we can.

At page 191 Mr. Wenham, catching at a straw, says, "'J. K. P.' *truly* remarks that 'a cutter made for a screw of any particular number of threads will not do for any other number.'" Now, our excellent friend "J. K. P." is remarkable not only for his mechanical knowledge and ability with the pen, but also for his transparent honesty and readiness to correct a hasty statement. It will be rather amusing if "J. K. P." finds it necessary to point out that this remark is *not* true, and it will be a practical commentary upon Mr. Wenham's mechanical knowledge. **Edward Hines.**

Griffin Works, Norwich.

[24206]—I INTENDED some time since to have written you upon this matter; but my time has been so fully occupied that no opportunity has arisen until now. I inclose you a tracing of the nose for a lathe mandrel and face plate screwed thereon; good, simple, and thoroughly efficient, free from all unnecessary complication, and not liable to get out of order. In its use all that is required is a fair amount of care, but, beyond all else, "cleanliness."

I always kept a piece of soft wood, which I invariably screwed into all the chucks and face-plates, to remove any matter that may have got into the female threads, and passed the palm of my hand over the back surface of the boss which impinges against the collar of the mandrel, to be sure that no dirt was there, and that the chuck would properly bed against the collar.

The thread being angular will keep the chucks true axially, and the surfaces of the collar and backs of bosses being surfaced true will keep them right on the face.

No cylinder fit is any use, and if put cannot be depended upon for any length of time; it certainly is an addition, but a useless one, and no improvement.

I for many years used sundry lathes, where the chucks would interchange, and the chucks were shifted from lathe to lathe with the work affixed to them.

In one case—my wheel-cutting machine—I turn up wheels in the lathe, unscrew the chuck therefrom, transfer it to the wheel-cutting machine, and cut the teeth in the wheel.

Only bear this in mind—the threads on the noses of the mandrels must be angular threads, and not square ones, all cut accurately to gauges in strong screw-cutting lathes by efficient workmen.

By mistakes and failures an observing man learns more than by any other means.

Many years ago, I was working a well-made lathe by a reputably good maker. The nose of the mandrel had a square thread. From some cause, now forgotten, I had to remove the work from the lathe (chuck and all), to put in another job urgently required. When I rescrewed the chuck on the mandrel nose, to recommence work, I was astounded to find my work out of round—not run true axially. At first I was puzzled. I unscrewed and rescrewed the chuck sundry times, until I found the position it had originally occupied upon the nose, and I then proceeded with work. When finished, I examined the chuck and nose, and found that they were a slack fit; hence the trouble I had.

Had it been an angular thread this would not have happened. I never after that either bought a lathe or made one (and I have made some hundreds) that had the nose screwed with a square thread, but always used an angular one.

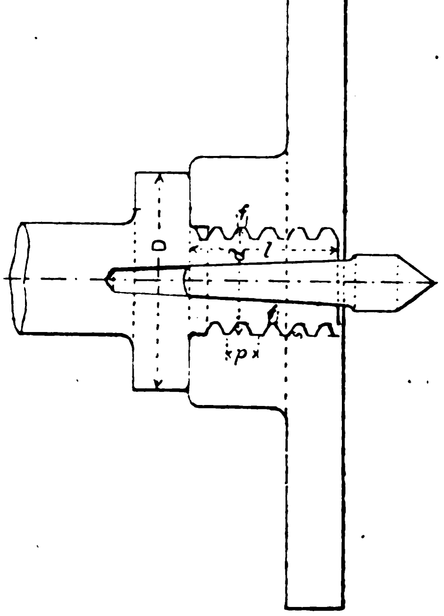
So much has been written by the various amateurs upon the mandrel nose. Simplicity and useful effect are the two great factors. If the thread is too fine, the chucks get jammed on so tight that there is frequently great danger in unscrewing them; besides, the fine thread has no durability, and one made with fine sharp edges is sure to get bruised, and its correctness destroyed. My experience has taught me that comparatively coarse threads are practically more useful than fine ones.

The thread on the nose of a lathe mandrel is put there for a specific purpose, and in choosing a thread, therefore, let us see and consider what will best attain the object. An angular one, whose pitch is not less than one-sixth of the diameter of the nose, or whose pitch is not more than one-fourth the diameter of the nose. That the top and bottom of the thread should be flat and not rounded.

That being so, the thread is more accurately cut, first on the nose, and afterwards on one or as many chucks as may be required.

The flat top and bottom does not stand the chance of being injured as the rounded top and bottom does.

I cannot see any reason why "Whitworth's" thread should be used for a mandrel nose in preference to any other, especially if the other is a better one. When Sir Joseph Whitworth introduced his system of screw threads, some 44 years since, his object, as he explains in his paper read before the Institution of Civil Engineers, was to render screw threads uniform (and, I also presume, universal) for bolts and nuts and other parts of machines. So far, I consider I may fairly say that has been attained, and his name is universally known therewith.



$d$ = diameter of nose of mandrel in inches.

D = diameter of collar of mandrel in inches $= d + \sqrt{d}$.

$p$ = pitch of screw thread $= \frac{d}{4}$.

S = depth of screw thread $= \frac{P}{2}$.

$f$ = flat on top and bottom of thread $= \frac{P}{4}$.

A = angle of thread = 53·0666° = 53° 4′.

A = an isosceles triangle, whose base and height equal.

$l$ = length of screwed nose in inches $= 1{\cdot}333 + d$.

He does not presume that they are applicable to every specific purpose that may arise, or for particular parts of a machine that has to be used in a peculiar manner.

As to the grinding or tapping up the angular threads of a screw or an angular helice upon a cylinder, have these gentlemen who say it can be done considered what the form of the thread will be. Will the sides of the angular thread be (in shop parlance) true?

A screw thread upon a cylinder, whether it be a square thread or an angular one, has its sides twisted, and nothing but a so-called point can truly trace that line. A revolving lap or emery wheel has breadth of surface, and if used for this purpose will distort the thread. **Tubal-Kain.**

## THE PARTIALLY GRAPHIC METHOD OF COMPUTING SOLAR ECLIPSES AND OCCULTATIONS BY THE MOON.

[24207.]—A FEW remarks by way of comment on the slight conferred upon me by the Council of the Royal Astronomical Society in their "rejection" of the paper, which you did me the favour to reprint in your last number, may be of interest to some of your amateur astronomical readers.

And, first, it must not be thought that a humble individual like myself ventured to approach that august body without previous preparation. I had paved the way by a preliminary correspondence with the President of the Society for the present year, Edwin Dunkin, Esq., F.R.S., so long ago as 1876. I think I may say I was almost inveigled into the bold step of addressing the Council by the insidious language then addressed to me. I quote from a letter dated Kenwyn, Kidbrooke Park-road, Blackheath, London, S E.

"1876, Nov. 23.

"My Dear Sir,—I am obliged to you for your letter of the 23rd inst., explaining a graphical method of computing eclipses and occultations. I have carefully examined it, and I think it is a convenient method for the determination of approximate times and angles, and that it might be useful to many for that purpose.

"If you could clearly explain your method in a short paper, it would be worthy of a place in the *Monthly Notices*.—"I am, my dear Sir,
"Yours truly,
"EDWIN DUNKIN."

The expectation thus created of a successful appearance in the *Monthly Notices* was destined to be rudely disappointed in 1885, for when the "short paper" was presented to the Council it was peremptorily "rejected." The secretary was instructed to inform the author that the Council, *after careful consideration*, had refused its admission, on the plea that a *similar* communication had been published in the ENGLISH MECHANIC, and that it was contrary to their *rule* to allow its insertion under these circumstances.

It was added that the paper was "rejected" for that reason *only*. But there must have been some mistake in this account of the matter, for I am told that "the paper was referred to a member of the Council of the highest authority." It appears from the assistant secretary that the paper was taken home from the R.A.S. meeting by Prof. Hind, F.R.S. I conclude, therefore, he was the "authority" referred to. If so, he gives a *different* version of the matter. The *reason* assigned by the "highest authority" is as follows (according to a note just received on the subject):—"Mr. Pearson, I think, fails to see the scope of such a paper as that of Mr. Woolhouse, to which he refers, and which includes the determination of all the lines required for the construction of the maps of solar eclipses, published in the 'National Ephemerides,' as well as the circumstances of lunar eclipses, transits of the superior planets and occultations, and he seems to be under a misconception as to the time any ordinary computor would require for the application of an accurate trigonometrical method to the prediction of an eclipse or occultation for a particular place."

In direct contravention of this statement (which it is evident was the *ostensible*, not the *real*, ground of "rejection"), I may state that I put myself in personal communication with Mr. Hind in 1858, and submitted to him a calculation of the solar eclipse of that year worked out on this very method of Woolhouse, which he checked by causing a copy of the printed form of computation, as done at Greenwich, to be sent to me, thus proving that I am not quite as ignorant on the subject as he would have others to believe. Besides, if the "rule" was absolute, why require "careful consideration"?

But let any one make the attempt of working out a solar eclipse or occultation on the "partially graphic method" (as Mr. Woodside has done), and compare the time occupied with that employed in working the same eclipse or occultation on Woolhouse's or Shadwell's method, and he will decide the question for himself.

Prof. Asaph Hall, of Washington (no mean "authority"), writes:—

"1884, Sept. 18.

"Your method seems to be remarkably neat and short, and is, no doubt, sufficiently accurate for all the purposes of observation. I hope you will publish it."

I trust amateurs will profit by my experience of the doings of a clique. Sir James Simpson had to undergo many rebuffs when he discovered chloroform, and Prof. Adams would have sooner risen to distinction, in connection with the discovery of Neptune, if he had had the support of a certain institution, which might have helped him. Novitiates in science must beware of those who seek more their own aggrandisement than the promotion of learning. **James Pearson, M.A.**

Fleetwood, April, 1885.

## MINERAL OILS AS DOMESTIC ILLUMINANTS.

[24208.]—THE more extended use of liquid hydrocarbons as popular illuminants has been much retarded by a rather general misconception of their nature, and a mistaken classification of various substances as one. Perhaps a few words of explanation in the most popular and simple form about these oils might be of some use, for although all that can be at present written on the subject has from time to time appeared in this journal, and is familiar to most of its readers, yet a little summarising of the matter may be convenient to some.

Popularly, these oils may be conveniently classed as paraffin and petroleum, though the one is a manufactured article and the other in its raw state is a natural production, yet, to all intents and purposes, the same observations refer to the use of both. Now, in a general way, these oils (as far as their use by the public as illuminants is concerned) may be classed as "benzoline," water white, and "standard white." The first is a highly volatile spirit, and should not under any circumstances be used in lamps as a domestic illuminant, as it gives off a very inflammable vapour at a comparatively low temperature, and at present its storage and domestic use are rather dangerous. The second is the whitest and purest oil, and is retailed under various fancy names and prices, at from 50 per cent. to 150 per cent. profit, according to the clientèle of the vendor, and his ingenuity in pushing its sale. The third is the "Standard White" (the title belongs in strictness to the Standard Company, but is here only used as an easily understood definition of a quality of oil made by many refiners). Generally speaking, these are the oils usually sold, and should at present prices be retailed at from 8d. to 1s. per gallon.

The popular idea of these oils "blowing up" must be at once dispelled on considering their nature. The oils themselves never can "blow up": only the vapour that is evolved from them at a high temperature can do this, and then only when mixed with a certain amount of atmospheric air, and as no good lamp of the present day is at all likely to heat the oil to this degree, all uneasiness on this subject should cease; the flashing point being roughly stated as over 150° in a close test, and a permanent firing point of over 250° (see for fuller information "E. M." Vol. XXXIX., page 191). It being thus shown that in the use of these oils there is no danger, the storage of same in private houses should cause no uneasiness.

The lamp, its fittings, and method of using it should next be considered, and among the vast number of these offered to the public, the specification of any particular make might be invidious. Let it suffice to say that in a general way they are all good enough for their purpose, the only object of these lines being to popularise the rationale of lamps in general, and assist consumers to use their own judgment in selecting such lamps as best suit their means and requirements.

The present lamps may be best classed by the form of their wick, the double wick (Duplex), the flat wick, the round wick, so woven (reading lamps, &c.), the flat wick taking a circular form (Silber, &c.), the cord wick used for small lamps and in a large annular cluster (the Argand); there are also excellent lamp modifications of the above, and some with mechanical arrangements that consume no wick. As the comfort and usefulness of all these lamps depends entirely on the care and cleanliness of trimming and using them, a few observations on these points may be of assistance.

In selecting a lamp, see that there is no opening in the fitting except the wick sheath. The fitting should fit the collar by a well-made screw of at least five threads; the container should be of as great a diameter and as shallow as possible, as few wicks will draw well for more than 4in. from their point of combustion. See that the collar is fixed airtight to the container. This prevents the escape and aëration of vapour should it be generated, and compels its consumption by the flame; it also prevents the exudation of oil mentioned hereafter. The pinions for raising should be well made, and have their teeth fine and sharp, and where two are used they should be very evenly adjusted, as, if not, they raise one side of the wick faster than the other, destroying the level of the light. The lamp-stands should be well weighted, and have a good broad base to render them firm and secure.

More consideration than is generally accorded to it should be devoted to the chimney, the special function of which is to cause a steady draught on the flame, and so insure its perfect combustion; without this chimney (which was first accidentally discovered by the younger Argand) no lamp can give a steady or white light. No one can but wonder at the senseless way that perfectly unsuitable forms of glasses are applied to different makes of lamps—not only by the public and retailers, but even by the manufacturers, and many a good lamp has from this cause alone been most unjustly condemned.

In round-wicked lamps the chimneys must be made with a shoulder, with or without a "choke." The latter, perhaps, is the best, for, though it may limit the diameter, it provides a larger flame of white light; in either case the shoulder must be close (from ¼in. to ⅜in.) above the head of the wick tube, and where the chimney "carrier" is fixed (that is not adjustable), care should be taken to provide chimneys so conditioned; otherwise the light will be poor in quality and apt to dance.

For "Duplex" lamps there can be no better chimney than that now sold.

For large or small flat-wicked lamps there is really no very good chimney at present sold, "the square peg being made to fit the round hole"; the best form, however, is one made a good deal in the shape of the "Duplex," that is, more cylindrical and less bulbous than the usual form, and which can be bought in all sizes. The proper form would be an acute oval, choked like those used for round-wicked lamps, only made oval; but fittings for this shape are nowhere made, nor one chimney of this form to be had, although in one Belgian glass-works there are over 300 patterns of lamp glasses. A good general rule is to use as small a glass as will suit the flame; for small wicks and large bulbous chimneys are very often sold, in some cases half-roughed, to act as a compound of chimney and globe. The construction in such lamps is imperfect, and the atmosphere of the room is vitiated by the unconsumed products of the oil.

The glass carrier and dome should be easily removed that the wick may be trimmed, and the sheath and ventage perforations properly cleaned. There are lamps sold where this dome is a fixture, and such can never give satisfaction or comfort in use.

Though the consideration of the wick comes next in order, it is really of the first importance. This should be rather loosely woven, and, without being in any way impacted, should well fill the sheath. Before putting it in the lamp, it should be well baked or dried at the fire; the least moisture prevents the oil readily rising in it; place it in the sheath from the container end, and when through, before being put in the oil, it should be burned at the end to give it a level edge. Scissors should not be used to trim the wick. This is best done with a flat hard brush, such as is used for washing hands, and is sold at 2d. or 3d. Raise the wick above the sheath, and brush off the charred part; then, with the brush, trim it into an elliptical shape, like the section of a watchglass, taking care to keep the corners nice and round, and not to make the ellipse too high, or the wick will not burn at its full width. Keep the lamp well wiped with a soft cloth, and always light it with a wooden match or spill.

When not using a lamp, keep it clean and empty, and when in use, but not lighted, keep the wick well down in the sheath, as the oil mounts it by capillary attraction; and if the wick is above the sheath, the oil flows imperceptibly over the top and extends all over the lamp until the container is quite voided, and much mischief done. This action gives rise to a very ignorant but popular belief that the oil percolates *through* the glass or metal.

An oil "drum," containing from five to ten gallons, should be provided in town, and one of a capacity of forty gallons (equivalent to a cask) for the country, as these oils should never be kept in wood. These drums should have a good sound tap, and the oil may be drawn off in the required quantities without any unpleasant dirt or smell; and any extensive retailer will sell the best oils in these quantities at from 8d. to 1s. per gallon.

Chimneys can be bought quite good enough for general use by the dozen, at, for the large, such as "Duplex," from 3s. to 4s., and the smaller, like "reading lamps," at from 1s. to 1s. 6d., and they are not a bit more likely to break than more expensive articles. When first lighting a lamp keep the wick low, until the chimney is well heated, then raise it to full combustion, and keep it so while lighted; no lamp should ever be turned down, or burned below its proper power.

To extinguish a lamp do not blow it out; lower the wick into the sheath, and raise and lower it a few times quickly. The wick should always reach the bottom of the container, and though it may last months, should be often renewed.

Doubtless all these observations are familiar to most people, some of whom may know very much more of the matter; the pity is that they do not impart this information. In the hopes of their doing so, these lines have been hastily put together. They do not pretend to any fuller knowledge than is supplied by familiarity with the subject, and are only addressed to the general users of these lamps, who, suffering from various inconveniences in their use, do not readily perceive any simple means of remedying them. J. B.

### MINERAL-OIL LAMPS.

[24209.]—IT would be of great advantage to readers if correspondents could confine themselves strictly to the point at issue, which in this case is the respective merits or demerits of glass or metal containers.

Mr. G. B. Postlethwaite, in his championship of "paraffin oil," must be well aware that that is the popular name of all hydrocarbons, as in this form they were first introduced by Mr. Young, and in this sense I am sure Sir Fredk. Abel spoke. Further on, to refute my argument (which has reference only to English domestic lamps), he instances oil stoves, optical lamps, and American street lamps, all burned under other conditions. While combating my assertions, he goes out of his way to prove me right by admitting the advisability of using a cork washer at the collar, which is quite unnecessary in glass containers, as they do not heat.

My observations have been general and impartial. All the replies (except Col. Shakespear's) have been particular and interested, advocating as they do some special lamp or oil, and directly or suggestively hinting at the danger (?) of others.

J. Hughes.

### ENGINE MAKING AT HOME—REPAIRING BOILERS—MODEL TUG BOILER, &c.

[24210.]—IT gives me much pleasure to observe that "J. H." has kindly assisted my desire to ventilate and discuss matters relating to an amateur's engine. The interchange of ideas with a practical and gentlemanly correspondent is not only a pleasure to the parties themselves, but elicits many valuable points of general interest; thus, such a discussion resolves itself into an exchange of ideas, alike benefiting all interested.

Now, as our friend thus very fairly answers my friendly criticisms, he has brought to the front another practical point. In some horizontal engines I designed for a small maker the very point he raises was mentioned—viz., that the hooded end and the core box for it must be arranged to form the stuffing box in the core box. My friend in question had some misgivings as to this, and I suggested two modifications that at once got over the difficulty. One was to cast the cylinders, which were never more than 8in. stroke, with the one end cast on the gland, being, of course, cast with the end and easy to get at or to form the front end as follows: the hooding was cast out, and subsequently bored out in a recessed ring. Into this recess went a disc, having the piston-rod gland on it. The cylinder, when bolted on by its flanges, was maintained central by a rib on the loose cover, and as it was drawn up made a joint with it at the same time that it was bolted to the hooding. These engines had also another modification—the guide was a modification of Fig. 4, the modification being that instead of planing out the path for the guide block, a semi-circular path was used, which was bored out at the same time as the flange on the hooding. The centre line of the cylinder was thus very much lowered and the thrust brought in a more favourable position. The guide shore having been turned also the guide strips were simply flat ones of rectangular section. As far as a practical job goes, I must say that Fig. 5 is very good indeed, the crosshead shoe being made adjustable to take up wear.

I must certainly say that the way "J. H." has treated the matter is exceedingly practical. No doubt the bed he shows is, as he states, so simple that any amateur would experience no difficulty. This is a great point in construction. And I would wish to bear personal testimony that the reasons given by him show that the subject has been most thoroughly thought out by him, and he is clearly entitled to the sincere thanks of the readers of this journal, and I trust they will not be niggardly bestowed.

Has "Os" taken into consideration when he writes on the subject of repairing shot holes in a boiler, at p. 193, that the completion of the work in the shortest possible time is of the greatest importance? He asks me how I should like to get inside. Well, my answer would be that it is not essential to get inside at all, and I mention the *manhole as giving egress*, as showing that, on a pinch, a man could be sent inside to assist. The holding up can be done from the outside; therefore a man inside is not an absolute necessity. Now, to drill and tap holes in the boiler shell is a job that would take some time, and even then there is the making of a joint and screwing up. The piece that "Os" would propose to fix on the boiler would also be outside, so that the pressure within would be resisted by the screwed pins only. In the plan I named, the strain is borne by the piece of plate itself, the outside piece being used to draw the joint up with; so that in my example the repair is as strong as any manhole joint can be, being an exact equivalent. If studs or bolts screwing into the thickness of the boiler shell be so simple and effective, then why are manholes not made so, instead of fitting against the inside exactly as I say?

I can quite understand the idea that is floating in the mind of "Os." But I can tell him of a much more nasty job than going inside a boiler to hold up whilst the joint is being drawn up, and I have had personal experience of it. It is going into the return of a large boiler to plug up a burst tube. Now this is a job I don't care for. It may be instructive to our friend, so I will briefly describe it: A tube having burst, the water is blown out. The steam jet is started, and as much air sent through the boiler to be repaired as possible. The fire bars are pulled out, and in you go into an atmosphere heated to something terrible. With the aid of a short-handled sledge or a heavy fitter's hammer you drive in the wood plug, which you have prepared, into the end of the burst tube; a blow or two to drive it in steam tight, and you are frequently even then dragged out by your heels by your firemen next door to fainting. The patent tube stoppers were not in use in my time, so that it meant going in in person. Now has "Os" ever done this? I have, and would do it again if occasion needed. Here we have, in my opinion, a job that is done under conditions still more trying than sending an Arab fireman into a boiler, the Arab being able to bear with impunity a far greater heat than the writer. And we have also another factor in the case. It is that the plates and boiler originally mentioned could readily have been cooled by copious volumes of water whilst the covering plate that friend "Os" mentions was *drilled with clearing holes*. In my case the boilers were empty only, and were not cooled by water sent in for that purpose. In repairing shot holes, when I have been present, water was plentifully sent in by either a hand pump or in buckets, and the temperature quickly reduced so that it was bearable, to blacks at any rate. I do not wish, nay, I will not say, anything that may even savour of an acidulous reply to "Os"; but perhaps he would not mind my asking him: Has he ever, in person, dealt with a burst tube as I describe? And has he also had practical experience in stopping shot holes in a boiler? If he has not, I have, and can speak from what I have gone through in person, and the ordeal in either instance is not *nice*. I have seen some practical repairing of war ships that would surprise many of our friends, "The gentlemen of England, who stay at home at ease."

In referring back for another matter, I chanced to see the reply on p. 153 (query 56240). Surely our friend J. Anstie must have made a mistake on the question of tubes. He advises 40 tubes, 7-16in. diam. outside, and about 9¼in. long. Surely he must know that such small-bore tubes are practically useless, as, allowing for metal, the clear bore would only be at most about ¼in. diam. Again he discards a steam dome, yet has for water and steam but 1¾in. over the firebox crown. The engines also, in my opinion, are far too small to get the maximum speed out of the hull. I certainly think our friend must have made a mistake in respect of the space for steam and water, whilst the steampipe, ¼in. bore, is none too large. It is very easy in writing off a quantity of figure dimensions to make a mistake, and I fancy this must be so. Again, the safety-valve for a boiler with a large furnace in it, as he mentions, seems very small, especially if life is worth anything. Now a pump on the engines looks well, but if they were driven at the speed I should want to run them at, I don't think the pump would do much feeding. Certainly it must be a better one than I have been able to get as yet, especially when it has a ¾in. plunge and only ¾in. stroke, and has to feed against 60lb. steam pressure. No doubt our friend will be able to tell us something further, and, I should imagine, would see his figures have been transposed. If not, I am certainly at a loss to understand his practice. Our friend must, and will, I am sure, take my remarks as friendly criticism, and, no doubt, will at his convenience afford some explanations of what seems to me unusual. **Invicta.**

### THE MUSICAL SCALE.

[24211.]—IN letter 24096, No. 1048, I should have said tune monochord to *tenor viola C string*, as tenor C really means an octave higher than I wish it to be understood. I have to ask the Editor's forgiveness for the error.

New Cross, S.E. **W. H. Elphick.**

### NEW MIDLAND ENGINES.

[24212.]—THERE has been a deal of mischief made about the new Midland engines, but the letter of "Locomotive Man," p. 172, clears all up. It is as plain as daylight now that the engines are failures from *one* cause, and that is a bad one—shortness of heating surface. It is all very well, Sir, for all the blame to be pushed on to the drivers, just so that the truth shall not come out. Whoever did the calculating of dimensions made a fearful mistake in putting on these little boilers, but let *him* have the blame, not the drivers. I hear they are going to put a lot more tubes in the boilers now, after all this correspondence; let us hope that plan will do good, and get more steam.

It may be a matter of interest to your numerous readers to know that some more tubes have been put into the boilers of some of the new Midland engines, and it is an improvement; last week No. 1675 ran the Scotch Express to time upon two occasions, taking the twelve coaches without any pilot. In looking over the ENGLISH MECHANIC for a few years back, I notice that at that date our correspondents, Mr. Stretton or "Meteor," always came forward to defend the 800 Midland engines if a word was said against them; but these two gentlemen do not seem to enter into this important matter of the 1675 class. Have these "big engines" no one who will come forth and do battle for them in the "E. M."? I rather expected that with big cylinders and Joy's gear we should have had good results. **Midland.**

### RAILWAY-AXLE LUBRICANTS.

[24213.]—THERE is a subject that might, with profit, be discussed in your columns; it is the question of railway-axle lubrication, and the points I should like to see settled are:—

1st. Which is the better lubricant, grease or oil?

2nd. What is the best form of axle box?

3rd. The successes as regards capillary attraction, and the arrangements for dropping the oil upon the axle. **Lubricant.**

### CONTINUOUS BRAKES.

[24214.]—THE return relating to continuous brakes in use to 31st December, 1884, has recently been published; but, unfortunately, like its predecessors, it furnishes evidence that at present there is no prospect of the adoption of one general system, and that several companies are actually continuing the absurd practice of fitting rolling-stock with inefficient brakes, showing practically that they care neither for the safety of their trains nor for the waste of their shareholders' capital.

| | Engines fitted with brakes. | Engines fitted with apparatus for working brakes. | Carriages, &c., fitted with brakes. | Carriages, &c., fitted with pipes, chains, &c. | Miles run. |
|---|---|---|---|---|---|
| Total amount of stock returned as fitted with brakes which appear to comply with the conditions of Board of Trade | 3,066 | 90 | 19,047 | 4,037 | 31,953,436 |
| Total amount fitted with brakes which do not comply with the conditions | 1,111 | 482 | 13,005 | 3,049 | 21,854,973 |
| Total fitted | 4,749 | | 39,138 | | |
| Not fitted with any continuous brake | 1,705 | | 11,374 | | 15,881,925 |
| Total passenger rolling-stock therefore | 6,454 | | 50,512 | | |

It should be mentioned that the Board of Trade has considerably improved the form of the "return" by placing engines and vehicles which are fitted with brakes complete in different columns from those which have "apparatus for working" or through pipes or chains only; the percentage of vehicles and mileage on each railway is also valuable information.

The above tabulated statement shows the amount of rolling-stock fitted and unfitted on 31st December, 1884.

The above figures show very plainly that the majority of railway companies are not making sufficient progress, for out of a total of 6,454 engines only 3,066 have brakes which even "appear" to be efficient, and of 50,512 vehicles only 19,047 profess to have those brakes, and it must also be remembered that (to use the words of the return) "some of the brakes so returned but very imperfectly fulfil that designation." For instance, the North London Company returns 83 engines and 560 vehicles fitted with Clark and Webb's chain brake as fulfilling the "conditions" of the Board of Trade. It is not necessary for me to say that it does nothing of the kind. Then, again, the Midland and Great Western Companies take credit for a large number of engines fitted with non-automatic steam brakes, and vehicles provided with that most dangerous of all appliances—the Clayton two-minute leak-off system.

No person can honestly say that the "leak-off" brake is safe, nor that it fulfils those well-known and excellent "conditions" contained in the circular of 30th August, 1877.

Having given the total amount of stock fitted, reference should now be made to the actual "progress."

The following table shows the total number of engines and vehicles which were fitted with each system during the half-year ending 31st December, 1884:—

| Name of Brake. | Engines. | Vehicles. |
|---|---|---|
| *Westinghouse Automatic.. | 97 | 601 |
| †Sander's and Bolitho Automatic Vacuum........... | 64 | 534 |
| Smith's Automatic Vacuum. | 87 | 339 |
| Clark and Webb's Chain.... | — | 20 |
| Smith's Vacuum........... | 46 | 259 |
| Newall's.................. | — | 10 |
| Vacuum (L. and N.-W.).... | 7 | 671 |
| Heberlein................. | — | 3 |
| Westinghouse Pressure..... | 6 | 54 |
| All other Systems.......... | — | — |
| Total................ | 307 | 2,491 |

* In addition to the above, 25 goods engines on the North-Eastern Railway have been fitted with the Westinghouse brake.

†The 64 engines fitted with Sander's brake have non-automatic steam brakes.

From these figures it will be seen that sufficient progress was not made during the last half-year, and it must also be remembered that a large amount of stock returned as fitted in the six months is nothing more than a change of system. The London and North-Western Company appears to have fitted a large number of vehicles with the "Vacuum" brake. This is not progress, as another brake—the Clark and Webb chain—is being taken off, and it is by no means certain that the new "simple vacuum" is a better or safer appliance than the discarded "chain."

The following table is obtained from a comparison of the last two returns, and shows that during the half-year the undermentioned brakes were removed:—

| Name of Brake. | Engines. | Vehicles. |
|---|---|---|
| L. and N.-W. Ry., Chain.. | — | 881 |
| West Coast Joint Stock Chain................. | — | 77 |
| Great Eastern Ry., Smith's Vacuum............... | 5 | 70 |
| Great Eastern Ry., Fay's.. | — | 3 |
| Lancashire and Yorkshire, Fay's................. | — | 28 |
| Great Western, Smith's Vacuum............... | 4 | 55 |
| Caledonian Ry., Steel McInnes............... | 1 | — |
| Total.............. | 10 | 1,114 |

The fact that in six months companies should take off such a large number of inefficient brakes shows the absurdity of money having ever been thrown away upon fitting them.

The most unsatisfactory part of the Return is again that portion relating to "failures," the information in many cases being either incorrect or absolutely false.

The Manchester, Sheffield, and Lincolnshire Company reports an actual "failure" under the head simply of delay.

The Midland Company reports one case only of the failure of the "two-minute leak-off vacuum," yet it is a well-known fact that numbers of failures have taken place, causing trains to run past stations and signals. This is not hearsay evidence, as I have seen some cases and been in the trains; therefore to these I can speak with certainty.

At the Congress of the Amalgamated Society of Railway Servants, held at Bath last year, it was distinctly stated that "failures" were not reported by the companies, and nothing can confirm the truth of that statement more than the recently published return. **Clement E. Stretton,**
Hon. Member A. S. Ry. Servants.
Leicester, 2nd May.

### HOW TO MAKE UP A SET OF RESISTANCE COILS.

[24215.]—HAVING received many letters asking for advice on the above subject, from those who have purchased the standard ohms which I advertised in this paper, I proceed to give the information publicly, trusting that it may be of general interest.

Although coils may be made up without the use of a Wheatstone's bridge, yet the employment of this latter will greatly facilitate operations, and will conduce to greater exactitude. A simple bridge, which is perfectly suitable for this purpose, may be made from a piece of dry, well-seasoned pine, about 16in. long, by 4in. wide, and ½in. thick. After being planed up true, this may be stained and varnished. A strip of copper, about 12in. long by $\frac{1}{16}$in. thick and 1in. wide, is screwed down against one edge of the upper face of the board, leaving 2in. at each end uncovered.

Two strips of the same copper, 1in. wide, but only 4in. long, are now to be fastened down to the board, across its width, one at each end. This leaves a gap between the long strip, and the two short ones, of birch, at each end of this board. Ten small telephone binding screws are now provided, and inserted: First (*a*) one in the centre of the 12in. strip of copper. (To this one pole of the battery is afterwards connected). (*b*, *b*), one at each extremity of the 12in. strip.

Secondly (*c*, *c*, *c*, *c*), one at each top corner of the 4in. strips, facing the 12in. strip; and lastly (*d*, *d*) one in the centre of the lower extremity of the 4in. strips. Between these latter two about 14in.

of No. 30 soft iron wire can be stretched when required by passing through one binding-screw hole, clamping, passing through the hole in the opposite binding-screw, pulling pretty tight, and then tightening up this latter screw.

Before putting the iron wire in its place, a simple form of contact key is slid on the wire, by which contact with the other pole of the battery is made when required at any given point along this stretched wire. This consists in a little inclined plane of wood, on the highest portion of which a binding-screw (for attachment to battery) is fixed. This screws down upon a flat, thin spring, which, on being depressed, makes contact with the wire.

Now for the way of using this bridge. Connect one pole of the battery with the sliding contact (which must stand at exactly half-way between the two arms of the bridge) and the other pole with the binding-screw in the centre of the 12in. strip. (N.B.—The battery had better be a Daniell, charged with sulphate of zinc, in order to be very constant.) A fairly sensitive galvanometer should now be connected to the two outer binding-screws at the farther end of the 4in. strips. A standard ohm is now placed in the gap between the long strip and one of the short strips, and connected to both by means of the binding-screws. A length of the wire which it is desired to make up into a coil is now placed in the remaining gap, and connected up in the same manner. The key of the shifting contact is now momentarily depressed, so as to allow a current from the battery to pass. If the trial wire is of the correct length between the gap, *no deflection* of the galvanometer takes place, as the standard ohm and the said wire balance each other; but if a deflection is shown to either side, the sliding contact is shifted to the one side or other, and depressed until balance is obtained, then by noticing on which side the extra resistance has been inserted (which side has the longest piece of iron wire to the right, or left, of the sliding contact), it is easily seen whether too much, or too little, wire has been placed between the gap. This length, making allowance also for the length required for soldering, or otherwise fastening to the copper poles, or binding screws of the desired coil, may now be cut off, the wire folded once on itself, to prevent self-induction, and wound round a reel, the two free ends being soldered (with rosin as a flux, *not* chloride of zinc) to the desired terminals. Before definitely soldering down, the reel and its connections should be again placed in the bridge to insure perfect accuracy. It is needless to say that the wire should be German silver, insulated with silk, and well paraffined.

From the 1-ohm just made, a 2-ohm and a 5 can easily be measured, and from these any number up to thousands can be constructed. A convenient set consists of an arrangement of 1, 2, 2, 5, 5, 10, 20, 30, &c., up to 100, double the hundreds, and also the thousands. **S. Bottone.**

## THE NEW THEORY.

[24216.]—IF J. L. Gordon expects any sane English Mechanic to believe his theory, I trust he is mistaken. As jokes are out of place in this paper, I suppose we must try to look sober while we argue about the "expansion of energy" and the "flashing train of atoms."

I fear that the law of the expansion of energy has not been properly investigated, for I have never succeeded in finding the coefficient of expansion in any table.

I am quite at a loss to see how dynamos can generate a current of the "fleeting H." Perhaps "J. L. G." can tell me at what part of a dynamo circuit is the H evolved, or what part of a thermopile generates the "fleeting H"? He, of course, with that delicate instinct which leads him to such correct conclusions in the field of mechanics, will have a better chance of solving these problems than we who depend solely on reason.

It is alleged that the intense heat of the electric arc is caused by the hydrogen burning. Suppose that the wires of the dynamo are charged with a limited number of hydrogen molecules, the arc would rapidly burn the H, and the dynamo would cease to give a current. If I may be allowed to tender a little advice to this dashing theorist, I would say—First. Study the first principles of chemistry, and learn that an *atom* cannot exist free in nature, and, second, before you write a book on your new theory, learn that *whenever* a current passes through a wire, heat is evolved.

**A. H. B.**

## A DISAPPOINTMENT.

[24217.]—SEEING "Montmartre's" kind offer anent opera-glasses of high power—a great dedesideratum—I wrote, inclosing £2 16s. 6d., for a glass "of superior manufacture," mentioned in a former reply to the secretary of the A. and N. Cooperative Society. In answer, I received back the money, with the intimation that the rules of the society do not admit of goods being supplied to non-members. As I mentioned the advertisement in the ENGLISH MECHANIC, there must have been some misunderstanding. I am much disappointed, as I expected to be in the enjoyment of a treat by this time. **G. Dickson.**

## LATHE MATTERS.

[24218.]—WHAT "J. K. P." has told us of his magic "touch" makes me long to know more. Will he kindly describe the process, and say a word as to the degree of accuracy before and after the operation?

The question in our minds must be, If "J. K. P." can make a mandrel nose with a screw so perfect that it will enable chucks to be exchangeable without the need of a cylindrical fitting, why cannot Mr. Evans or other first-rate workmen do the same? Then the suspicion that he may be contented with a less degree of accuracy forces itself upon the mind; but does not satisfy those who have been accustomed to think of him as representing the highest attainable accuracy of workmanship.

Does "J. K. P." use any methods that are unknown to other workmen? Can we adopt some test by which the accuracy of the results of the two methods under discussion can be compared?

I should much like to see the drawing of the front slide lathe in the *Machinist* mentioned by Mr. Myall. Can the number for March 7th be obtained in this country, or will he lend it to

**F. A. M.**

32, St. James's-road, Tunbridge Wells.

# REPLIES TO QUERIES.

*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[54825.]—**Salt, &c.**—I am not at all surprised that "F. W. H." never heard of "corn and baked cakes of bread having been found fossilised in the geological strata." I never heard of it either, nor I suppose anybody else, and why "F. W. H." should have introduced the geological strata is more than I can tell. The remains of man that I referred to were what has been found at the Swiss Lake Dwellings, and instanced them as showing that those men were not primitive, although they were so early as to be living up to the ice border at the time the Glacial period was moving off from that and the northern part of Europe, and among the things found at Rosenhausen were traces of bronze, pieces of pottery, portions of woven cloth, and some crucibles, one of them having a small bead of copper in it. At Wangen were found quantities of corn, baked cakes of bread, flax, and perforated stone axes. I suppose this will be enough. In the following answer (54825) by "Nun. Dor.," he seems to object to a special creation for the different food plants, and says: "It is much easier to believe that they have been developed by cultivation." But supposing they were so developed, it does not take away the need of a special creation, because if the different qualities which go to make up the various plants had not been in the originals, they could never have been developed, according to the law that you cannot get out of anything what's not in it, so that we are just where we were. —DENS.

[55522.]—**Hexagonal Parts of Globe-Valve.**—If you have the means of attaching a horizontal division-plate on your slide-rest, you could bolt the globe-valve on it and shape the hexagon with a milling tool held in a suitable chuck. "O. J. L.'s" much-abused "Unlimited Liability Lathe" (Vol. XXXVIII. p. 507) would probably be useful, in default of special tools.—GLATTON.

[55535.]—**Boiler Chimneys.**—Rankine gives $\frac{1}{10}$ area of grate as the area of chimney; Bourne gives as Boulton and Watt's rule: Area of chimney in square inches—

$$= \frac{\text{lb. coal burnt per hour} \times 12}{\sqrt{\text{height in feet}}}.$$

There are many others. The chimney should be equal to the sum of the areas of the chimneys which would be required if each boiler had its own. Molesworth gives a rule similar to Bourne's, but substitutes 15 for 12.—GLATTON.

[55565.]—**Cone Pedals.**—Yes, there is a bending stress due to the pressure of the foot. I have not an opportunity of measuring one; but I think the pin on which a bicycle pedal turns is about ½in. diameter.—GLATTON.

[55634.]—**Engine Boiler.**—This is too big a job to undertake without special tools. The valve you sketch is faulty in several respects: it is unbalanced, and would not work freely: the rectangular section is bad for strength. You do not say what pressure you wish to work at. ¼in. plate would do (if carefully riveted with double riveting for longitudinal seams) to work at 50lb. per square inch, the best plate being used. Could you bend and punch or drill plate of this or a greater thickness?—GLATTON.

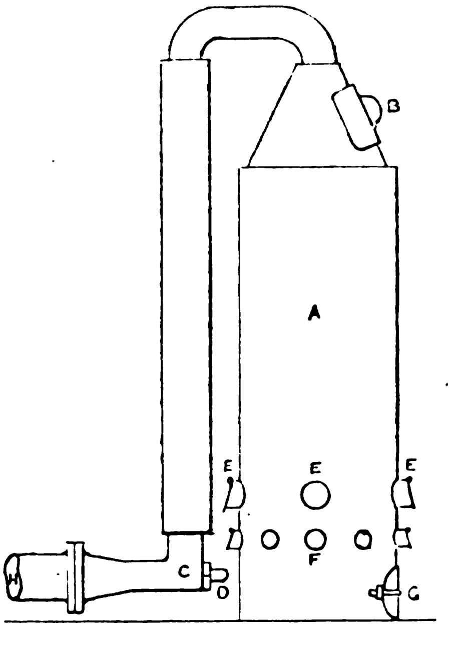
[55700.]—**Strength of Shafting.**—I was glad to see "G. O. T.'s" letter: his is a far simpler demonstration than mine. He will see that the mistakes he refers to were slips of the pen, which I corrected as soon as they appeared.—GLATTON.

[55700.]—**Strength of Shafting.**—On reading "Glatton's" reply to this query in the "E M." for April 24th, I noticed several clerical errors in the concluding sentences; but the preceding portions of the answer made the meaning of the writer so clear, that I did not think the mistake required correction. Another correspondent signing himself "G. O. T.," who has evidently read only that part of the reply in which the slip of the pen occurred, seems to suppose that the whole answer must necessarily be wrong. The new "demonstration" is, however, far less satisfactory than the one already given by "Glatton;" and I think, in common fairness, "G. O. T.," when he wishes to pose as a critic, should in future refrain from slashing at isolated sentences until he has taken the trouble to read the context.—BACCHUS.

[55700.]—**Strength of Shafting.**—To "GLATTON."—In your reply to me in "Ours" of the 24th ult., you say if I work out the power again, I shall find I have made a mistake; the 6in. shaft comes out exactly nine times as strong as the 2in. one; but do you not, in your correction made in last issue, prove that I was right? I stated a 2in. shaft at 20 revs. by your rule gave 4·47 h.p., and a 6in. shaft at 20 revs. gave 121 h.p., which is exactly 27 times the power of the former, and does not this show that the passage I quoted from the book mentioned by me before is altogether wrong and misleading. I beg to tender my best thanks for the great trouble you have taken to explain the matter to—ONE IGNORANT.

[55717.]—**Agricultural.**—I do not know the rule; but if H. Hannen likes to give the usual proportions of such heaps, I might put him in the way of making a rule for himself.—GLATTON.

[55875.]—**Cupola Blast.**—To "INVICTA."—Some matters of further experiment have caused a delay in my reply to this querist. But I now inclose a sketch (not to scale) of the cupola in question.



A is the cupola of usual construction, with the exception that the top is closed, and the coke and charges of iron are fed in through the door B. The hot gases are taken off by a bent pipe and then downwards. The vertical down pipe is surrounded by a light outer casing, leaving an annular air space between the down pipe and the casing; at the bottom at C is a steam jet fitted with a faced cone, so that the jet itself is an annular one. The steam pipe enters at D. At E is one of a series of large air inlet ports. And at F a similar set of double the number but of much less size. All the inlet ports have flap lids, which are made to hang more or less open by a chain and hook. O is the usual door through which after the blow the contents are raked out. The sizes of both E and F are entirely dependent on the size of the cupola itself. Much good has in practice resulted from the addition of the annular casing round the down pipe. H is carried to any convenient chimney or flue. Some little management is wanted at first or a mass of partly melted iron would form at one of the blast holes E or F. But in practice, as soon as this is observed the lid is closed, and in a few minutes the part fired iron disappears. I shall be, of course, happy to afford any other information I may have on this subject, as the rough sketch only explains the rudimentary idea.—INVICTA.

[55897.]—**Internal Resistance of Battery.**—The E.M.F. of a Bunsen cell will be considerably lessened by using sal-ammoniac in the zinc compartment—that is instead of sulphuric acid diluted on account of the action of the sal-ammoniac on the zinc being so much less intense than that of the sulphuric acid, I should think that the internal resistance would not be affected or if anything reduced by using sal-ammoniac. Surely "Bunsen" might find out by experiment what quantity of crystals of bichromate of potash to add to the nitric acid; about ¼oz. to a pint will be sufficient. I should think that the ten cells all connected in series would only light two 5 c.p. lamps, if that. I should advise "Bunsen" to join the other set of five cells in series. I think he will get the required result. The multiple system of connecting cells is only intended to be used when the external resistance is less than the internal resistance. The connecting of a battery in series, called an arrangement for intensity, is used to overcome a great external resistance, the best results, however, being obtained when the external and internal resistances about balance each other.—J. KEAN, Northampton.

[55962.]—**Gas Reaction Wheel (U.Q.)**—How do you make the joint gas-tight? I should think a mercury trough with an inverted bell dipping in it, both made of iron, would make as free a joint as anything. I do not know how those I have seen in the shop windows were made, but I think the length of arm is about right.—GLATTON.

[56025.] — **Trueing Grindstone. — Patent Law.**—As it is now quite settled that we may make a patented article for experiment (p. 195), I may just as well say that I have not ignored the prohibition in the grant, and, as mentioned on p. 174, quite appreciate the difference between the granting and the prohibition clause, even to splitting the hair between "make, use, exercise, *and* vend," and "make, use, exercise, *or* vend." I wanted to show that one must not "make use of" a patented invention, and had no occasion to explain all the prohibitions against selling, &c.—NUN. DOR.

[56041.]—**Gun-Metal.**—I have read "Nun. Dor.'s" letter, p. 196. I see that he is driven to support his argument by suggesting that bronze, when melted in a cupola in which iron has been melted, will contain a trace of iron, which improves it. Still, this was an accidental incorporation of iron with the bronze. In Dr. Ure bronze for cannon is stated to be copper and tin (see p. 460, edition of 1861). The title "Gun-Metal" does not occur in my edition of Ure; but under title "Artillery," p. 202, occurs a sub-heading, "Cannon of Bronze," and at p. 203 it states these guns present every variation of copper and tin from 7Cu + Sn up to 83Cu + 4Sn. Again, at same page (203), "Brass ordnance are made of what is called gun-metal, 10 parts of copper and 1 of tin." But "Nun. Dor." has gone far away from the original question—viz., whether gun-metal, as ordinarily known and used in a workshop, contains iron? In other words, if I order a chuck, or other casting, to be made of gun-metal, should I get a casting which (except by the accident of the alloy having been melted in a cupola in which iron has been melted) contains iron as one of the alloys? Is not this the true question? —Z. Y. X.

[56112.]—**Testing for Arsenic in Wallpaper.**—Mr. J. Kean, in his reply to my critique, states that the query was not how to distinguish arsenic from antimony, and that antimony does not find a place as a colouring matter in wallpaper. Granted that it is so. But he must not forget that an inexperienced person would not hesitate to apply the test in any other case in which he might suspect the presence of arsenic, for he would naturally think that if the test was good enough for the presence of arsenic in wallpaper, it should be equally good in any other case, and which case might contain antimony instead of arsenic, and obtaining the result as described by Mr. Kean, would at once conclude that arsenic was present. Mr. Kean must know that some, at least, of the subscribers to our well-known paper are not so well coached in chemistry as himself, and I contend that to make his reply complete he should have pointed out the error which could be made by the use of Marsh's test by an inexperienced person; and it was to avoid this that I pointed out what I thought Mr. Kean overlooked, but not with the object of casting any reflection upon him, or of raising a discussion. —R. FORREST, St. Helen's.

[56189.]—**Books on Brickmaking.**—Thomas Plunkett will find practical information on brickmaking in "Bricks and Tiles," by Dobson, published by Crosby Lockwood and Co., and in "A Practical Treatise on the Manufacture of Bricks, Tiles, Terracotta, &c.," by C. Davis, published by H. Carey Baird and Co., Philadelphia. — F. CHADWICK.

[56209.]—**Sunshine Recorder.**—There are some notes on the various sunshine recorders in Vol. XXX. p. 476, and the correspondent can see one at almost any philosophical instrument makers.—CYRAX.

[56223.] — **Grinding and Polishing Plate Glass.**—This querist wants something like a lapidary's mill; but, of course, he will find full details in the papers on grinding and polishing glass specula.—J. T. M.

[56225.]—**Spray.**—Surely, this is a very comical query. The apparatus "ought to have acted," says the querist, but it didn't; and he expects that some one will be able to tell him why, when, as the matter stands, it is a puzzle to conceive what the apparatus can possibly be like.—E. G. M.

[56226.] — **Frame Gilding.** — If this querist would look through back volumes, he would find much information on the subject; but as he asks whether there is any book, I may tell him there is the "Practical Carver and Gilder's Guide."—FRAME-MAKER.

[56229.]—**Cholera Bacillus.**—The "scientific aspect" regarding the alleged "cholera" bacillus is just simply that nothing definite is known. The comma bacilli are at present discharged with a verdict of "not guilty," or "not proven."—NUN. DOR.

[56233.]—**Intensity Coil.**—If this querist will only take the trouble to refer to back numbers, he will find that he must try for himself. No one can answer such questions, except by stating what has been done with other coils, without trying.—NUN. DOR.

[56234.]—**Wimshurst Machine.**—This machine does not depend for its efficiency on the thickness of the glass discs, but it looks better to have them ground on the edge. The "current generated" is not a current at all; but the sparks follow one another with sufficient frequency and intensity to vaporise metals. Suppose "Spectrum" reads up the subject of static electricity in one of the text-books.—NEMO.

[56242.]—**Relation of E.M.F. of Dynamos to their Size and Speed.**—In order to express the E.M.F. of a dynamo quantitatively—

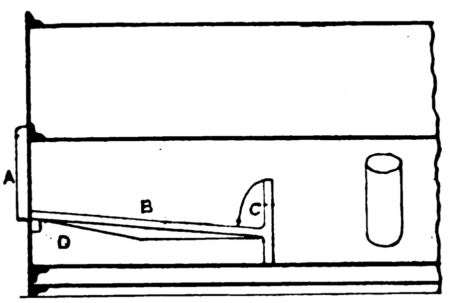
Let M = the intensity of the magnetic field, the unit of which equals $10^8$ centimetre gramme second units.
R = No of revolutions of armature per second.
N = No. of turns of conductor on armature.
A = area in square centimètres inclosed by one turn.

Then, electromotive force in volts = 4 R M N A. In practice the intensity of the magnetic field is only to be obtained by experiment, as no mathematical formula can accurately express it, depending as it does on the quality and quantity of the iron, the shape of the magnets and pole pieces, the shape and position of the coils, the magnetising current, also the quantity of iron in the armature. The graphic method of characteristic curves forms a valuable practical aid to the construction and perfection of these machines. I have this week measured some Siemens dynamos, of which the following particulars will show the influence of increasing the quantity of iron. In these machines the field-magnets are formed of rectangular bars of best wrought iron, six on each side, united by a yoke of cast iron at each end. The middles are bent out in a circle, forming two consequent poles around the armature. The first machine giving a current of 60 ampères and an E.M.F. of 60 volts at 1,010 revolutions per minute. Height, 30in. F.M.'s contain 568 cubic inches of iron = 149lb. Compound wound. The next machine, also giving current of 60 ampères and 60 volts, but at a speed of only 730 revolutions per minute. Height, 30in. F.M.'s contain 768 cubic inches of iron = 215lb. Compound wound. The third machine, giving a current of 60 ampères and 100 volts, at a speed of 900 revolutions. Height, 38in. F.M.'s contain 1,200 cubic inches of iron = 336lb. Shunt wound. The armatures of these machines are similar, being 9in. in diameter by 12in. long; total weight, 131lb. They are wound with 20 coils, each coil of four layers of five wires each, forming 200 complete turns and a 40 part collector.—EUGENE BROWN, Newcastle.

[56245.]—**Britannia Company's Foot-Power Circular Saw.**—Permit me to point out that, as the statement referred to is made by the company, they will no doubt have pleasure in showing the querist that it is true. If anyone were to come forward and say he has "seen the facts stated," "Z. Y. X." would still deem them extraordinary, and probably enter into argument about the perspective of the machine.—ESSAR.

[56246.]—**Legal.**—This query is of no interest to anyone but the persons concerned, and "W. H. B." would do well to consult a solicitor, giving him all the facts, and the opportunity to peruse the leases and any agreements.—LIMB O' TH' LAW.

[56271.]—**Portable Engine.** — To "INVICTA." —Pray no thanks. It is always a pleasure to help an amateur. And if you will recollect, there is a proverb—"That it is as much a pleasure to give as to receive." Therefore, all I can do to assist you at any time, you are most freely welcome to. To answer your question properly, I must again ask the forbearance of our mutual friend, the Editor, for space for another sketch. Now, the firebox is simply a portion of the furnace-tube, in which no cross water tubes are fitted. A is the firedoor and fittings, bolted to the front plate of the boiler. B are firebars cast in one, with a bridge piece as shown; the bottom part filling the curve of the furnace-tube. A piece of fireclay C rests on the bar ends, and prevents the intense heat distorting the vertical bridge. At the front end the bars are carried by a bar across the furnace D, and to this a bolt or cast projection secures the bars B, so that in stoking you do not push the entire erection down the furnace-tube. If you don't understand any other detail, I am happy to explain. In reply to your latter query, I have assumed a coal fire would be used, and you may consider that the boiler in question and the engine of the size you originally name would drive a family sewing-machine nicely. Of course, supposing a suitable pressure of steam be used, say, 25lb. to 30lb., or so, the length of firebars should be equal to the diameter of the furnace-tube—or 7in. long. In starting a fire in such a boiler, a fire-lighter such as we use for household purposes, is a very handy thing, and is a long way superior to paper and sticks. Cover the bars with coal the size of hazel nuts, and put the fire-lighter next the fire-door, packing it round with more coal; apply a match, and you will soon find a good fire, and steam rising quickly.—INVICTA.



[56291.] — **Wheatstone's Bridge.**—Twelve No. 2 Leclanché cells would be most suitable for testing the resistances named with 1,000 ohms out in each of the back arms of bridge known as A and C; multiply the resistance which is out in the three front arms, B by C, and divide by A, which is the total measurement. In testing short lengths of wire, great care must be exercised not to apply the battery current too long; otherwise the bridge coils will become heated, and their resistance will be increased.—J. C. BARTER.

[56303.]—**Blowpipe Lamp.**—Why not try one of the small benzoline spirit lamps, sold for fourpence half-penny or sixpence. They are fitted in the manner described by Col. Ross. By pressing the top of the wick-holder into an oval form, and using ball-cotton wick, you will obtain a clear blue flame, with but little smell, and no trouble of trimming. I have made one from the lower half of a condensed milk-can, with the wick-holder of this shape and size (section) ⬭ and nearer one side for convenience in using. With this lamp I get a flame, the inner blue part of which is 2in. long, and from the burner to the extreme end of the outer, almost invisible flame, 8in. or 9in. I find this little lamp extremely handy and clean. It is doubtful, perhaps, whether it gives quite the amount of heat to be got from a lamp burning olive oil, and upon this point I should like to have the opinion of someone who has tried it. If any-one will tell me his experience I shall be much obliged. While writing this, I must thank Col. Ross for his kind and detailed reply to my last letter.—W. BEVINS.

[56346.]—**Sellers' Screw Thread.**—I note that, by some mistake, the formula I gave for this has been set up incorrectly. I have referred to my copy, taken by the ink process, of that I sent you, which please refer to. The formula as it stands does not convey the proper meaning. It should stand thus—

$$p = \frac{\sqrt{16 \times D + 10} - 2\cdot909}{16\cdot64} \qquad (1)$$

The vinculum is on p. 198 prolonged beyond the 10, whereas it should have ended at the 10. Please correct, or your readers will be mystified and puzzled. In the (7) I find the figure 8 does not appear under $p$. Whether too low and the paper did not get its due impression on the type, or became "pie," your overseer will best know. It should be, $f = \frac{p}{8}$ ... (7).—TUBAL-KAIN.

[56346.]—**Sellers' Screw Thread.** — Since writing you, I find two correspondents have replied to this. With all due respect to them, I do not believe they are right. I gave you my authority, and could, if need be, supply a copy of the whole in a tabular form, as published by John W. Nystrom in his "Pocket Book for Mechanics." If we take the principle laid down by these two correspondents and simplify it, I believe they, as well as you, will see its fallacy. All dimensions being inches $p = \frac{d + ·25}{10}$ where $p$ is the pitch in inches, $d$ the diameter in inches; $t$ = number of threads per inch. By Nystrom's table, 6in. diameter has 2¼ threads per inch, using $\frac{10}{d + ·25}$, 6 becomes $\frac{10}{6 + ·25}$ = 1·60 thread per inch. $\frac{10}{5 + ·25}$ = 1·905 per inch, by table 2½ per inch for 5in. diameter; for 4in. $\frac{10}{4 + ·25}$ = 2·35 per inch, and by table 3 per inch for 3in. $\frac{10}{3 + ·25}$ = 8·175 per inch, and by table 3½ per inch.—TUBAL-KAIN.

[56353.]—**Planetarium.**—I here give the number of teeth to wheels for the above (I have copied them from an old work) that I think will answer inquiry. I have made a section and plan, partly by copy and partly worked out, but fear it will take up too much room for the E.M.; but will write you if you give your address—at any rate, I will give the numbers below:

| | Days of Orbit. | Proportion of Teeth in Wheels. A | B | |
|---|---|---|---|---|
| 365·25 | 88· | 83 : | 20 | Mercury |
| | 224·7 | 52 : | 32 | Venus |
| | 365·25 | 50 : | 50 | Earth |
| | 686·9 | 40 : | 75 | Mars |
| | 4332·5 | 7 : | 83 | Jupiter |
| | 10759 3 | 5 : | 148 | Saturn |

The above numbers on wheels, under A, are to be fixed to spindle running through them; those under B on hollow spindles.—W. H. ELPHICK, New Cross.

[56358.]—**Chronic Cold.**—With a large camel's hair brush lubricate freely the interior of the nostrils with fresh olive oil, at the same time sniffing it up until it gets well drawn into the throat. Do this many times a day. At first a little difficulty may be found as to inserting the brush as far as it should pass, both from a slight irritation it may at first produce, and also from nervousness. I have found this application for many years a most useful remedy against hay fever and the dust in summer in travelling by rail or road.—K. L. E.

[56375.]—**Microscopical.**—Hartzell's method: Spread a small quantity on a slide as thinly and evenly as possible, and allow to dry. Then pass slowly several times through Bunsen or spirit flame, and apply two or three drops of the following fuchsin solution: Carbolic acid, 15 minims, dissolved in distilled water, ½oz.; saturated alcoholic solution of fuchsin, ½dr. Allow stain to remain on sputum from three to five minutes. Wash slide thoroughly in distilled water to remove excess of fuchsin, and then completely decolourise in a saturated solution of oxalic acid. Thoroughly wash again in distilled water, and allow to dry. Mount in glycerin or balsam. With a power of 500 or 600, the bacilli will appear as brilliant red rods on an uncoloured ground.—W. J. ABEL, B.A., &c.

[56379.]—**Bichromate Battery for Lighting.**—TO MESSRS. "ACCUMULATOR" AND "BOBADIL."—I passed over the question as to liquid-proof separate cells for this reason—that if you can get the liquid in the bichromate battery to circulate through the cells, the circulation prevents the battery from polarising so quickly as it would otherwise do. But since you now intend using 10 earthenware jars, no more need be said on this point. The size of your carbons and zincs will do; but the latter should be ⅛in. thick, and if you use two carbons for each zinc, apart from their size altogether, the E.M.F. of the battery will be increased. You can get a 10 c.p. Swan lamp of 10 volts, of which fact Mr. J. Kean seems to be unaware when he states in last week's reply that 25 volts are required. I have used 10 c.p. lamps of 14 volts by other makers. To prepare the solution dissolve bichromate of potash in hot water, in the proportion of 2oz. of bichromate to one pint of water. When cold add about 2oz. of sulphuric acid. The addition of the acid will generate heat; but when the solution is again cold it is ready for use. A more convenient preparation is to use what is known as "Crystals for the bichromate battery," which is prepared by dissolving 1oz. of the crystals in 4oz. of water, and the solution is at once ready for use. Your experiment is certainly a doubtful one, and not only so, but troublesome and expensive, as most experiments are in the direction of producing electric light by batteries.—BOBADIL.

[56387.]—**Medical Coil.**—Many thanks to "C. D. R." for his reply. The cell I use is 4 zincs and 16 carbons, and I connect it to the usual coil, and apply the fluid to different parts of the body for the relief of rheumatism. Will "C. D. R." please say if I can charge with the bichromate of potash and sulphuric acid in this case?—D. W. G.

[56391.]—**Haydon's Cutter Bar.**—I am now preparing for the pages of the ENGLISH MECHANIC a full account of the principles involved, mode of construction, and of grinding the cutters, and this will appear almost immediately, and will answer the queries of "Bellicose" better than a short letter can do.—O. J. L.

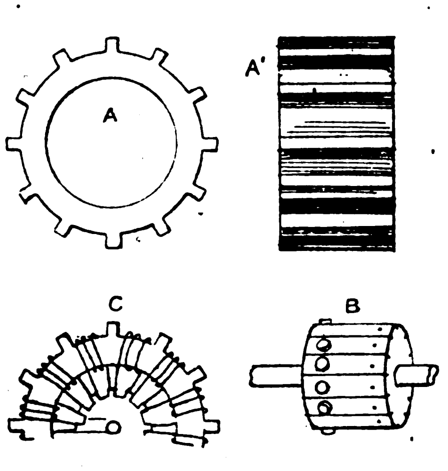
[56400.]—**Harmonium.**—I must apologise to the readers of "Ours" for having unintentionally made an error in my quotations of prices for certain fittings for a harmonium. The price of a set of reeds (five octaves) is 10s. 6d., and not 6s. 6d. as stated on p. 199. A really good pan for one row of reeds of 61 notes would cost between 8s. and 9s. Four shillings would be the price of a pine pan for four octaves, and 12s. 6d. about the lowest price for a four-octave keyboard. A five-octave keyboard would cost from 16s. to 25s. The price charged for the various fittings of the harmonium depends on the quality of the material used, and also the care bestowed in the manufacture of them. In an early volume I was found fault with because I stated that a set of reeds would cost 18s., which was a price frequently charged by a local dealer in harmonium fittings. Since that time I have had a great number of opportunities of discovering that from 20s. to 25s. is charged for a set of reeds by some dealers. In such cases as these quality and good profits have to be taken into consideration; and if we purchase a set of reeds of medium quality from a dealer in such articles for the amount of 10s. 6d., I do not consider that there is any room to complain. I still retain my unalterable opinion that 18s. is a very moderate charge for a set of reeds of good quality.—G. FRYER.

[56417.]—**Dynamo.**—TO MR. BOTTONE.—Wrongly connected. Connect one field-magnet wire to one binding-screw for outer circuit; the other field-magnet wire must connect to one of the brushes, and the other brush must make connection by means of a wire or copper strip with a second binding-screw, which forms the other terminal for outer circuit. Hence the flow of the current is from armature to one brush, from this brush right through the coils of the field-magnet, from the field-magnet to the external circuit (lamps, &c.), back to second brush and armature again.—S. BOTTONE.

[56418.]—**Gramme Dynamo.**—The insulation on the armature has broken down at some point; hence its resistance is much less than it was before. Therefore the resistance of the fields is much higher in proportion than it ought to be. By putting a wire across, sufficient current passes to magnetise the fields; hence you can get a light. Remedy: re-wind the armature.—S. BOTTONE.

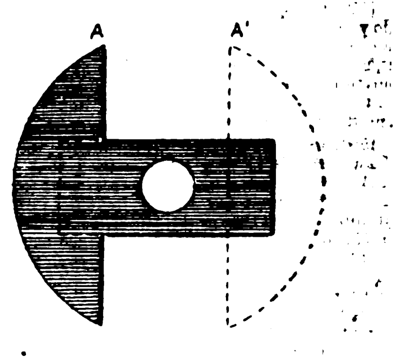
[56421.]—**Bichromate and Hydrochloric Acid with Platinum.**—Not advisable to risk it. Chlorine is sometimes evolved if the solution heats. —S. BOTTONE.

[56427.]—**Armature (Gramme).**—The best form for a small machine is the one figured in the annexed cut, in which A is an annealed cast-iron ring 3in. in diameter, with twelve teeth ½in. high round the periphery, the width is 2in., as shown at A¹. The commutator consists of a boxwood cylinder about 1½in. long by 1in. in diameter, B, around which are fastened, by screws at one end and pins at the other, twelve brass slips, not touching each other. The cylinder is mounted on a spindle, and care must be taken that neither screws nor pins reach through the wood to the spindle, or else short circuiting will take place. To the spindle or shaft is also keyed a wooden boss, to which the mounted ring is cemented. A ring this size will require about 1lb. of No. 20 silk-covered wire to wind it; each section is wound separately, and will take about 1¼oz. of wire. The end of each coil is carried to the commutator screw just under it, and from this same screw starts the beginning of the next coil, and so on (see C), so that the wire is really continuous around the ring; the field magnets, if wound in series, will require about 4½lb. of No. 16 cotton covered. When finished, this will light easily six 5-candle lamps without getting hot.—S. BOTTONE.



[56434.]—**Pure Woollen Material.**—If cloth is adulterated with cotton, that is easily detected by untwisting a few threads, or by applying a hot iron to a small portion, only enough to burn the face; then scrape it. The cotton will show itself, as it does not burn so readily as wool. Shoddy is more difficult to detect, as it is worked up with good wool; but if a large quantity is used, there is mostly sure to be cotton one way to give it strength. Shoddy cloth has the touch of a dirty carpet. Cotswold wool is largely used for making blankets, being long and strong in fibre.—VERAX.

[56442.]—**Laminated Armature.**—Annexed is half-size sketch of the punchings required to make a laminated armature. The punchings are in the shape of a T with a rounded top; these are strung on a shaft, which has a shoulder at one end and a screw at the other, and when the entire number is got on (about 100) the whole is tightened up by means of a nut. In putting on the shaft, place first A with the rounded portion to the left, then A' with the rounded portion to the right, and so on to the top. Mind, this is a patent of Mr. H. Jones's. the thickness of iron for a 3in. armature would be about $\frac{1}{10}$th of an inch, the entire length about 10in. The laminations are kept sufficiently apart by being laid odd and even, as described above. No boss is required.—S. BOTTONE.



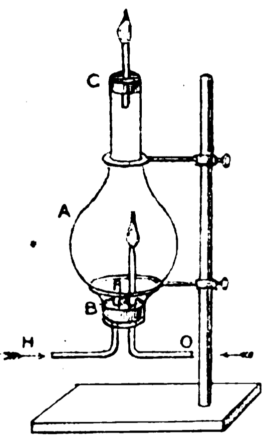
[56446.]—**Cement for Rain-Water Pipe.**—Perhaps the following will suit:—3 parts finely-ground litharge, 3 parts of clean white sand, 3 parts of plaster of Paris, and 1 part of finely-ground resin. Mix well while dry, and make into a putty with boiled linseed oil, to which a little driers has been added. Beat mixture well and stand for a few hours before using. This makes a strong and durable cement for fresh or salt waters.—A. R., King's College.

[56451.]—**Preparation of Sodium.**—The clay plugging which fits when cold does not fit when hot; besides, sodium vapour acts on clay, being thereby reconverted in sodic oxide.—S. BOTTONE.

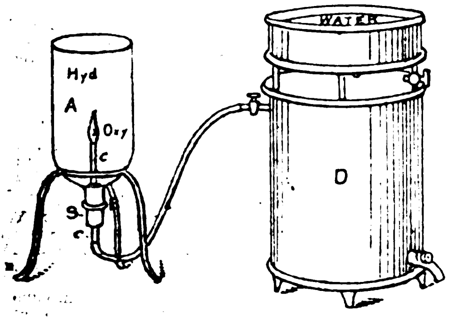
[56451.]—**Preparation of Sodium.**—Did "Perplexed" dry his sodium carbonate and finely powder his charcoal and chalk, and thoroughly mix before making the experiment, and was the clay plug perfectly tight? If so, I don't see why the experiment should fail. I would advise "Perplexed" to try the experiment once more according to the following directions: Well dry your sodium carbonate (7 parts when dry) and intimately mix with 2 parts of finely powdered charcoal, and 1 part of chalk (also finely powdered); make the whole into a paste with oil and transfer to a crucible (if you do not possess such an article, an old iron pot or vessel will do), and apply heat until the mass becomes partly fused (the object being to carbonise the oil). When this happens, transfer the fused mass to your apparatus and apply a moderate heat at first, gradually increasing until a white heat is obtained, when, if these instructions have been followed, sodium ought to be found in the naphtha. Please report progress—R. FORREST, St. Helen's.

[56456.]—**Strad. Model Violin.**—I regret I cannot give the thickness of Stradivarius violins; they, of course, vary with the density of wood. If you make yours one-fifth at the thickest part of back, reducing gradually to one-tenth at the ribs, and make the belly one-eighth all over, you will not be very far wrong.—T. LISLE.

[56459.]—**Burning Oxygen in Hydrogen.**—I have seen this experiment performed with the following simple apparatus:—A is an ordinary lamp chimney, supported in a ring stand. Two corks are fitted, one at each end. B is bored with two holes, into which are fitted bent glass tubes. The tube O is furnished with a jet. The cork C is also fitted with a jet. The apparatus is first filled with hydrogen by means of the tube H, C being closed up. When the globe is full of hydrogen, B must be withdrawn, and the oxygen or air tube O lighted. B must be then replaced, and the jet C' lighted, serving to carry off excess of hydrogen. There may be a little difficulty in getting O to light at first; but when this is managed, the oxygen burns easily in the hydrogen.—T. H. L.



[56459.]—**Burning Oxygen in Hydrogen.**—The best way, I think, to show that oxygen burns in hydrogen is as follows:—A is a large jar containing hydrogen. If the gas be inflamed at the mouth B, and the glass tube C delivering the oxygen from the gas-holder D be pushed through the gas burning at B, the flame will follow the end of tube on its way up into the jar, and by putting the cock into the neck of jar the burning hydrogen will be extinguished, but the flame within the jar will continue to burn where the oxygen gas meets with the hydrogen. Instead of the gas-holder D, which may not be procurable, a big bladder filled with oxygen with a weight upon it will answer the same purpose. In much the same way air may be made to burn in an atmosphere of coal-gas.—Combustion.



[56463.]—**Vertical Boiler.**—To "Invicta."—Very much must depend on your being able to do a little boiler-making. If you have a vertical of the usual type, I would suggest you should make it as follows:—Shell plate, ¼in. thick; height, 24in.; diam., 8in., riveted-up seam; firebox, 6in. diam., 15in. high—the bottom of firebox riveted to outer shell by flanging out the firebox round the bottom, or by the use of a wrought-iron ring, through which the rivets would pass. I prefer the latter for my own use somewhat, as the water space is not contracted round the bottom of firebox, and the plates do not need so much working and flanging. Funnel should be 2in. outside diam., and may be best secured by screwing both ends of a piece of steam tube, and by using lock nuts each side of the shell and firebox plates where the tube comes through. You will also want a fire door. This should be oval, size 2in. by 3in., with a similar wrought iron ring through, which would pass the rivets, holding all together. The funnel should be of larger size, so that it just slips over the 2in. tube; and if it is not carried into another chimney, should be at least 4ft. long. A boiler of the size I mention will give you plenty of steam for your engine at, say, 30lb. to 40lb. pressure; and if the exhaust is taken into the funnel to help the draught, it will still further increase the steam producing power. Do not forget an efficient safety-valve having, say, a clear aperture of ¾in.; also a water-gauge, and, if possible, a steam-gauge, and you will have an efficient and reliable generator which will fulfil the conditions you very reasonably lay down in your query.—Invicta.

[56469.]—**Skrivanoff's Dry Battery.**—To "Bobadil."—Not so fast Mr. "Experimenter." My reply can scarcely be called a repetition of "Starlight's" words, as I was not aware of his reply in the pages of "Ours," and had I been aware of it, as I am now, I should have referred the gentleman who asked the query to "Starlight's" page and number; but, apart from this, you will know that where two replies are given for constructing the same battery, in which the proportions must be exact, and never vary, both replies cannot but be substantially the same. Nor can the one be called a repetition of the other; but their sameness affords another example of the affinity which sometimes exists between two great minds. Your query belies your name, as you might have tried boiling the "substances" in a liquid, with which all "experimenters" are more or less familiar—viz., water, and using no more of it than will saturate them well.—Bobadil.

[56470.]—**Fitting Fusee Chain.**—"Nomen" may dispense with chain by the adoption of gut of the proper thickness to fit the channels of the fusee. Should he find any difficulty in making the ends secure, a little study before operation may prove a sufficient safeguard against ultimate trouble. After securing one end to the fusee attach the other to M.S. barrel; now wind up the gut by turning the M.S. barrel arbor with key or pliers, place on ratchet wheel, let click fall into tooth of same, press the click with one hand, and with the other give a turn more of the arbor: this secures the gut on barrel; wind up, coaxing the gut into fusee channels.—Fred. Hunt, Widnes-road, Widnes.

[56472.]—**Slide Valve, &c.**—I have so little time at my disposal this week that I am unable to set out as I should like a diagram, but let your slide valve be as follows: Height 1⅜in., length 1¾in., exhaust port in it ⅜in. long by 1⅜in. high, travel of valve 9/16in.; therefore the throw of the eccentric must be 9/32in. The ports are none too large, especially the exhaust, and I should have liked wider bars; for 300 a minute the ports are small; in fact, the power at that speed must, in great part, depend on the internal resistance. But you must not expect a great amount from so small a cylinder. The piston area is but about 3¼ square inches; so that in practice you might expect, perhaps, a man-power from it; theoretically, the speed and pressure would give you more than I name. But do not expect much as, practically, you won't get it. In theory it would come out at about ¼-horse; but, at 300 a minute, with the small area ports you would never get anything like 80lb. on the piston.—Invicta.

[56473.]—**Corn Drill.**—I see no very great difficulty in this. Possibly some of my brother contributors will at once deal with the query as the result of a practical and actual machine; if not, I will give the querist a plan I have in mind how it can be done.—Invicta.

[56476.]—**Incandescent Lamps.**—Because, when the air is admitted, the incandescent carbon instantly combines with the oxygen in the air to form carbonic anhydride, thus—$C_2 + 2O_2 = 2CO_2$. As long as the glass is not broken, the filament continues to glow, because, there not being any air in the globe, it cannot combine with it to form $CO_2$.—R. A. R. Bennett.

[56476.]—**Incandescent Lamps.**—What makes a piece of hot coal or coke burn when exposed to the air? The oxygen gas contained by the air. In precisely the same way the carbon filament raised to nearly a white heat by the passage of the current, cannot burn so long as no air is in the bulb; but directly the bulb is broken the air rushes in, the carbon finds the necessary oxygen, with which it immediately combines, forming carbon dioxide.—S. Bottone.

[56476.]—**Incandescent Lamps.**—To preserve incandescent carbon from chemical change, it must be hermetically sealed in vacuo, or in a globe containing a dry gas incapable of entering into chemical combination with the carbon, such as nitrogen, hydrogen, or hydro-carbon; if there be a trace of oxygen or other gas or vapour present, chemical change is the result. The oxygen having a great affinity for heated carbon, combines with it, and the dissociated carbon atoms are deposited on the inner surface of the globe. It follows that if the glass of an incandescent lamp is fractured, the air instantly rushes in, and its oxygen tears asunder the carbon particles composing the filament, and its destruction is the result.—H. H. Bales.

[56477.]—**Action of Glucose on Fehling's Solution.**—One molecule of glucose is said to be able to reduce five molecules of cupric sulphate, precipitating two and a half molecules of cuprous oxide; and the change is used as a method of estimating glucose. The exact reaction which takes place does not seem to be known, but it is very complicated, resulting, according to Claus, in the production of acetic, tartronic, formic, and various other acids, together with some kind of gum. It may be added that Soxhlet disputes the accuracy of the method, maintaining that the reducing power is greater in a strong solution than in a weak one.—Wm. John Grey, F.C.S., Analytical Chemist, Newcastle-upon-Tyne.

[56481.]—**Diameter of Tube.**—This seems rather a difficult question to answer directly; but, taking the weight of the tube and platform together at 7cwt., or ½cwt. per foot run, the area of the immersed part of the cross-section of the tube must be about 130 square inches, or 135 square inches for 6cwt. platform, and 1½cwt. tube. A diameter of 16½in., immersed 10in., will give about 135 square inches of immersed cross-section, leaving 6½in. above water line. But the whole thing would have no stability, and the platform (unless buoyant in itself) would very soon be below, instead of above, the water-line.—J. S. C.

[56484.]—**Varnished Wall-Paper.**—Will "Virago" try the effect of a piece of rag just moistened with the "paraffin oil" she burns in her lamps?—Nun. Dor.

[56485.]—**Model Boat.**—You may pretty easily do as you say. The blind laths are usually nice, clean, straight-grained stuff. As to sizes, I should myself never use wider laths than 1in., as the narrower they are the more flexible and easily bent to the run of the lines. Next you ask as to the overlap. If you do not know, I may tell you that boats are built in two ways, either clinker or carvel. The first is when the planks overlap; the second, and by far the best, is where the planks abut edge to edge. For a model of a steamer or yacht by no means use the clinker form. I have tried in times past both plans; but found the carvel-built boat by far the easiest. Not only so, but the stopping of the joints or seams is far easier. I fasten mine with shoemaker's brads, as having neat heads, and as with wire nails, they hold until further orders. I always use instead of ribs, bulkheads of hardish wood, say elm, or even pitch-pine. If these are objectionable as interfering with the engines, boiler, or other fittings, they are easily cut away, leaving still a stout rib firmly attached to and strengthening the planking. For a 4ft. boat I should use seven bulkheads; besides these, it is advantageous to use bent ribs of ash, steamed and bent to the curve of the planking. A good section for these is, in my opinion, ¼in. by 1in. The keel, stem and stern post, I like of either ash or elm. Knees of the same material are useful to stiffen and keep in place the planking at the bow as well as the overhang of the stern.—Invicta.

[56491.]—**Long-Distance Electro-Magnet.**—I should advise "W. A. G." to use his electro-magnet as a relay to switch on a local current of greater strength, which, being sent through a larger magnet, would be much more powerful. He can get any strength desired in this way. Had he mentioned the purpose for which it is needed, we should be better able to advise.—H. H. Bales.

[56495.]—**Feeding Bottle.**—If Mr. Morgan Thomas will use the best made black teat, with leech-bite incisions, the trouble will be remedied, although it is rather more difficult for the child to get the milk.—W. F. Harold.

[56495.]—**Feeding Bottle.**—We were troubled with the same inconvenience of which Morgan Thomas complains; but found a remedy in putting the bottle rather far down between the side of the cot and the bed. The shorter leg of the siphon being thus in the baby's mouth, it required some little suck to get the milk (which was good for the child's constitution), and when she ceased to draw the contents of the tube flowed back again into the bottle.—J. L. D.

[56499.]—**Electrical.**—A similar question was answered in the "E. M." a few months ago, a diagram being then given showing that you can ring in both directions as desired, with ordinary pushes and one battery, by the use of three wires instead of the usual two. Where the distance between the two stations is not great, this arrangement is more economical and simple than using key pushes and two batteries; but for anything over quarter of a mile, the cost of the additional line wire would place the balance of expense on the opposite side.—R. T. Lewis.

[56501.]—**Dynamo.**—Cogs and ring are in one piece; wire wound in channels between cogs; made of annealed cast iron. There are as many sections in commutator as there are channels in armature. The end of one coil coming from armature fastens to one section of commutator, and forms the beginning of the next coil, and so on all round. Would work well, but less E.M.F. and less R.—S. Bottone.

[56502.]—**Faulty Dynamo.**—To Mr. Bottone.—Reason of failure: Resistance of wire on fields insufficient for that on armature, when used as a shunt machine. A shunt machine will take from 60 to 100 times the resistance of F.M. to that on the armature. Calling field magnets M, resistance R, armature A, and external resistance X, then the best shunt arrangement is $RM = \frac{RX^2}{RA}$.—S. BOTTONE.

[56504.]—**Hand Dynamo.**—To MR. BOTTONE.—The same leather bands that are used to drive sewing machines. I always drive with straight band, and have no difficulty in getting up a speed of 3,000 revs. per minute. As to joining, cut the band a trifle shorter than will loosely fit the wheels; make a hole in each extremity with a cobbler's awl, insert a short length of No. 16 hard iron wire, previously bent into the shape of a flat U, and then hammer the ends of the wire inwards until they do not protrude beyond the level of the band.—S. BOTTONE.

[56505.]—**Flow of Gas in Pipes.**—The quantity of gas delivered by pipes of a given diameter is found by the formula—

$$Q = 1,350\ d^2 \sqrt{\frac{h\ d}{s\ l}},$$

which is plain enough to any "Young Gas Man" who will take the trouble to use his brains. Multiply the pressure in inches of water ($h$) by the diameter of the pipe in inches, and divide the product by the specific gravity of the gas multiplied by the length of the pipe in yards ($s\ l$). Extract the square root of the quotient so found, and multiply it by 1,350 multiplied by the square of the diameter of the pipe in inches ($d^2$), and you will have the number of cubic feet (Q) discharged in one hour. The querist can take the specific gravity of the gas at 0·4, which will be sufficiently accurate for all practical purposes. A difference of pressure of 1in.—that is, from 1in. to 2in.—will increase the delivery by, roughly, one half.—NUN. DOR.

[56505.]—**Gas.**—The following may be of use. Mr. Sugg, in "The Domestic Uses of Coal Gas," gives the following table of flow of gas per hour through a 30ft. length of pipe:—

| | | | Diam. of Pipe. | | |
|---|---|---|---|---|---|
| Pressure in tenths. | | | ½ | ¾ | 1 |
| 2 | ,, | .... | 53 | 147 | 302 c.f. |
| 4 | ,, | .... | 75 | 207 | 426 |
| 6 | ,, | .... | 92 | 254 | 522 |
| 8 | ,, | .... | 106 | 293 | 603 |
| 10 | ,, | .... | 119 | 328 | 675 |

The following is from "Clegg on Coal Gas":—Discharge of gas in c.f. per hour through ¾-pipe at different pressures (s.g. of the gas estimated at ·4, air being 1)—

| | Length of pipe (yards). | | | |
|---|---|---|---|---|
| | 10 | 20 | 30 | 50 |
| Gas delivered with | | | | |
| ·1 press... | 104 3 | 73·8 | 60·0 | 46·6 |
| ,, ·2 ,, .. | 147·5 | 104·3 | 84·9 | 65·8 |
| ,, ·3 ,, .. | ,, | ,, | 104·3 | 80 9 |
| ,, ·4 ,, ... | ,, | ,, | ,, | 93·2 |

—GAS CONSUMER.

## UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

Since our last, "Glatton" has replied to 55962.

55972. Glass Working by Lamp, p. 569.
55978. Dyeing, 569.
55979. Lathe Bed, 569.
55985. Flange Iron, 570.
55992. Vertical Drilling Machine, 570.
55993. Screw Cutting, 570.
55994. Telephone Stations, 570.
55995. Pirn Winding, 570.
55996. Planishing Machine, 570.
55998. Rose-Engine Turning, 570.
56009. Matriculation Examination, 570.
56011. Portable Iron Folding Music Stand, 570.
56012. Microscopic Tests, 570.
56018. Photo Lenses, 570.
56019. Copper on Silvered Glass, 570.

56208. Train Indicator, p. 89.
56218. Electric Clock Dials, 89.
56224. Dynamo, 90.
56231. Dynamo, 90.
56232. Photographing Sunspots, 90.
56235. Medals, 90.
56249. Electric Bell, 90.
56252. Latch Opener, 90.
56255. Arranging Engine Belting, 90.
56257. Telescope Stand, 90.
56260. Wicker, 90.
56262. L. and N.W. Tank Engines, 90.
56263. G.W. Compound Engines, 90.

## QUERIES.

[56507.]—**Engine Query.**—Will any of your readers kindly inform me how it is that, having attached a McNaught indicator to the cylinder of a beam engine (h.p. condensing) that was wasting steam, instead of a pressure it showed a vacuum of from 5lb. to 11lb., although a pressure in boiler of 12lb. of steam? I may remark that the indicator was attached to a tallow cup on top cover, which is cored hollow, and at bottom to drain cock which comes in the space between bottom of piston and cylinder bottom.—AMATEUR.

[56508.]—**Royal Engineers.**—To COL. ROSS, "GARRISON GUNNER," AND OTHERS.—I am an electrical engineer. I should like to know if I am suited for the R.E., or any division of the service where a thorough knowledge of electricity, engineering, and chemistry would be required. I have a splendid constitution and am 5ft. 10½in. tall, 13st. weight (normally 12), know my drill well, though I am not a volunteer. I have travelled in almost every portion of the globe. I should like to know the pay, duty, and chance of raising myself from out of the ranks, also where to apply? What is the extreme age they enlist one? I am well connected, and shall ultimately come into considerable possessions, though I am, for the present, placed in very straitened circumstances; am also a University man. I have been a constant reader of the "E.M." for nine years, and have answered, as far as I could, very many questions under a certain well known n.d.p. I should feel extremely grateful to the gentlemen named, or any others for kind advice.—F. L. B., Kew.

[56509.]—**Cheap Gas.**—To "INVICTA."—In answer to "Glatton's" query regarding cheap gas, you volunteer to give him private information, by way of the Address Column, respecting this gas; and also as to some recent improvements in your apparatus. Now this is the very thing I want, having a small gas-engine, but no gas to drive it. If you will kindly communicate with me, respecting this gas apparatus, you will find my address in the "E.M." of April 10, it having been inserted in order to attract your notice, but you seem to have overlooked it.—W. J. BARRY.

[56510.]—**Extra Strong Magnets.**—I lately noticed an advertisement of, "Magnets made very much stronger than the ordinary ones, by a new process, so as to lift from ten to fifteen times their own weight." Can anyone inform me what the "new process" is? I have made a magnet, horseshoe, of the best cast steel, weighing 3lb., as hard as fire and water will make it; but cannot get it to lift more than 6lb., although the armature fits the poles as a slide-valve its face.—ZINCI SULPHAS.

[56511.]—**Mathematical Astronomy.**—Will "F.R.A.S." or some other of our well informed astronomical contributors, kindly say what course of mathematics, pure and applied, one should read, in order to understand the higher parts of astronomical science? Any information as to list of works, and how to proceed, will be esteemed by—ANOTHER AMATEUR.

[56512.]—**Diamond Tools.**—Will Mr. Wenham kindly describe the ingenious sliding or dividing-frame, by means of which a little piece of carbonado is used for dressing millstones?—T. W.

[56513.]—**Chemical.**—Hydrogen peroxide, or rather its watery solution, is made by decomposing $BaO_2$ with HCl, or clear suitable acid and water. The $BaO_2$ is made by oxydising Ba O, with one third its weight of $KClO_3$, being somewhat in excess of the amount theoretically required, the excess of oxygen passing off, the product being really $BaO_2 + KCl$. In practical work, about 4lb. of this mixture is required for 1gal. of $H_2O_2$ solution of 12 volumes. I want to know, when testing the $H_2O_2$, with potassium bichromate, for its volume, whether the whole of the oxygen given off is derived from the $H_2O_2$ or partly from the bichromate; in other words, whether the $H_2O_2$, of 12 volumes does not only contain six times its volume of oxygen? Also what quantity of $H_2O_2$, of 12 volumes, as above, can theoretically be produced from the 4lb. of the $BaO_2 + KCl$?—HYDROGEN PEROXIDE.

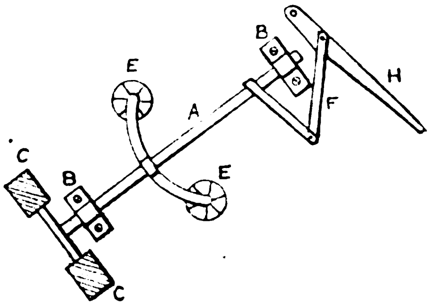
[56514.]—**Chemical.**—In bleaching ostrich feathers, I use hydrogen peroxide, and I find it is of two different qualities; the difference appearing only on the addition of solution of ammonia. One kind remains transparent on the addition of ammonia, the oxygen passing off somewhat quickly; the other kind becomes opaque like milk and water, curdles almost to the consistence of jelly; on the addition of ammonia; the curdled matter gradually separates, leaving the rest transparent, but the oxygen passes off slowly. Will some practical chemist kindly inform me what impurity or substance is dissolved in the hydrogen peroxide, to cause this change with ammonia solution?—OSTRICH FEATHER BLEACHER.

[56515.]—**Lead Burning.**—I am about burning on some lead pieces, to cover fracture of a large chemical chamber, which is now full of acid, and find a great difficulty in doing so, owing to the acid continually running through the open space. Is there anything I could bed against it, while performing the work, or should I get the chamber emptied before commencing, which of course is very undesirable if it can be done otherwise? A few hints would greatly oblige.—A. B. C.

[56516.]—**Disabled Marine Engine.**—What should be done to bring a ship into port with one engine, the low-pressure having broken down; and what if the high-pressure engine broke down, the low-pressure remaining intact and is there any book on remedies for breakdowns at sea?—VALVE.

[56517.]—**Microscope Construction.**—I have read with much pleasure, the promise of "Rob. Crus." (24143, on page 109) to give complete instructions in the grinding and fitting of glasswork for the microscope. I have in process of construction, a full sized stand of the Jackson-Lister type, with mechanical stage, substage, &c. It is my intention, as soon as the stand is completed, to attempt the glasswork, such as achromatic condenser, paraboloid, and the lower power objectives. Now, I am sure the instructions "Rob. Crus" proposes to give, would prove most acceptable to very many readers. No doubt an amateur's first attempt at achromatic lens construction, will be a failure; but amateurs, as a rule, are not easily discouraged by failure, and generally succeed in the end. I have been a subscriber of "Ours" for some years, but I have not seen any complete working instructions. When my stand is completed, I shall be pleased to give my way of constructing it in an ordinary lathe, with a fair amount of ingenuity and mechanical skill.—J. J. B.

[56518.]—**Organ Building.**—To MR. FRYER.—As I am about to build a small chamber organ of five or six stops, should feel very much obliged if you could spare time to answer these few questions:—Will these be the most suitable stops?—Two 8ft., two 4ft., one 2ft., stops, viz., stopped diapason (wood) CC to F in alto. Open diapason, C to F in alto (wood). The lowest octave of stopped diapason to draw separately, so as to answer for both. Flute, CC (4ft.) to F in alto (paper); dulciana, CC, 4ft. to F in alto (metal) and one, 2ft. (in metal or paper)? Also, as I should like to make the dulciana the speaking front; can I make the shorter pipes (say the 2ft. ones) 2ft. 6in. long, and cut open at back, so as to make a cover for the back pipes? Would you also tell me the best scale to make the stops to? The stopped diapason will be 3½in. by 4in. deep. Should like to run the 8ft. and 4in. stops an octave higher, and have a coupler. The wind will be 2in. Will it not be best to have two feeders to blow by foot and by hand, according to this plan? A, rocking shaft of gas barrel; BB, bearings; CC, treadle; EE, two wheels on curved arms to work under feeders; F, arms to connect to handle; H, blower handle when required. The lowest octave of stopped diapason, and of the flute; shall put on lower soundboard at back (or could I use conveyancing tubes)? The lowest octave of dulciana should have along one side, and of the open diapason on the other, and inclose them all in the case. If you could suggest any improvement to the general construction of the organ, should be obliged. Is it necessary to have iron bits for soldering the metal pipes—if so, why?—ANXIOUS.



[56519.]—**Chemical.**—What is the chemical action of soap on (1) boiling water, (2) on cold water, (3) and the action of soap on cold water when a quantity of ordinary shaving soap has been first added?—C. W.

[56520.]—**Gasoline Generator.**—To T. F.—1. You kindly answered me about four months ago, that a gallon of gasoline would absorb 250 cubic feet of air. Can 250 cubic feet of gas be made by forcing that amount of air into a generator, which holds one gallon of gasoline? 2. I presume this 250ft of gas, so made, would require about five times as much common air to dilute it in the engine cylinder; if not, what proportion, about? 3. A Clerk six-h.p. gas-engine (cylinder, 7in. diameter, 12in. stroke) compresses the charge of coal gas to about 70lb. before ignition, the explosion gives a maximum pressure of 250lb., and an average pressure of 69lb. What do you think would be the maximum pressure of the above-mentioned gasoline gas, used in the same engine, and compressed to same amount, previous to ignition.—E. C.

[56521.]—**Jupiter.**—The o.g. of my telescope is 2¾in; is this too small to perceive the transit of Jupiter's satellites across the disc of the planet, the power I use being 100? What size of o g., and what power of eye-piece will enable me to witness this phenomenon with certainty and comfort?—E. B. F.

[56522.]—**Legal.**—A. has rendered some services to an English Co., for which a commission has been allowed him, but payment of said commission has been deferred until a certain date. The Co. is wound up before that date. Is there any difference to A.'s claims on account of this winding up? What course should he pursue now?—LEGAL.

[56523.]—**Finishing Silver-Plated Goods.**—Will "Goldsmith" please give the promised instructions how to finish silver-plated goods, after they leave the bath? and any other practical hints will greatly oblige.—LANTERN.

[56524.]—**To Mr. E. M. Nelson.**—Please describe the two lenses in Swift's £4 popular condenser; are they both made of same sort of glass, and non achromatic? Also the shape of the top lens, which appears to be somewhat peculiar? What do you think of turning it over, silvering the convex surface, and grinding off the apex? Which has most flint glass, a dry or immersion o.g.?—AN AMATEUR.

[56525.]—**Cyclist Tour in Scotland.**—Will some reader kindly say whether the roads in the district between Trossachs and Oban are good for cycling, and name a good road map of the district?—G. R.

[56526.]—**Stained Floors.**—A floor has been stained and varnished last year; being worn, it is desired to restain it, but on doing so the stain becomes patchy, not taking on top of varnish. What would be the simplest and cheapest way of obviating this?—E. C. OSWALD.

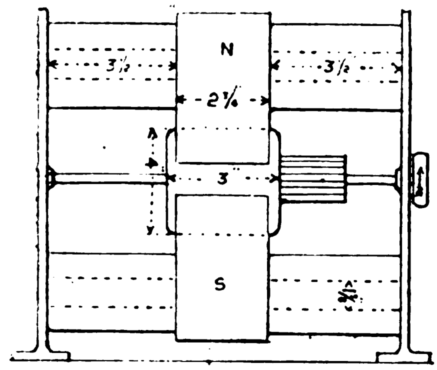
[56527.]—**Engine.**—To "INVICTA" OR "GLATTON." Will you please kindly help me a little? I am making pair of engines, 3in. bore and 4½in. stroke. I want to know the length of slide valve; this is the size of ports—Port ¼ $\frac{1}{32}$in.; bar between, ¼ $\frac{1}{32}$in.; exhaust port, ont to out of ports, 1½in.? Also say what power she will be with 60lb. of steam, running 140 revolutions per minute, driving a boat? Say how large a fan she will drive, and the pitch of same, and width of blades? How large a boiler would it take to steam her easily? I rather prefer the horizontal type of boilers. Say how it should be made to give best results, size of fireplace, and number of tubes, if any? Any information will greatly oblige.—C. L. L.

[56528.]—**Bending Box Spade Handle.**—Would some one kindly inform me the sort of machine used for bending box spade handles?—Box Handle.

[56529.]—**Legal.**—Would any of your legal correspondents kindly name one or two of the clearest and most comprehensive "Justice's Manuals or Guides"?—and oblige.—T. G. T.

[56530.]—**Pallet Holes for Harmonium.**—Will some of our harmonium friends kindly inform me the size of pallet holes for two rows of reeds, also size of holes for reeds, and if reeds will sound right if simply screwed on top of holes?—and if not, kindly state how they want fixing, and how the valves are opened in the American exhaust principle? Any details will be very acceptable, as I am about to add two more rows of reeds on my harmonium, and want to draw the wind through them.—Harmonica.

[56531.]—**Gramme Dynamo.**—I have just completed a Gramme dynamo but can get no satisfactory result therefrom. General arrangements and size may be seen from sketch. Side cheeks are of cast-iron, and pole pieces of malleable cast-iron, driven at a speed of 3,000 revolutions per minute. Can get no appreciable current. When coupled to another dynamo, it acts as a motor, although weakly, and, strange to say, if wires from dynamo are reversed, the direction of rotation is still the same in the driven machine. Armature consists of 16 segments of No. 18 S.W.G., and total wire, weight of 2lb. 2oz.; usual Gramme core (solid); wire on field-magnet, S.W.G., and total weight, 14lb. 4oz. Machine during experiment was coupled up in series throughout. Any suggestions to enable me to put it right, stating amount of current it should give, will oblige.—Vandee.



[56532.]—**Rates and Taxes.**—To Mr. Weatherfield and Others.—An answer to the following will greatly oblige. Last year I was assessed at £50, and paid on £40 for poor and boro' rates, and £50 for property and house duty, but this year I appealed against the poor rates, and now pay on £32 (net). What I want to know is, can I be made to pay the property and house duty on the old assment (£50) or only on the present gross assessment £40?—A. R. James.

[56533.]—**Pocket Telescope.**—I have a small pocket telescope, which has an achromatic ¾in. object-glass, and four other lenses: it opens to 16in., and having six draws, closes to 4in., it is powerful (for its size) and has fair definition, but seems to absorb a considerable amount of light. Is there any cheap expedient by means of which the light might be improved, without much detriment to the power and definition, especially the latter?—Devoniensis.

[56534.]—**Opera-Glasses.**—I notice that opera-glasses are spoken of as "power, four, seven, ten," &c., how is the power ascertained?—Devoniensis.

[56535.]—**Yellow Photographs.**—I have a number of photos which have turned yellow, but have not faded much. Is there any restorative process, and if so, will any kind reader give it?—Devoniensis.

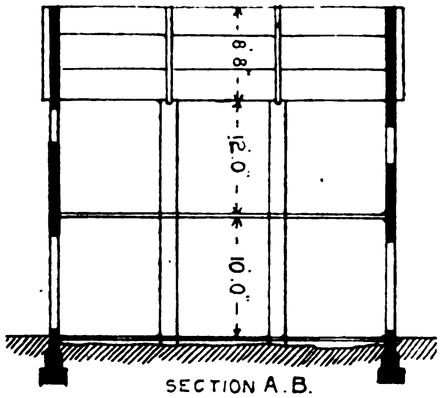
[56536.]—**Special Run.**—On the occasion of the Duke of Albany's death, the Prince of Wales came from Edge Hill to Euston in 3h. 40m., according to newspaper reports. Can any reader give details as to stops, running time, composition of train, &c., such as we have in the case of the noted runs of the Prince of Wales and the Lord Mayor, on the Great Northern a *few* years ago, and with which this North Western performance appears to compare favourably?—L. N. W.

[56537.]—**Railway Distance.**—What is actual distance (via. Crewe and Runcorn) between Lime-street and Euston? It is variously stated at 193½ miles, and 201½ miles.—L. N. W.

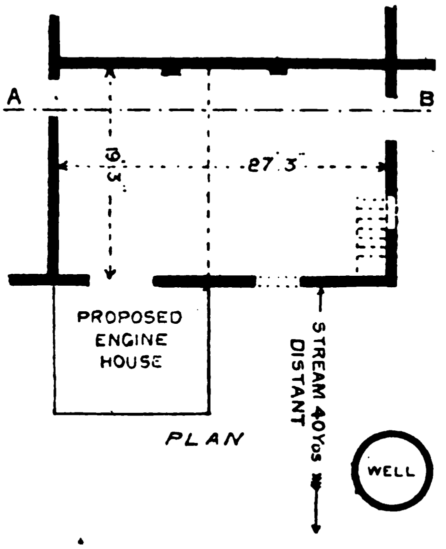
[56538.]—**Ink for Black Edged Note Paper.**—Can any kind reader tell me how to prepare the ink, or material used to black the edges of note paper, and how it is done?—Spot.

[56539.]—**Electric Lighting.**—I am desirous of fitting up the electric light in the sunk flat of our warehouse. In one corner there is a gas-engine driving our machinery, from which I hope to get sufficient spare power to drive the dynamo. The flat is at present lighted with 12 gas jets burning about 54 hours a week on an average, the cost being about £20 annually. I may mention that this flat is usually full of large piles of paper which will interfere with the proper diffusion of the light. Would any of "ours" be kind enough to enlighten me on the following points? 1st, What is the best system for electric lighting under these circumstances? 2nd, What number of lights would be required, and the power of each? 3rd, What size of dynamo would be required, and how much horse-power would be needed to drive it? 4th, Supposing I had sufficient spare power to drive the dynamo, what would the probable cost be of dynamo and lights, and also the annual charge necessary to maintain the lights in working order?—Enquiring Subscriber.

[56540.]—**Westinghouse Engine for Flour Mill.**—I am building a small flour mill, see plan and section, in connection with another establishment, and intend to use Ganz's roller mill, No. 21, capable of grinding daily say, 80 bushels of wheat. I would like to know the most suitable motor to employ. I intend to use a Cochrane's patent boiler of 160 square feet of heating surface and 80lb. working pressure. I have been told that there is little economy in small compound engines, say, of 10-h.p. nominal. Having regard to economy in coal consumption, and maintenance of engine, which of the following would be most suitable? 10 H.P. nominal compound engine; h.-pressure cylinder, 6½in. by 12in.; l-pressure cylinder, 10in. by 12in.; flywheel diameter, 5ft. 2in.; revolutions 180 per minute. A high-pressure expansive condensing engine, cylinder, 10in. by 20in., flywheel, 7ft. 1in., revolutions per minute 108. A Westinghouse engine, 18 horse-power, cylinder, 7in. by 7in., revolutions per minute, 375, piston speed, 437, flywheel 27in. diameter. Will some practical man give opinion on the above, or a better arrangement? A sketch of arrangement of shafting and requirements desirable, as I have no experience in the business, and I am where I can get no professional help. Are the sizes of engines and boiler suitable? There is a well about 20ft. from the building, 6ft. diameter and 9ft. deep, with about 6ft. of water in it. There is also a small rivulet 40yd. distant, the water of which is about 9 or 10ft. below the level of ground floor of mill. As far as I can understand, I prefer the Westinghouse engine, if it is suitable for mill work. Would like to know how the speed can be varied, and how slow can it be run? I should be glad to get any and all the information possible relative to the above.—Miller.



SECTION A. B.



[56541.]—**Experiments with Magnetic Machine.**—Will some fellow reader kindly tell me of a few experiments which we may perform with this instrument? Ours is a machine with multiplying wheels, which cause the armature of coiled wire to revolve rapidly before the poles of a large horseshoe magnet. It is used for medical purposes, but we are quite tired of the monotony of shocking our friends, and as a pleasant variety would like to now charm them with a few instructive experiments. Can we fire gunpowder with the machine, or show the electric light, or cause models to revolve?—Claudius.

[56542.]—**Staining Deal Floors.**—Would some reader kindly favour me with a good method of staining yellow deal floors subject to much foot traffic, such as corridors, &c. The doors and other woodwork are painted a darkish brown-colour, and walls buff in distemper. A very durable colour that would harmonise with the two colours named would be best, no doubt. Any information on this matter, as it is for an important building, would greatly oblige a 12 years' constant reader of the English Mechanic.—G. R.

[56543.]—**Carpenter Brake.**—Could Mr. Stretton or any other railway correspondent give a description of this brake? A friend, recently returned from Germany, informs me that it has been fitted to a great number of vehicles on one of the railways there. He says it is very similar in action and construction to the Westinghouse, and that it does away with the triple valve. Is this so?—G. Park.

[56544.]—**Coulomb or Weber.**—Wormell says, "The practical unit of quantity is 1-10th of the absolute unit, and is called the coulomb." Everett says, "The weber is 1-10 of the C.G.S. electro-magnetic unit of quantity." Is there any difference between them? If not, why the two names?—G. Park.

[56545.]—**Legal.**—Suppose a person was christened, say, John Henry Smith, who had been previously registered as John William Smith, which would be (legally) his correct name?—G. Park.

[56546.]—**Magnetic Moment.**—I should be much obliged for a clear definition of magnetic moment. I cannot understand Guthrie's definition at all. Everett (Deschanel) defines it as the "product of the line joining the two poles by the strength of either pole." What does this mean? By what units are the line and strength measured? How is the answer 300 obtained to this question: "A magnet, 1 decimetre in length, has poles of strength 3 units each, and is placed in a field of 10 dynes intensity. Required the magnetic moment?—G. Park.

[56547.]—**Geometrical.**—Can any correspondent help me to understand the following question in Todhunter's Euclid? It is among the Exercises in Euclid, at end of book, No. 570. "Four straight lines are drawn in a plane forming four triangles; show that the circumscribing circles of these triangles all pass through a common point?" Todhunter is usually so exact, but I quite fail to see how I can form four triangles with four straight lines.—J. C.

[56548.]—**Ferro-Prussiate Copies.**—Will any of your readers kindly inform me how it is that ferro prussiate copies of drawings, i.e., the white line on the blue ground, turn pale and become almost invisible if left for any time in a strong light? Also if anyone can tell me how to fix the copies so as to prevent the fading?—W. T. B.

[56549.]—**Bronzing Iron.**—Can any reader inform me how I can brass-bronze a quantity of small stamped round iron plates?—S. T.

[56550.]—**Sawing.**—I have been trying to saw some trees into planks, but do not get on well at all. We seem to get on all right for about 12in. and then it cuts hollow sometimes as much as ½in., and all the way on the twist, so they are not much use. Is it the fault of the saw or the men using it, and it is such hard work lifting the saw up? Any information I should be very thankful for.—Alabama.

[56551.]—**Wheelwrighting.**—To Mr. King.—I should be obliged if you or any other reader could tell me the best way to get old spokes out of knaves? I use hoops and wedges and sledge hammer, but I cannot draw them. Is there any machine for the purpose? Do let me know or any other way.—Alabama.

[56552.]—**Gas-Engine.**—To "R.A."—Will you please send full description, with sketch, of your gas-engine for small powers, as promised some time ago? I desire to build one at once of ½-h.p.—B. R. W.

[56553.]—**Gasoline Gas-Engine.**—Thanks to "Invicta." I have ordered the patents he mentions, but not living in England, they will be some time in reaching me. Will "Invicta" please give me dimensions of cylinder, diameter, and length of stroke, for ½-h.p., and if seamless mandrel drawn tubing 1-10in. thick would be strong enough for cylinder and suitable for.—Gasoline.

[56554.]—**Ordnance Factory, Enfield.**—Can any one tell me how many men are employed at the Ordnance Factory, Enfield?—Kappa.

[56555.]—**Professor Langley on the Solar Rays and the Atmosphere.**—Your last week's number contains a notice of Prof. Langley's lecture on the absorption of sunlight by our atmosphere, in which he showed that a great difference is observable in the solar spectrum taken at the foot of a high mountain and at its summit. How far is this change due to the difference of atmospheric density (to which Prof. Langley ascribes it), or to the effect of the difference of temperature (between the plain and the summit where the observations were taken) upon the prisms used in the experiment—a make referred to in a paper by Dr. Draper quoted in your last week's number? The obtaining of more heat from the solar beam, or from ordinary flames in a rare atmosphere as compared with a dense one, is surely opposed to previous experience.—R.

[56556.]—**Heating Surface in Vertical Boiler.**—Having finished the engine, I am about to make a boiler to suit. The engine is 3½ h.p. Will any kind reader tell me what heating surface I shall require in the firebox and tubes to make enough steam to feed the above, having a working pressure of 25lb. to the square inch?—A. J. Lawrence.

[56557.]—**Coefficient of Centrifugal Force.**—This expression occurs at page 212, of Richards's work on the Indicator, third edition. Its numerical value is given as ·000341. What does it mean?—Wm. John Grey, Analytical Chemist, Newcastle-upon-Tyne.

[56558.]—**Lincoln Cathedral.**—In "All the Year Round" for April 24th, 1875, there is a description of the above cathedral, in which it says:—"Singular paradox in stone"; "that architectural puzzle, the centenarian beam"; "a daring artifice of the old Gothic builders"; "a more magical and exquisite gauge and test-piece was never invented by human ingenuity." Will some of our architectural readers kindly describe, void of technicalities, the wonderful property of the said beam, and how it is constructed? Doubtless many have never heard of it, including your humble servant.—Gwent.

[56559.]—**A New Gum.**—*Chambers's Journal* for April 26th, 1878, gives an account of a newly discoverd gum "of a dark amber colour"; "can be moulded to any form"; "and on cooling becomes tough and strong"; "does not warp"; "and resists acids." Has the gum become a trade article yet, or has it died out for want of the characteristics described, or what? If to be obtained commercially, what is its name?—Gwent.

[56560.]—**Eight-inch Spark Induction Coil.** Would Mr. Earnest Haugh kindly tell me if he puts more than one disc of ebonite of thickness mentioned in a place on tube? Secondly, does he put paraffin wax in the bottom of each section, to keep spark from passing between disc and ebonite tube? Thirdly, in ordering sheet ebonite, does he get it ready cut in discs at 7s. per pound? Fourthly, does a small dynamo machine work coil as well as batteries?—Ross.

[56561.]—**Electric-Pen Battery.**—I use a four-cell Fuller's bichromate, to drive this pen, and find that it soon gets out of order. Can any one recommend me a better battery? Would the use of bichromate salt be advisable?—No Sig.

[56562.] — **Medical Battery.** — I want a good medical battery to give a current equal to a 12-cell Daniell. Have been recommended to fit up a 15 to 20 cell Leclanché, but fear it would not be constant enough. I want it to work one hour a day. Would the Becker-Muirhead be suitable?—if so, how should it be constructed?—No Sig.

[56563.]—**Medical Coil.**—In using a medical coil, how am I to distinguish between the positive and negative currents? I have a book on medical electricity, which repeatedly refers to the negative magnetic current, and I would like to know how to tell the difference.—No Sig.

[56564.]—**Pocket Battery.**—To Mr. J. E. Chaster.—I wish to make a pocket primary battery, to light, say, a 4·5 volt incandescent lamp. If you would give me the following particulars I should be extremely obliged:—Size and materials of plates; exciting solution, and number of cells to give required E.M.F. How would Skrivanoff's battery, mentioned in your reply 56244 do? From half to three-quarters of an hour's light would answer my purpose very well?—Centauri.

[56565.]—**Dynamo.**—I beg to thank Mr. Bottone for kindly answering query 56320, in No. 1048; but am I to understand it will take so long after the accumulator has been once formed? I shall make a dynamo with a Pacinotti ring armature, half the size given in Vol. XXXIX., if I can get one with cogs inside as well as outside. Is it necessary for the ring to be insulated from the spindle that turns it?—A reply will greatly oblige.—Microscopist.

[56566.]—**Iron Moulding.**—Would some correspondent please explain the difference between green-sand and dry-sand moulds, and to what class of work is each suited? Is there any difference in the composition of the sands, and what is the best composition for each?—Apprentice.

[56567.]—**Dark Room, Wooden Sink for.**—I am intending to fit up in my dark room, a table with small sink in one corner. I wish to make both impervious to water and chemicals. Can anyone give me instructions how to do this?—Hereward.

[56568.]—**Violin.**—Can any reader give me any information regarding violins by Thos. Kennedy, maker, No. 19, Princes-street, Westminster, 1809?—W. E. Toombs.

[56569.]—**Pressure of Boiler.**—Will "Boswell," or any other of our correspondents, show me the method used to get the bursting and working pressure of our boiler, which was made in 1870, and say whether 15 years is a reasonable time for a boiler to work at the pressure it was made for? The brand is Bowling iron. Length of boiler inside, 26ft. 10½in.; diameter of shell inside, 7ft. 1in.; thickness of shell plate, $\frac{7}{16}$in.; thickness of flue tubes, ⅝in.; diameter of fire-box, outside, 2ft. 9½in.; pitch of rivets shell, 2in.; pitch of rivets flue tubes, 2in.; Galloway tubes in each flue tube, 5in. diameter, 11in. at top, and 6in. at bottom. Hoping that someone will oblige in plain figures.—Sammy.

[56570.]—**Brazing.**—Will some reader inform me how to braze ⅜in. or ¼in. thick of copper or yellow metal with a gas blowpipe? I have a good bellows and gas, but no blowpipe—what blowpipe will suit me for the above purpose?—W. J., Llanelly.

[56571.]—**Electrical.**—Can anyone inform me the time in which a given quantity of water can be split up, or decomposed into its component parts of oxygen and hydrogen, by the use of four or five Grove or Bunsen cells, and the volume of the gases that are produced from a given quantity of water?—Witch.

[56572.]—**Lathe Mandrels.**—Perhaps some of our readers will be kind enough to tell me what advantage there is in the inverted loose cone which is found at the back end of some lathe mandrels, principally of the cheaper kind I believe. To me it appears that two cones on the mandrel itself, the back one smaller than the front, and lock nuts to take up wear is a much better plan. Will a mandrel of soft steel, unhardened, running in phosphor bronze, make a good job? I thought of having cones tapering from 1¼in. to 1in. in front, and from ⅞in. to ⅝in. in back, each cone being 1⅜in. long and their bearings 6in. apart. How would this work for a strong 3in. lathe? "Invicta," with his usual courtesy will probably oblige—A. L.

[56573.]—**Chronic Rheumatism.**— To "B.Sc., Plymouth."—Having read your answer to "Chronic Cold," I have ventured to write to you concerning myself. I have suffered some eight years from what has been termed chronic rheumatism of the nerves, and during that time have been quite unable to follow my usual occupation; but by the aid of plenty of flannel, and abstaining from all things likely to assist the complaint, I have seemed to stave off a deal of the pain until now and during the last winter, in which time it has seemed to have laid fresh hold of me. I ache with cold inwardly, at the same time am suffering from cold clamminess on the skin; cannot stir outside only on a still warm day, although I have persevered: it only results in fresh pains next day round loins, shoulders, face and legs, a bruised kind of feeling. I perspire profusely after after taking liquids hot or cold: am very thin and weak; my age is 58. Any advice you can kindly give me I shall esteem a great favour, trusting our Editor will kindly insert this for a—Many Years' Subscriber.

[56574.]—**Bearing Grease.**— Will one of your correspondents kindly give me, through the columns of the "E.M.", a recipe for making hot neck (bearing) grease, the price of which must not exceed 2½d. per lb.?—Inquisitor.

[56575.]—**Galvanometer.** — An astatic galvanometer is inclosed in a machine and entirely concealed from view. Will anyone kindly suggest a plan for telling when the needle deflects?—Jesse Budge.

[56576.]—**Insulators.**—Can any of "Ours" kindly inform me what substance is that which is put in with the bolts of insulators?—some kind of a cement it is.—Therma.

[56577.]—**Soap.**—Can any of your correspondents inform me if cotton seed oil is used in the manufacture of hard soap, and whether it can be used alone or only when mixed in certain proportions with tallow or other fat.—Carpe Diem.

[56578.]—**Electric Bells.**—I intend fixing up a circuit of electric bells, single stroke, worked by local batteries by means of relays. Calling the different stations (of which there are seven) A. B. C. D. E. and F. A. is at distance from B. of 1 mile; C. from B. of 1¼ mile; D. from C. of ½ mile; E. from D. of 2 miles, and F. from D. (in another direction to E.) of 3½ miles. At each place I intend having a relay, but wish to know what resistance to put on bobbins of same, and size. All the relays to be connected up in parallel and line wire consisting of No. 11 galvanised telegraph wire. I wish to use the smallest number of cells possible at each place; I thought perhaps five or six would be sufficient; also give description of relays. Will No. 28 silk-covered wire do for the single-stroke bells, which are of the upright form with pivoted armature? A reply to the above would greatly help me out of my difficulty.—Electra.

[56579.]—**Pumps.**—Will some of your readers be kind enough to explain the principle upon which the American pumps work, capable of drawing water 70, 80, or 100ft. deep, and give their mode of construction?—Chappie.

# ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

## HINTS TO CORRESPONDENTS.

**1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.**

***** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.**

The following are the initials, &c., of letters to hand up to Wednesday evening, May 6th, and unacknowledged elsewhere:—

John Browning.—H. M. Thompson and Co.—E. S. Hindley.—G. Weston.—Signal Engineering Co.—Dr. Draper.—F. A. Cobbold.—H. H. Holt.—Rev. H. Dowsett.—A. Ireland.—W. Harding.—Iron Horse.—Frank Broadbent.—Vulcan.—A. Roods.—E. C.—T. J.—O. S. —Ignorant.—M. C. H.—C. E. J.—Glaston.—O. J. L. —H. Ritchie.—J. H.—J. K. P.

Young Boiler Maker. (Your query is ably answered in Mr. Nicholl's book, "The Theoretical and Practical Boiler Maker," price 7s. As a "young boiler maker," you should procure that work.)—W. G. (If you will say what it is you want to electroplate, we will point out where you will find the information; but you will, by searching the indices, discover many references to articles, &c., on the art.)—E. B. F. (Will not some of those illustrated in back volumes answer the purpose?)—Grey Hair. (Besides those mentioned, there are Mrs. Marcet's "Conversations on Natural Philosophy," Pepper's "Playbook of Science," "The Magic of Science," &c.)—Mosart. (Such a query is altogether inadmissible, as the replies must of necessity be advertisements. Look over our advertising columns, and procure the lists of the dealers in musical instruments, such as Wallis, Euston-road, and Dawkins, Charterhouse-street.)—T. J. J. (The most complete directions yet published for nickel-plating will be found on pp. 96, 117, 189, Vol. XXXIX.)—John Parton. (To obtain a berth as stoker on an ocean-going steamer, you must apply to the chief engineer on board. There is no examination: the principal requirement is what is popularly called a "cast-iron constitution.")—E. Thornton. (See indices. Indiarubber dissolved in mineral naphtha is frequently used; but Prout's glue and compositions containing guttapercha and cobbler's wax are also employed.)—B. A. (The pores must be filled with size (glue water) first of all, and when dry coat with gold size or varnish. Then when the varnish is tacky, dust on the bronze powder. Clean off with a brush when thoroughly dry.)—Domestic. (It is quite beyond our province to offer advice of the kind. The usual plan is to submit the goods to those likely to take them up.)—Young Electrician. (You do not give address. There are schools in London—the Finsbury Technical College, for instance.)—Medium. (You cannot "burnish" such articles in the technical meaning of that term; but you can polish them with crocus and a brush.)—One Anxious to Know. (We answered your queries in this column on p. 180.)—H. M. Edwards. (Your reference is to the number for March 27, not 20. The query has been answered several times in back volumes, and may be answered again. It is inserted because a reply would be information useful to many. See pp. 262, 286, 617, Vol. XXXIV., and the indices.)—Spes. (What is there to explain? You were out on the cliffs during a thunderstorm, and, in common with other people, felt a blow on the head. Many persons have had a similar experience, and some have been so unfortunate as to have been right in the path of the lightning flash.)—W. F. H. (See the indices, or one of the little handbooks of the art. The manufacturer of the plates usually supplies a formula which is known to give good results.)—R. S. T. (The first query we must leave you to answer. 2. Some specimens of corundum contain silica. 3. According to the analyses, some sapphires contain silica. 4. In return, we must now ask what you mean by "oxide of alumina," seeing that alumina is the oxide of aluminium?)—Cambo. (Yes, it is "reliable")—J. S. (Your best plan is to seek the assistance of a capitalist, as the case appears to be one of those in which the possessors of money can frighten a poor patentee.)—Camera. (You now give the size of camera, but do not state what it is you wish to know. We do not preserve the letters which reach us. Have you read one of the cheap instruction books?)—Griffith. (The query is unsuitable. You can easily ascertain the market price on inquiry.)—Little Jimmy. (If you cannot procure the back numbers you will find "The Slide Valve Practically Explained," by Joshua Rose, a useful work. It costs 5s., and can be obtained of Mr. Calvert, Great Jackson-street, Manchester.)—Stationary. (For grinding-in taps, see p. 21, No. 781. For finding horse-power, see many references in the indices. The only approximately accurate way is by the use of the indicator. The formula for calculating has been given many times, and is to be found in any pocket-book for the use of mechanics.)—Hydrathana. (Heat and pressure, sometimes comparatively sudden, sometimes gradual. 2. Where do you find the statement about the frog?)—Nemow. (We do not think there are any now; but you can easily ascertain all particulars by addressing the inquiry to the Agent-General for Cape Colony, London, S.W.)—A New Subscriber. (There are a series of articles on Spectroscope Making in Vol. XX., and several descriptions of cheap spectroscopes in back numbers—No. 774, p. 488; No. 666, p. 389; but it would be an advantage if some one who examined the apparatus exhibited by Mr. Cunynghame would explain how to make a spectroscope for 5s. Browning's "How to Use the Spectroscope," is a useful brochure. 2. Mr. Shelford Bidwell's instructions for making a phonograph appeared in Vol. XXVII. p. 157.)—British Workman. (You will find several methods of making electric contact on clocks in No. 1026. 2. It has been asserted that it cannot be done, and certainly no one but an expert could do it. A remedy is to stick a piece of silver foil over the scratch.)—Multum in Parvo. (All you can do is to sue him in the County Court for the balance.)—E. Elgar. (A little zinc ointment is the best thing you can use.)—L. H. H. (The publishers of Col. Ross's book are Messrs. Lockwood and Co., Stationers' Hall-court, E.C. Such a clock as you inquire about could, doubtless, be had of Messrs. Lund and Blockley, 42, Pall-mall, the makers to the Admiralty and the Royal Geographical Society.)—E. A. Tindall. (We will insert two more letters; but could not find space for so many illustrations with either. The subject is an interesting one, and the information you have kindly favoured us with most welcome; but, after all, it appeals to a very limited section of our readers, and we have so many matters constantly claiming their share of space.)—B. (We could only spare room for one drawing; but your kindness is as much appreciated as if we had used that you sent.)—W. H. Eaves. (In type.)

Quantum Libet. (The copy of your query about dynamo has been lost or mislaid. Will you repeat it? The blocks have been engraved.)

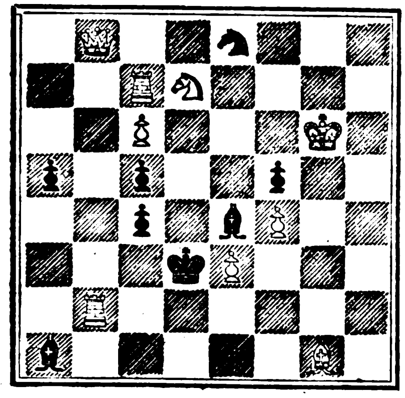
**Influence of the Electric Light on the Development of Plants.**—In the *Journal* of the Society of Chemical Industry is described the results of experiments carried out by P. P. Dehérain on the influence of the electric light on vegetation. Experiments in this direction had been previously made by Siemens, but not for such extended periods. The effects of the naked rays noted by Dehérain were very curious; some of the plants lost their leaves, some became spotted, weak, and unhealthy, others turned black, while in the case of some elder shrubs, leaves directly exposed to the electric rays were blackened, although the more protected leaves retained their green colour. The outlines of the upper leaves were found in many instances depicted on those underneath with the distinctness of photography. The influence on vegetatation of electric rays which had passed through transparent glass globes was not so prejudicial, although complete development was greatly interfered with. The following conclusions were arrived at by the author:—(1) The electric light contains rays which are injurious to vegetation; (2) the greater part of these rays are kept back by transparent glass; (3) the electric light contains, on the other hand, sufficient rays useful to vegetation to maintain the life of plants entirely under its influence for 2½ months; (4) this amount of useful rays is, however, insufficient to bring on young germinating plants, or to bring full-grown plants to maturity.

## CHESS.

ALL Communications for this department must be addressed to J. PIERCE, Langley House, Dorking.

PROBLEM DCCCCXXXVIII.—By ARIADNE.

*Black.*



*White.* [9+8

White to play and mate in three moves.

SOLUTION TO 936.

| *White.* | *Black.* |
|---|---|
| 1. K to K R 6 | 1. Anything. |
| 2. R to B 8 | 2. Anything. |
| 3. R mates. | |

### NOTICES TO CORRESPONDENTS.

CORRECT solutions to 934 by G. Stingfellow, Exon (good puzzle), C. Brady, and T. L. Robins; that by E. S. Follwell is wrong.

To 935 by H. Culmer, E. Stanley Follwell (easy; five minutes), T. L. Robins, G. Stingfellow, F. B. Webb (we have repeatedly stated that if competitors desire to score full marks they must give the principal variations), Exon (key rather easy), G. W. J. and R. C. J.

To 936 by H. Culmer, Brum (very poor), A. Orr (delay unavoidable, but will not occur in future), A. A. E. Lecluse, E. S. Follwell (poor; no scope for Black), F. A. Vincent, G. Stingfellow, J. A. M. (not a first class problem), Streetgate (solution easy owing to the position of the Black K). Rev. W. Anderson (Old Romney), E. S. and R. A. Bennett.

To 937 by J. A. M. (a fair problem), Brum, E. S., J. B. Piper (very neat), and Streetgate (ditto).

H. BRISTOW.—Sorry you are unable to join Tourney, as it promises to be lively.

J. H. BLAKE.—Thanks for games and notes.

**Every Workman** connected with the Building Trades requiring a Situation should advertise in "THE BUILDING NEWS," published every FRIDAY, price Fourpence, at 332, Strand, London, W.C.

"THE BUILDING NEWS" is the Principal Journal representing Architects and Builders, and has the largest circulation of any Professional Journal in the kingdom.

Every Workman should insist on seeing "THE BUILDING NEWS" every week at his Club or Coffee House. He will find more "Lists of Tenders" for new work in it every week than in any similar paper, and can thus judge where work is likely to be had. He is also specially invited to make use of "Intercommunication" if he wants to know anything about his trade; to write to the Editor if he has any suggestions to make, and to advertise in the paper when he wants work.

The charge for Advertisements for Situations is One Shilling for Twenty-four Words, and Sixpence for every Eight Words after

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6s. 6d. for Six Months and 11s. for Twelve Months, Post-free to any part of the United Kingdom. For the United States, 13s., or 3 dols. 26c. gold; to France or Belgium, 13s., or 16f. 50c.; to India (via Brindisi), 15s. 2d.; to New Zealand, the Cape, the West Indies, Canada, Nova Scotia, Natal, or any of the Australian Colonies, 13s.

The remittance should be made by Post-office order. Back numbers cannot be sent out of the United Kingdom by the ordinary newspaper post, but must be remitted for at the rate of 4d. each to cover extra postage.

Messrs. JAMES W. QUEEN and Co., of 924, Chestnut-street, Philadelphia, are authorised to receive subscriptions for the United States for the ENGLISH MECHANIC, at the rate of 3 dols. 26c. gold, or Thirteen Shillings per annum, post-free. The copies will be forwarded direct by mail from the publishing office in London. All subscriptions will commence with the number first issued after the receipt of the subscription. If back numbers are required to complete volumes, they must be paid for at the rate of 4d. each copy, to cover extra postage.

Vols. IV., VII., XXVI., XXVIII., XXX., XXXII., XXXIII., XXXIV., XXXV., XXXVI., XXXVII., XXXVIII., XXXIX. bound in cloth. 7s. each. Post free, 7s. 9d.
Vol. XL. now ready, price 7s. Post free 7s. 9d.

All the other bound volumes are out of print. Subscribers would do well to order volumes as soon as possible after the conclusion of each half-yearly volume in February and August, as only a limited number are bound up, and these soon run out of print. Most of our back numbers can be had singly, price 2d. each, through any bookseller or newsagent, or 2½d. each, post-free from the office (except index numbers, which are 3d. each, or post-free 3½d.)

Indexes for Vols. I., VI., VII., VIII., and IX., 2d. each. Post free 2½d. each. Indexes to Vol. XI. and to subsequent vols., 3d. each, or post free, 3½d. Cases for binding, 1s. 6d. each.

**Epps's Cocoa.**—Grateful and Comforting:—"By a thorough knowledge of the natural laws which govern the operations of digestion and nutrition, and by a careful application of the fine properties of well-selected Cocoa, Mr. Epps has provided our breakfast tables with a delicately flavoured beverage which may save us many heavy doctors' bills. It is by the judicious use of such articles of diet that a constitution may be gradually built up until strong enough to resist every tendency to disease. Hundreds of subtle maladies are floating around us ready to attack wherever there is a weak point. We may escape many a fatal shaft by keeping ourselves well fortified with pure blood and a properly nourished frame."—*Civil Service Gazette.*—Made simply with boiling water or milk. Sold only in packets, labelled—"JAMES EPPS and CO., Homœopathic Chemists London."—Also makers of Epps's Chocolate Essence

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| | s. | d. |
|---|---|---|
| Thirty Words | 2 | 6 |
| Every additional eight words | 0 | 6 |

Front Page Advertisements Five Shillings for the first 40 words afterwards 3d. per line. Paragraph Advertisements One Shilling per line. No front page or paragraph advertisement inserted for less than Five Shillings. Reduced terms for series of more than insertions may be ascertained on application to the Publisher.

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| | s. | d. |
|---|---|---|
| Twenty-four words | 0 | 3 |
| For every succeeding Eight words | 0 | 3 |

ADVERTISEMENTS in the SIXPENNY SALE COLUMN.

| | s. | d. |
|---|---|---|
| Sixteen words | 0 | 6 |
| For every succeeding Eight Words | 0 | 6 |

*** It must be borne in mind that no Displayed advertisements can appear in the "Sixpenny Sale Column." All advertisements must be prepaid; no reduction is made on repeated insertions; and in cases where the amount sent exceeds One Shilling, the publisher would be grateful if a P.O.O. could be sent, and not stamps. Stamps, however (preferably halfpenny stamps), may be sent where it is inconvenient to obtain P.O.O's.

The address is included as part of the advertisement, and charged for.

Advertisements must reach the office by 1 p.m. on Wednesday to insure insertion in the following Friday's number.

## NOTICE TO SUBSCRIBERS.

Subscribers receiving their copies direct from the office are requested to observe that the last number of the term for which their subscription is paid will be forwarded to them in a PINK Wrapper, as an intimation that a fresh remittance is necessary, if it is desired to continue the Subscription.

**Holloway's Pills and Ointment** offer to mankind the most effectual cure for Gout and Rheumatism. The Ointment should be thoroughly rubbed into the parts affected at least twice a day, after they have been fomented with warm flannels to open the pores, in order to facilitate the absorption of it.

**An Inventor** seeks a PARTNER to assist him in Manufacturing a small article of general use by all machinery users. Very little plant required.—Apply, in first instance, to J. C., 3, Gladding-road, Manor Park, E.—[ADVT.]

## OUR EXCHANGE COLUMN.

*The charge for Exchange Notices is 3d. for the first 24 words and 3d. for every succeeding 8 words.*

**Good Value Offered** (cash or instruments) for all kinds of sound or repairable scientific Appliances.—CAPLATZI, Science Depot, Chenies-street, near British Museum. Established 1862.

**Hot-Air Engine**, Buckett's Caloric, half h.-p., quite new, cost £42 10s. Will take exchange. Want tools or anything useful.—J. GRIME, Hull.

**Tricycles**, with Dunn's patent improved power appliance. 50 per cent. increase of power. Machines bought sold, or exchanged.—222A, City-road, London, E.C.

**Telescope**, 2½in. Reflector, two Astronomical Eyepieces, fine adjustment screw, on tripod stand, in oak case. What offers?—JOE BLAIN, Albert-square, Carlisle

**Medical Coil and Bichromate Battery**, in mahogany box, good condition; for Electric Scarf Pin.—JOE BLAIN, Albert-square, Carlisle.

**Electric Railway**, with Motor and Battery, not quite in working order; can be made right by any amateur electrician. What offers?—JOE BLAIN, Albert-square, Carlisle.

**Lathe Heads**, 4½ to 6in. centres, T and slide rests, wanted in exchange for corresponding value.—LINSCOTT, Ramsgate.

**Telescope**, 2in. achromatic object-glass, good definition, high tripod stand; for Lathe Appliances or other offers.—LINCOTT, Ramsgate.

"Sun Dial" Gas **Cooking Stove**, nearly new, two feet high, thirteen inches wide, eleven inches deep, complete, cost £2 8s. Will exchange for assortment of joiner's tools of approximate value.—Address, P. T., 227, Millbrook-road, Freemantle, Southampton.

For exchange, a Dr. Carter Moffatt's **Ammoniaphone**, quite new, owner has no use for it, been very little used. Exchange for small Shocking Coil or what offers.—REYNOLDS, Hepworth, Huddersfield.

"**English Mechanic**," from beginning, 40 vols., handsomely bound. What offers in cash? or exchange Photographic Apparatus, Tricycle, or anything useful.—Address, X.Y.Z., 8, Albany-road, Mile-end.

**Letter Copying Press**, foolscap size, quite new, never been used, cost £2. Will exchange for Printing Press or offers.—JAMES R. W. STIBBS, Commercial Wharf, Plymouth.

Wanted, pair 3in. centre **Lathe Heads and Rest** or Electro-Motor, any other Electrical Apparatus. Exchange 5-keyed Piccolo, with silver lip plat on, cost 32s. Offer.—B. SCHOFIELD, Diggle, Saddleworth.

Splendid **Electro-Motor**, Chester's form, but larger adjustable brush holder; for Bassinette or useful offers.—J. SMETHURST, 4, Oak-street, Radcliffe.

Wanted, set **Dynamo Castings**, about 150 c.-p., in exchange for Pint Bunsen Cells.—E. THORNTON, Hindpool-road, Barrow-in-Furness.

Offers wanted for a 6in. centre Woodturning **Lathe** and 4½ Leg Vice.—No. 3, Stanhope-street, off Winwich-road, Warrington.

Mahogany **Steering Wheel**, with drum, standards, and mahogany case, suitable for boat about 30ft.

**Propeller**, 26in., 3-bladed.

**Lathe Flywheel**, 28in. dia., and Crank.

Vertical copper **Boiler**, 24in. high, 10in. dia., 7 tubes, and all fittings, with firebox, &c

Horizontal **Engine**, brass, 2in. bore, 3½in. stroke, on brass bed-plate, in working order.

Offers in exchange or cash. Wanted, **Donkey Pump**, steam fittings.—A. G., 23, Sussex-street, Winchester

A beautiful **Russian Goatskin Rug**, cream colour, 6ft. long by 3ft. Exchange for Hand Sewing Machine or anything useful.—H. NELDER, Bridge-street, Abertillery, Newport, Mon.

**Dynamo**, superior finish, 10½in. Siemens armature, in exchange for good 6in. Slide-rest, or cash £5 10s.—J. BAMBER, 12, Bessborough street, London, S.W.

Wanted, a **Copying Apparatus**, for which good exchange will be given. Gelatine forms will not do.—T. H. M., Errigle, Cootehill, Ireland.

Horizontal **Engine**, link motion, locomotive boiler, 8 tubes, steam and water gauges, &c.; for 6in. Slide-rest, or offers.—SARGENT, 25, Holywell-street, Strand, London.

Wanted, an **Air Gun**, in exchange for a HORIZONTAL ENGINE and BOILER, in very good condition, cost 25s.—H. WILSON, Rock House, Clapham Common

Half-plate Sliding Body walnut **Camera**, dark slide lost, excellent condition. What offers of exchange?—STEAD, Lees, Oldham.

Going abroad.—**Induction Coil**, remainder Chemical Apparatus, Books, &c. Nominal exchange.—R. PORTER, 30, Aden-grove, Stoke Newington.

Newton's Patent Refulgent **3-wick Lamp**, new this season. Will exchange above for the "Safety Oxy-hydrogen Jet," or offers. Approval.—E. HOWGATE, jun., Water Hall, Mirfield, Yorkshire.

**Locomotive Castings**, Lee's, £2 15s. set, 18in. long; partly finished, cylinders bored. What offers in exchange Small Harmonium wanted.—MILLER, 3A, Park road, Battersea.

**Bicycle** wanted, 50in. to 54in. Will exchange GALVANIC BATTERY, by Halse, cost £10.—C. F., 19, Merrow-street, Walworth-road, S.E.

"**Popular Educator**," Vols. III. and IV., separately bound and in good condition. Exchange or offers.—POOLE, St. James's-green, Thirsk, Yorkshire.

Volumes I. to XIV. "**Mechanic's Magazine**," bound, good as new; 10 Vols. "Family Friend," bound; and other books, in exchange for Lathe and Tools, or offers.—W. S., 78, Viaduct-street, London, E.

52in. **Bicycle**, bent handles, lamp, bell; good as new Would exchange for good centre-second Chronograph Stop Watch and Chain.—HOWARD, 177, Guide-lane, Hooley-hill, Manchester.

Wanted, second-hand ¾in. spark **Induction Coil**, with commutator, in exchange for 6in. Bullseye and safety Lime Light Jet.—M., 5, Hanover Buildings, Southampton.

For exchange, about 100 yards of No. 16 copper thick Guttapercha WIRE. Exchange Silver Albert; also 2 Electrical and Pneumatic Indicators, 10 holes each, good condition. What offers?—W. MITCHELL, Engineer, Leicester.

Wanted, lady's hall-marked **Silver Lever Watch**, no rubbish, hunter preferred, for good exchange.—Particulars to T. A. C., Fairfield House, Warrington.

**Foot Lathe**, new, 3in. centres, 2ft. 6in. gap bed, treadle, tool shelf, back gear, compound slide rest. Exchange for Breechloader, equal value, choke preferred.—A. HALLS, Howard-street, Yarmouth.

Wide-angle **Lens**, first-class maker, Vogel, Philadelphia, U.S. Want ½-plate Portrait Lens (offers photographic).—H. REYNOLDS 77, West-street, Bristol.

Ten-guinea **Diamond Ring**, new, flawless, in exchange for 2ft. Locomotive in damaged condition.—Send particulars to W. HAUGHTON, 138, Park-road, Liverpool.

"**Flute Music**," in exchange for C. Nicholson's Pot-pourri and Weidner's Portuguese Air, flute and piano. One or both.—Particulars, J. DICKSON, Atlantic Avenue, Belfast.

54in. **Bicycle**, roller bearings, lamp, &c. Exchange for "Facile" or smaller bicycle, or sell cheap; also some locomotive photos.—W. ALGAR, Stonard-road, Winchmore-hill.

Double **Dark Slides** (2), quarter-plate, nearly new. Exchange turning tools, or offers.—J. T. SKINNER, Turner, Chase-road, Southgate, London, N.

"**English Mechanic**," Vols. I. to IV., bound; XXI. to XXVI., bound; XXVII. to XL., unbound, clean and complete. "Horological Journal" from commencement, 27 Vols. complete, to August, 1885, 19 Vols. bound. Tricycle or offers.—H. W. JOB, High-street, Harrow, Middlesex.

Wanted, good **Lever Watch**. Exchange WOODTURNER'S FOOT LATHE, 30s., Avery's Steelyards, weighs 14lb. up to 15cwt., cost £5.—W. SMITH, Bilston-road, Wolverhampton.

## THE SIXPENNY SALE COLUMN.

*Advertisements are inserted in this column at the rate of 6d. for the first 16 words, and 6d. for every succeeding 8 words.*

**Plating.**—Every description of Gilding, Silver Plating, Oxidising, and Bronzing, executed with very best finish. Speciality in nickel-plating. Special quotations on application. Send one stamp for price list. Small jobs attended to per return post.—MORRIS COHEN, 132, Kirkgate, Leeds.

**Fretwork.**—Illustrated Catalogue of every requisite and 400 miniature designs, 4 stamps.—HARGER BROS., Settle, Yorks.

**Trouser Lengths**, 5s. each. Cheap Cloth for Ladies' Dresses, Mantles, Boys' Suits.—HEWITT, 27, Winfield Mount, Leeds. Patterns free.

**Electric Depot**, 10, Deansgate, Manchester.—Electric Breast Pins, 25s. Electric Bells, 4s. Induction Coils, 8s.—MILLAR, Proprietor.

Shunt wound **Dynamo** and Serrin Arc Lamp, cost over £40. Will take £25 or good exchange.—JOHN GRIME, Hull.

Fletcher's **Foot Blower**, cost 35s., quite new; also large Blow Pipe and Hearth. Will take £2 10s., or offers.—J. GRIME, Hull.

**Billiards.**—Great success of Thorpe's Patent Automatic Cue Tips. Cannot fly off. Cues retipped instantly.

**Billiards.**—Excellent testimonials from Roberts, jun. champion, and other professionals. £5 per week easily earned.

**Billiards.**—District Agents wanted. Send 9 stamps for particulars and sample cue end fitted with patent.

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**Billiards.**—Apply to sole representative for United Kingdom.—A. W. MORGAN, Lancaster Avenue, Fennel-street, Manchester.

Hard **Vulcanised Fibre** for Magnet Heads.—MOSSES AND MITCHELL, 68a, Chiswell-street, London, E.C.

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**International Inventions Exhibition**, East Avenue, Group 21, Stand 1683.—MOSSES AND MITCHELL, 68a, Chiswell-street, London, E.C.

Tudsbury and Sons' "High Tension" **Wimshurst** MACHINES, with Compound Ebonite Plates. List, one stamp.—Edwinstowe, Newark.

**Castings.**—Bench Drilling Machine Castings, 3s. 6d. Small Brass Horizontal Engine Castings, 2s. 6d. New Price-list and designs of perfect Castings post free.—I. TOMLIN, Engineer, 28, Highfield-terrace, Barnsley, Yorkshire.

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**French Polishing**, Staining, Painting, and Varnishing. 122 receipts or trade secrets, with full instructions and details, free 1s.—I. Tomlin, 26, Highfield-terrace, Barnsley, Yorkshire.

**Cat Gut.**—Gut Hooks and Eyes for lathes and machinery.—James Bellaers. Regent-street, Leicester.

**Bellaers' Gas Stoves.** 1s. 3d., 2s. 3d., 3s. 3d., for boiling. Breakfast stoves, 5s., 11s., 14s. 6d. Send for lists.

**Showcases** for Exhibitions, Models, Scientific Instruments. Exhibition Stands supplied and fitted.—Write, Fry and Blatt, 90, Borough-road, London.

24 **Microscopic Slides**, in box, very cheap. List sent for stamp.—Well, Dalmain-road, Forest Hill.

**Mica**, otherwise Talc.—Richard Baker & Co., 9, Mincing-lane, London.

**Violin** for sale, magnificent solo instrument, suitable for lady or gentleman, labelled "Antonius Stradvarus, Cremona. 1690," with good case and mounted bow, only 25s. Sent on approval with pleasure.—Mrs. Jones, 50, Myddelton-street, Clerkenwell.

**To Capitalists.**—An Inventor seeks a Partner to assist him in manufacturing a small article of general use by all machinery users. Very little plant required.—Apply in first instance to J. C., 3, Gladding-road, Manor Park, E.

**Patents, Designs, and Trade Marks.**—For particulars of lowest charges, apply, G. L., Technical Bureau, 46, Queen Victoria-street, E.C.

**Tricycle Wheels**, Bicycle Wheels, and Fittings. Wonderfully cheap. Also for safety Bicycles.—W. Gwinnett and Co., Wolverhampton.

**Edward W. Drury**, Hull, Glass Bottle and Cork Manufacturer, Importer of Chemicals, Caramel, Glucoses, Tinned Wire.

**Lathes**, Lathes. Cheapest and best. List, 2 stamps. Nothing equal at price.—Robinson, Somerset-road, Sheffield.

100 **Foreign Stamps**, including Brunswick, Ceylon, Tasmania, Egypt, Greece, Luxemburg, free 7d.—Hely, Foley-street, London.

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Pumphrey's **Pocket Tripod**, for cyclists, professional and amateur photographers. Perfectly rigid. May be had on approval. Illustrations and testimonials free.—Pumphrey, Stanhope-street, Birmingham.

The **Camera and Lantern**, with three instantaneous photographs; gives full instructions in their production; 6d. post

**Camera and Lantern Apparatus**, dispenses with multiplicity of slides, 36 plates carried, changed anywhere.—Pumphrey, Birmingham.

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**Motor Castings**, materials for Electric Bells, Batteries, Galvanometers, Intensity Coils, Microphones.—King, Mendham, and Co., Bristol.

**Insulated Wire Table**, showing size, weight, resistance per foot, feet per ohm, &c., price 3d.—King, Mendham, and Co., Bristol.

**Standard Ohm**, in box, copper poles, guaranteed correct to ten thousandth of ohm, 21s.—King, Mendham, and Co., Bristol.

**Wimshurst Influence Machine.**—Sole Manufacturers of Improved Pattern. Numerous testimonials as to thorough efficiency.—King, Mendham, and Co., Bristol.

**Galvanometer Cards**, improved for tangent and ordinary combined, 2½in., 8d.; 4in., 10d.; 6in., 1s.; post free.—As above.

Write for **King, Mendham, and Co.'s** large new and reduced Price List, post free 4 stamps.

Col. Ross's Patent **Filter Pipe**, price 1s. 6d., post free 1s. 8d.—G. Deal, 7, Holborn Viaduct, London, E.C.

The **Pipe of all Pipes.** Price 1s. 6d., post free, 1s. 8d.—See above.

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A **Sure Cure** for Dyspepsia and Heartburn. Col. Ross's Patent Filter Pipe.—See above.

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Smoked all the World over.—**Col. Ross's Patent** Filter Pipe. Price 1s. 6d., post free 1s. 8d.—See above.

**Beware of Imitations**, useless and fraudulent. We sell only Col. Ross's Patent. Price 1s. 6d., post free, 1s. 8d.—G. Deal, 7, Holborn Viaduct, London, E.C.

**Col. Ross's Patent Filter Pipe.**—Look out for it at the "Inventories" Exhibition; meanwhile buy one of us.—G. Deal, 7, Holborn Viaduct, London, E.C.

**The Kinetic Engineering Company**, 36 and 37, Brooke-street, Holborn, London. Circulars and list post free.

**Dynamo Wire**, 1s. 2d. per lb. Line Wire, 29s. 6d. per mile. Pushes, 4s. per dozen.—Kinetic Company.

**Leclanche Cells**, best No. 1, 16s.; No. 2, 19s.; No. 3, 22s. 6d. per dozen.—Kinetic Company.

**Electric Bells.**—Best quality, workmanship, appearance and value in market, 40s. per dozen.—Kinetic Engineering Company.

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**Electrical Supplies.** Wholesale only.—Kinetic Engineering Company, 36 and 37, Brooke-street, Holborn, London, E.C.

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For **Model Work** (wheel-cutting in brass only); also Boring, Turning, and Screw-Cutting.—Cleoe, as above.

Grant Bros.' parts of **Electrical Apparatus** of every description for amateurs; wholesale prices; full instructions free.

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**Engine and Boiler** combined, 6in. bore, 12in. stroke, by Green; very cheap.—Rigby Smith, Fazackerley, Chorley.

Universal **Cutter Frame**, slide 3in., £2. Castings 4s. 6d.—Particulars, apply, G. Allsop, Derby-road, Belper.

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Magic Lantern **Photograph Colouring**, finely and artistically done, 12s. per dozen. Special terms to the trade on application.—C. Pilkington, 32, Sackville-street, W.

**Desmometer**, giving at sight weights of rivets and bolts of any size and length. Useful formulæ, 1s.—W. Stephen, 76, DeGrey-street, Newcastle-on-Tyne.

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Astronomical **Telescopes** of all kinds and Apparatus or Fittings made by A. Clarkson, 28, Bartlett's-buildings.

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**Copying Ink Pencil**, new patent indelible, Cam action; best ever introduced. Warranted to wear well. Post free 7 stamps.—Purkiss, 37, Huntingdon-street, Kingsland.

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**Organ Pedals**, mahogany; must be sold.—H. Reid, Addington Villa, Wendover, Bucks.

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**Diagrams**, large crayon, plain or coloured, for lectures in natural history or microscopy.—Parr, Ainsworth, Bolton.

Ivory handle **Pocket Knife**, 3 best steel blades, 2s. 9d.; sold at 3s. 6d. and 4s. Cash returned if not approved.—Marsh, Broughton-road, Owlerton, Sheffield.

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**Electric Bell**, Battery, Push, and 30 yards of Wire, carriage free, 9s.—A. Shafto, Urmston, Manchester.

**Electric Bell**, 4s. Leclanché Battery, 2s. Bichromate, 3s. Coil, 6s. Wire ½d. per yard.—As above.

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**Incandescent Lamp** in Gilt Scarf Pin, 20 stamps.—New and Co., 24, Dean-street, Soho.

**Incandescent Lamp.** Battery, Wire, Chemicals, Instructions, &c., in box, 2s. 6d. free.—New, 24, Dean-street, Soho.

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**One Recipe**, 7 stamps; two, 12; three, 16; four, 19. Returned if dissatisfied.—Stanley, above.

Genuine Commercial **Citrate Magnesia**, as prepared by largest firm in trade, 13 stamps. Returnable.—Stanley above.

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**Patterns** of 3in. Screw-cutting Lathe. No reasonable offer refused.—Bullocoh, 6, Mead's-row, Lambeth.

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**Fan Castings.**—Improved Registered Designs; sets 4in., 3s.; 6in., 4s.; [illegible]in., 6s. Drawings, 6d.—Wheeler, Engineer.

**Water Motors.**—Complete one horse-power, £9. Half, £6. Quarter, £4. Eighth, £3.—Thomas Wheeler, Preston.

Steel **Name Stamps**, 3d. per letter. Figures (set), 2s. 4d. Letters, 6s. 4d., per post.—E. F. Baldwin, Robinswood-hill, Gloucester.

**Dynamos**, Jones's Patent, 2,122, working at 12, Old London, in International Inventions Exhibition. Motor Castings, 3s. a set.—H. Jones.

**Formulas Worked Out** for winding Dynamos from 10 c.-p. to 500 c.-p., 8 stamps each.—H. Jones.

**Dynamo Castings**, Jones's patent H: 8 c.-p., 5s.; 16, 6s. 6d.; 20, 6s. 6d.; 30, 7s.; 70, 16s. a set.—H. Jones.

**Dynamos**, finished: 8 c.-p., 30s.; 16, 36s.; 20, 40s.; 30, 50s.; 70, 100s. each.—H. Jones.

**Dynamo Armatures** of above wired after fitted up 1s. each, own make, warranted.—H. Jones.

**Dynamos** for house lighting.—Jones's Patent Laminated Poles and Armatures, 5, 6, and 7 lights, £6, £7, and £8 each.—H. Jones.

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Model **Engine Castings.**—Best and cheapest. See list (stamp) and compare.—Wood, Dalley-street, Broughton, Manchester.

**Dynamos**, with lamps, new. Fine Hand Machine, by Brequet, cost £40; first offer above £15 taken. Inspection invited by appointment. Castings rough and finished. Repairs.—Letters, Warne, 39, St. John's-street-road, E.C.

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A few Gramme **Dynamos** for sale, cheap.—Walker and Olliver, 195, Severn-road, Cardiff.

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**Dynamos** repaired or rewound. Advice given. Competent men sent to all parts.—Walker and Olliver.

Send for **List** of Switches, Indicators, Telegraph Instruments, Parts, &c., for sale, cheap.—Walker and Olliver.

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**Dynamo**, new, laminated armature, lights 7 tens; price 70s.—J., South Cottage, Thurlow Park-road, Dulwich.

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**Induction Coil**, ⅜in. spark, with condenser, 30s. free.—A. Parks, 43, Coten-end, Warwick.

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**Launch Engines** for sale, 3in., 4in., 4½in., 5in., 6in., 9in. cylinders.—John Middleton, 16, Hope-street, Glasgow.

**Lathes**, 5in. centres, back-geared, complete with chuck, chuck, &c., £7 10s.—John Middleton, 16, Hope-street, Glasgow.

"**English Mechanic**," Vols. XXII. to XL., inclusive, unbound, 45s.—W. M., 64, St. Stephen-street, Salford.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
*FRIDAY, MAY* 15, 1885.

## TOOL EDGES, CUTTER BARS, AND CUTTERS.

THE query of a correspondent in a recent number has stimulated me to take pen in hand once more, and to resume a subject which can hardly fail to interest a large number of our readers, of whom many are new subscribers, who have not had the opportunity of reading previous articles in which this matter was more or less fully treated. For many years, too, I have had in my hands private notes and letters of "D. H. G.," in which he explained the whole system, and his reasons for adopting the bar known by his name. It was his intention to publish further notes in a separate pamphlet; but time went by, and his business engagements being of a pressing nature, he was never able to carry out his plan, and sickness—the result, I believe, of overwork—has now compelled him to lay aside the pen, as well as those lathe tools which he wielded so skilfully, and handled, I may say, so lovingly. I feel, therefore, justified in attempting this work myself, and in so doing I shall follow the plan which he would have himself adopted: of making each individual point clear before passing on to the next. In no other way is it possible to elucidate the system upon which the cutter bar and its tools depend for their efficiency. I am well aware, nevertheless, that some other correspondents are better qualified to do this work than I am, but I write for learners, and not for masters; nor would I write at all if "D. H. G." was in health or "J. K. P." at leisure and in the mood. No detail, perhaps, of lathe-work causes an amateur more worry and disappointment than metal-turning. He sees, probably in a lathe in some large workshop, a bar of metal in process of manufacture, and observes the shavings curling off its surface under the action of the tool, as if the material were almost as easy to pare as an apple. Trying to imitate the process at home, he becomes practically acquainted with the fact that knowledge and experience are needed to a degree which he can scarcely comprehend, and that metal-turning no more comes by nature than reading and writing. But what is still more aggravating is the fact that with a well-ground hand-tool—a graver, for instance—the tyro often finds that he can cut a clean shaving with far greater ease than with the slide-rest tool, while he naturally feels ambitious to excel with the latter. Let anyone take a graver and hold the lozenge-shaped face flat against the end of a bar mounted in the lathe, letting it lie, of course, across the tee of a rest put as closely as possible to the work. Then let him gently bring the upper edge into cut by inclining the face slightly towards the work. The cutting action will be so easy that no exertion is necessary to hold the tool steadily—the resistance is so apparently slight that he may hold the tool with thumb and forefinger, even, for a light cut. Using, however, both hands, no difficulty is experienced in taking as deep a cut as is generally needed. Why is it that the substitution of a slide-rest tool for the graver does not bring about a far superior result, as it ought theoretically to do? In the first place, the graver is correctly formed; the cutting angles are those best suited to separate the shaving, and, in the next place, the position of the tool is accurately, because tentatively, adjusted. If it is seen to fail in its work, an almost imperceptible movement of the hand corrects the error of position, and sets matters right.

With the fixed tool, even if it is correctly ground, no such minute correction is possible as tool-holders are now made; but the tool must be packed-up, or re-ground, or lowered, as may seem necessary, and again tried—often with the result that it has again to be ground and readjusted. It is not very easy to contrive a holder that will place a graver in the position mentioned above, nor is it really necessary, because we can give to a slide-rest tool any desired cutting angle, and also place its edge quite as favourably, while we can retain it rigidly in exact position.

If we consider attentively the cutting-action of the graver, placed as stated, we shall observe, first of all, that the lozenge or face lies almost flat against the end of the bar to be cut, the slightest possible leaning

FIG. 1.

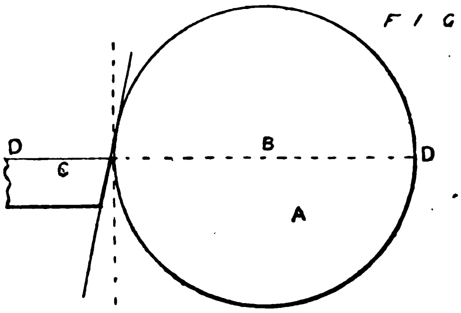


FIG. 2.

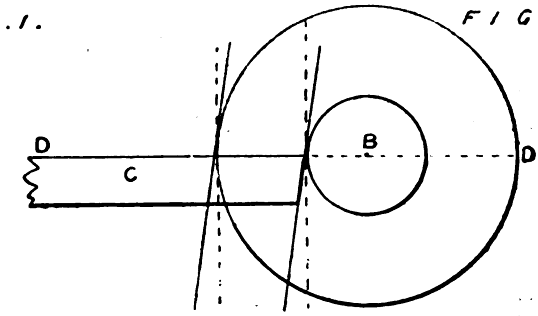


FIG. 5.

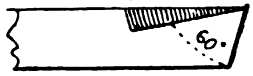


FIG. 6.

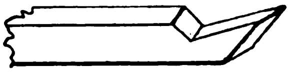


FIG. 7.

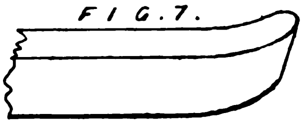


FIG. 8.

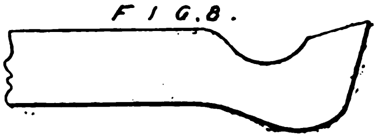


FIG. 3.

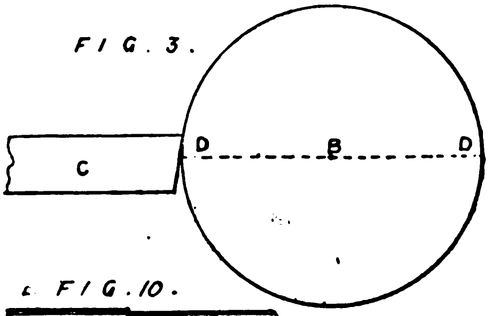


FIG. 4.

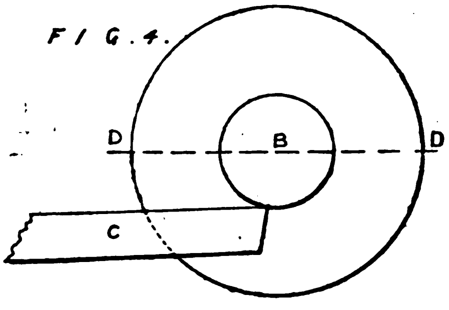


FIG. 12.

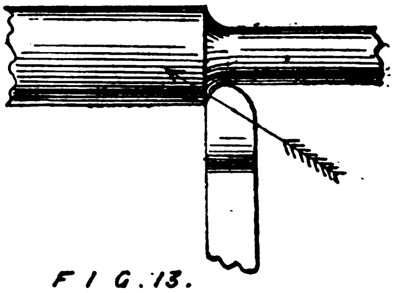


FIG. 10.

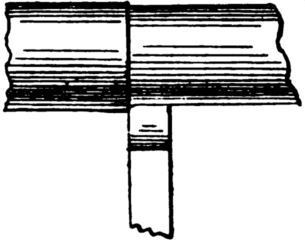


FIG. 14.

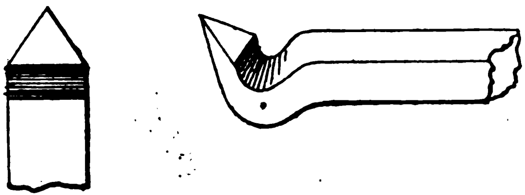


FIG. 13.

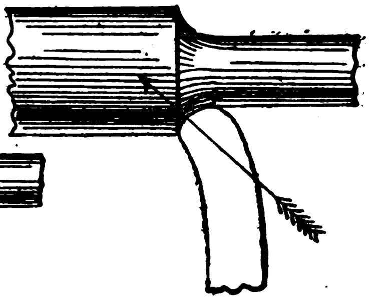
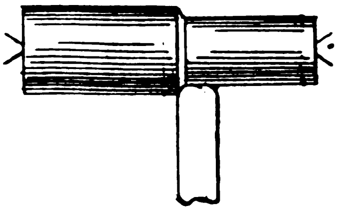


FIG. 11.



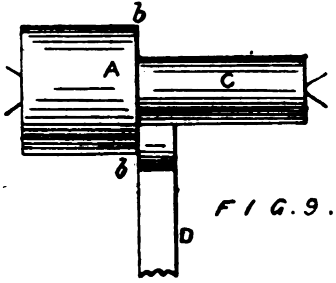
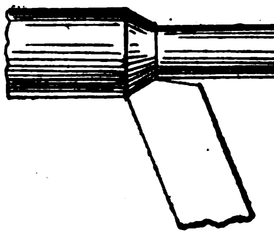


FIG. 9.

FIG. 15.



of that face to the left bringing its edge into action. This should be practically tested by the reader. The small angle made by the face of the tool with the work is known as the clearance angle, and the smaller it is the easier will the cutting-action be. We have, therefore, the first secret—viz., a small clearance angle between the work and the face of the tool which is next to it. Then, secondly, if the graver is ground as usual to an angle of 45° with its length—i.e., more correctly, if the face makes 45° with the axis of the bar, each cutting-edge will be 60°. Now there are many who ridicule this measurement of cutting angles, notably American writers; but it stands to reason that on any given material—e.gr., wrought iron—there must be a certain keenness of edge, which will give the best results, lasting longer and cutting better than any other. It may vary within certain limits, because a bar of wrought iron is not always precisely alike in its structure; but the best average for this metal will be 60°, and a graver will cut it extremely well. We may, therefore, take it as about the angle to which a tool for wrought iron should be ground.

Thirdly, the position of cutting edge.—This, for reasons that will presently be stated, should be always at the height of the lathe centres. With a hand graver it is of no special importance, because the cut is not continuous, and, after a shaving has been removed, we readjust the tool for a second cut; but for a fixed tool, the axial horizontal plane is the only one that will answer. If the cutting edge is above the line of centres, the face of the tool will rub unless the clearance angle is unduly large; and if it is below the centres, the work will have a tendency to ride up on the tool and break the edge. No really good work can be done unless the tool is accurately set to cut on the line of centres, especially if the work be of small size. In the latter case, which is that most frequently met with by the amateur, I have found that a rather greater clearance angle is better than the typical one of 3°. There is no such hard and fast line that a departure from this small angle can be considered wrong; and if it is always retained, the difficulty of accurately adjusting the height of tool will often be considerably increased. The accepted limit has been stated to be 3° and 6°. There are, however, other matters besides clearance and rubbing which have to be considered, which are dependent on the size of this angle. These will be understood presently.

Let us take one detail at a time. Fig. 1, A, represents a cylinder in section turning on its centre; B C is a tool by which it is to be turned. Its edge is a bad one, but let it stand for the present. Observe here that this edge is of 87°, because we have ground away the 3° of the right angle to get the clearance angle, by which the face of the tool is prevented from rubbing. Notice also that the edge is placed on the line of centres D D. Such a tool, thus placed, would cut brass, but is not sufficiently keen for iron. In Fig. 2 the tool is supposed to have advanced considerably. The cylinder upon which it is acting has become much smaller; but it will be seen that all the conditions are the same, the tool occupying the same position and retaining the same clearance. In Fig. 3 the same tool is applied above the line of centres D D; but now the end of it rubs against the work, and the higher it is placed the greater will this effect be. Now let the edge lie below the line D D, as in Fig. 4; it will not rub, but by-and-by the edge will be out of cut, and the smaller cylinder cannot be further reduced. There is another drawback to these faulty positions, but the easiest method of grasping details is to take one step at a time; and here I am only considering the position of the edge, and its effect upon the clearance angle. Of course the defects are here exaggerated; by placing the tool considerably above or below the line of centres; but the effect will be felt in any case, and we are trying to understand why one position or one angle is better than another. If we only had this clearance to consider, we might easily place the tool above centres, and then grind away to 6° to make it clear; but there would be no advantage gained by so doing, and it would materially affect the tool in another way.

The next consideration will be the cutting edge, and for the present I will speak of it as an "end on" tool—*i.e.*, it is to stand square to the work, so that it can be traversed in either direction with equal effect. Fig. 5 represents the tool in profile, which has been already used in illustration of the clearance angle; and, as I stated, it is a very blunt and, for iron, a very bad tool. To give it a greater clearance angle will not sharpen it: it will only weaken the edge, leaving it a mere scraping tool as before, because its upper face is at right angles to the work. It is this upper face, therefore, that we must attack, and we can file out the shaded part of Fig. 5, so as to get a sharp edge of 60°, more or less. We now get an efficient tool like Fig. 6; but in actual use we should not place it quite end on, as its chisel-like edge is too wide, but should so place it as to free about half (or more) from cutting. The same sort of tool with a rounded edge (Fig. 7) is really a very common one, and very useful; but, instead of having to file out a portion, the tool is bent up and then ground.

Now, supposing this tool, when new and laid in its place on the table of the slide rest, to be exactly the correct height, with its edge on the line of centres: it is evident that as soon as it needs grinding its edge will be too low, and then the shank requires to be packed up with bits of hoop iron, unless, as in some American rests, means exist for raising the tool-holder. To pack it up to the *exact* height is by no means easy. It is also an awkward tool to grind, as its shank is in the way. Hence, to facilitate grinding, the cranked form, Fig. 8, has been adopted; but here again packing becomes necessary as the edge gets lower, and this is the case with all solid tools of this kind which have also to be constantly re-forged as the end gets worn down. In large establishments, where such tools prevail and a tool-maker is at hand to renew the supply, these drawbacks are not so much felt; but with an amateur the case is different; and even in the largest workshops the solid tools are being very generally displaced by cutter bars; the prejudices of workmen being the sole bar to their universal adoption. Before speaking, however, of this modern substitute for solid tools, one other matter needs consideration—namely, the traverse of the tool sideways parallel with the work on which it is engaged. Let Fig. 9 represent in plan a piece of work which has been turned as far as the shoulder *b b*, D is the tool, such a tool as Fig. 6 laid end on.

The depth of cut is, of course, much exaggerated; but the shaving has now to be cut away till A is obliterated—the tool traversing towards the left hand. Now, although we gave a sharp edge to the front of the tool, and also a suitable clearance angle, it is evident that great force alone could advance the tool sideways against the shoulder *b b*, and it is here that a mistake in grinding is so commonly made. In Fig. 9 the absurdity is plain, solely on account of the exaggerated depth of cut; but with Fig. 10, or still more, with a round-end tool, Fig. 11, where the depth of cut is not exaggerated, the same error existing is not perceived, and many a tyro wonders why a tool ground with ample front clearance works so heavily and so badly. The truth is that the sharp edge is needed with requisite clearance both in front and at one side—the side next to the shoulder, which, in ordinary practice, is mostly the left. This appears easy; but, curiously enough, it is not so, for if we give a 3′ clearance all round the end and side, and then grind the tool at a given slope to make an angle of 60° at the front or extreme end of that curved edge, it will be 60° nowhere else, but blunter as it gets towards the sides of the curve. A compromise has, therefore, to be made. The part which is to take the lead must be rather less than 60°, or a little sharper, and that will give a fair average sharpness to the whole of the edge engaged. The beveling ought, therefore, to be in the direction of the arrow in Fig. 12, making *a* the sharpest point, and this is always to be the leading part of the edge, so that this tool is to be advanced invariably from right to left. The end of the tool is, for this reason, sometimes bent towards the left, like Fig. 13, or it is put on the tool holder so as to have the end turned a little in that direction; but in one way or the other the left side, if it is to lead, is made the sharpest. We shall always recognise it as the "leading edge," and it will become, in another sense, the prominent one when we speak of double edges.

The only remaining point to be alluded to in this kind of tool is the gliding of a shaving over its upper face. It is not unimportant; but if other details are attended to, this face will allow such a gliding motion to take place without undue resistance, which would break the edge of the tool if thin, or need greater power to carry it forward. To take now the *résumé* of the several points already treated, and upon which depends the efficiency of the tool, they are:—

1. The clearance.
2. The height of the cutting-edge.
3. The sharpness of the front edge.
4. The sharpness and clearance of the side edge.
5. The escape of the shaving by sliding over the upper face of the tool.

These are the essential points to be studied and thoroughly grasped, after which the following details will be also easily understood.

Remarking upon what is technically known as side-rake, which includes the clearance as well as sharpness of the tool on the side which is to lead, it is plain that we might consider this part, which is engaged in cutting the shaving from the shoulder, as a distinct edge, and the front one as a second. One would be the *leading edge*, to cut down the shoulder; the other would be the *following edge*, to cut the shaving from the cylindrical surface of the bar; and this surface would be good or bad according as the following edge did its work well or the contrary. In a round-edged tool the point at which the two edges meet would be indefinite; but we can just as easily grind them to meet at a given angle—as, for instance, in the tool numbered 14. This, which is the ordinary diamond-pointed cranked tool, is commonly used as, and also called, a straightforward tool, and is ground so as to give to each edge the same degree of acuteness. It does well enough for the purpose of roughing down a shaft, but it is plain that its real action is to cut a spiral channel or to trace a screwthread, fine or coarse, according to the rate of feed, and the result will not be a smooth surface, but one with a fine spiral line upon it, needing a flat-edged tool or the application of a file to finish it. Now instead of making and using the tool in this way, there is no reason why it should not be placed, so that the second or following edge shall at once leave a finished surface, needing no further application of any kind. (See Fig. 15.) The second edge, lying parallel to the cylinder, and acting as the chisel does on a cylinder of soft wood, will cut away the roughness left by the leading edge. But just as the soft-wood chisel is not placed *quite* parallel, to prevent a hitch, in, so neither is the following edge here to be so placed, but the right-hand corner of it must stand back a little. Here, again, the leading edge should be rather sharper than the following or finishing edge, as it has the most work to do; and, if it is keen, it will even tend to draw itself into cut, instead of requiring, as it otherwise would, to be hard driven by the slide rest. But here, again, moderation is needed, as it will, if too keen, draw in, hitch, and break. The extreme point at which the two edges meet may readily be conceived to be a drawback, rather than otherwise, to the tool; and so it is. The best way is to round it off slightly, as it generally gets broken. But it is well also to make this angle quite a large one—more than a right angle. Unless the tool is to work into a corner, it may be 120° or even more. The point will then be so much less acute that it will stand ordinary work without much risk of breakage. Even then, it should be rounded off on the oilstone.

This is the principle of double-edged tools which some think such a mystery; and even a round-edge tool is one in reality; but the meeting of the two edges is indefinite. It is, nevertheless, plain that as the shaving is cut from the shoulder as well as from the cylindrical surface—*i.e.*, in two directions, two edges are in reality engaged.

I have already remarked upon the necessity of packing up a tool each time it is ground, and also of repeatedly sending it to the forge; which last soon deteriorates the steel, and is seldom within the capacity of the turner himself, whether he be amateur or professional. Hence has arisen the cutter-bar—that is, a holder for short bars of steel—upon which last the cutting edges are formed by grinding alone, no forging being required. The bar forms the shank of the tool, and lies on the tool-plate of the rest; while the cutter itself, as it can be raised or lowered at pleasure, can be set to the exact height of centres with the utmost facility. This latter point alone should place the cutter bar in the foremost rank of lathe tools, as this accurate adjustment is hardly possible if the only means of attaining it are packing bars of hoop iron. Many designs of such cutter bars have been successively submitted to the test of practical use, and it is hard to determine which bears the palm. Some are for steel of round section, some for square bar, some for other less usual forms. With the exception of that now known as Haydon's, either the front or clearance angle is a fixed quantity, or the cutting angle. In the Smith and Coventry bar it is the first; in that used by Tangye and Co., it is the latter. In the Haydon bar, where, instead of one, there are three faces to be ground, all angles are variable at pleasure. At first sight it would naturally appear to any workman more desirable to have a cutter bar in which only one face of the tool needed to be ground, and hence the favour shown to that of Messrs. Smith and Coventry, in which the tool is a bit of steel of circular section, held so as to give at once the requisite clearance. The upper end of the round steel bar forming the cutter is ground off at any desirable angle, according to the nature of the metal upon which it is to be employed, and all is at once ready for work. The faults of such a tool have, however, been already pointed out—viz., the different degrees of acuteness of the elliptic cutting edge. The tool is otherwise one of great simplicity, and was, I believe, the first to be recognised as a practical workman's tool fit for the rough-and-tumble of a workshop. As a roughing-down tool there is very little, in fact, to be said against it; but Haydon's bar will do the same work better, and with less strain upon the machinery, and will leave the surface turned in a far more finished condition.

(*To be continued.*)

## THE INTERNATIONAL INVENTIONS EXHIBITION.—II.

### Naval Architecture.

AMONGST the groups which may be considered to be in tolerably complete order at the Inventions Exhibition is that entitled Naval Architecture, which is situated in the Queen's Gate annexe, and embraces ship and boat building, ships' fittings, and marine propulsion (including steering). The exhibits are rather mixed, it must be confessed, for while marine engines and nautical instruments are properly relegated to their more appropriate groups, there are several stands admitted here which in reality belong to other groups. The most notable exhibit is that of Sir W. Armstrong and Co., displaying a splendid collection of models and half-models of the specimens of naval architecture completed by this firm within recent years. Here one can see a full model of the Chilian cruiser *Esmeralda*, about which so much has been said in Parliament and elsewhere; models of the Austrian torpedo cruisers now building, which have twin screws, a ram, and a torpedo firing tube at the bow; models of the new Japanese protected cruisers, with bow and stern chasers, dumpy masts with tops for firing machine guns, and a speed of 18 knots. Besides these, there are many models of other war-ships, built for foreign nations, of the cable ships, like the *Faraday*, and what will interest Londoners especially, of new paddle steamers building for the River Thames Steamboat Company, and intended for employment between Battersea and Greenwich. These vessels are a decided improvement on anything yet seen on the river for passenger traffic between the points mentioned, for they are fast and commodious, with light and airy cabins, while they are practically unsinkable, as they are divided into compartments by water-tight bulkheads. Feathering paddle-wheels are to be used in these steamboats, and the passenger decks are carried well up, thus obtaining the greatest advantage for fine-weather traffic, and more comfortable saloons or cabins in the event of wet weather. Two exhibits which illustrate in a remarkable manner the great advances made in naval architecture are those of the Thames Ironworks and Shipbuilding Co., and of the Messrs. Laird. The former presents us with a full model and section of the *Warrior*, the first ironclad built in this country, and a fully equipped model of the *Benbow*, one of the Admiral class of line-of-battle ships which has recently been the subject of much discussion. We gave an illustration of one of these ships on p. 557, Vol. XXXIV.; but the *Benbow* has 10,000 tons measurement, with 9,000 indicated horse-power, and is estimated to steam at 16 knots. She has 18in. and 14in. armour, steel-faced, and carries two 110-ton guns, ten 6in. breech-loaders, twelve 6in. quick-firing guns, ten 4-barrel 1in. machine guns, and four 5-barrel ·45in. guns. The Messrs. Laird exhibit models showing the progress made in steamships during the last half-century, and notable amongst them is the new mail steamer *Ireland*, for the Holyhead and Kingstown mail service. This paddle steamer has 6,000 indicated horse-power with forced draught, and an estimated speed of 20 knots. She is 380ft. long over all, with a breadth of 38ft. and a depth of 19ft. 3in., and compared with the *St. Columba* of 1840 and the *Ulster* and sister vessels of 1860 well exemplifies the enormous strides which have been taken in recent years. The White Star Line show a model of the famous, and, perhaps, most successful (from all points of view) Atlantic steamer *Britannic*, a vessel which for many years has maintained a high speed with commendable regularity in her voyages. The exhibit of the Lords Commissioners of the Admiralty is a very poor affair, and is redeemed only by the fact that some full-sized sectional models of the armoured sides of a few of our most celebrated ironclads are included, showing the proportionate thicknesses of steel, iron, wood backing, and inner skin. Amongst the novelties may be noted the model of a sea-going torpedo boat, by T. Williams, 11, Queen Victoria-street, E.C., which is armed with two Nordenfeldt guns in shell-proof turrets and shields, two Hotchkiss machine guns, and provided with two tubes for discharging torpedoes. It is asserted that a vessel built to this design will steam for 1,600 miles at 12 miles an hour without coaling, although the total displacement is only 70 tons. The engines are calculated to develop 850 indicated horse-power, and the estimated maximum speed is 27 miles. Turning from the war ships we find a good display of boats of all kinds, including a specimen of the Nile boat used in the Soudan expedition, exhibited by Watkins and Co., of Blackwall. Amongst steam launches that shown by Simpson and Denisons, of Dartmouth, will attract attention from the compactness of the machinery, as it is fitted with one of Kingdon's compound engines, in which one valve supplies both cylinders. The space occupied on the floor is thus only that required by the large cylinder and valve-chest. The high-pressure piston-rod has a number of annular grooves, and the course of the steam is so arranged that a high-pressure gland is dispensed with. The Messrs. Yarrow show a model of the shallow-draught stern-wheel steamers used in the Nile expedition; and Pothonier and Co. show a model of a 1,000-ton steamer, specially designed for light draught, such as the steam colliers which now bring coals from Newcastle to Vauxhall. There are a variety of new inventions, more or less promising, connected with naval architecture, and the usual exhibits of boat-lowering and detaching apparatus, in connection with which may be noted the patent davits of Barry, Rees, and Co., of the Royal Naval College, Greenwich, which enable a boat to be swung outboard from the chocks with great facility. That is accomplished by semi-circular arms pivoted to the fixed davits, and worked by tackle. Capt. Heathorn shows his water-brakes and rudder propellers in working model, and Lieut.-Col. Hime a method of propulsion based on the swimming motions of flat fish. Four hinged plates worked by piston-rods descending through the hull present a series of changing inclined planes to the water, and when worked, give the idea of wave motion. There are other schemes of propulsion exhibited, all of which, however, would receive more attention if their capabilities had been demonstrated by practical trial. Apparatus for saving life at sea is exhibited in considerable variety, including the now well-known Copeman deck seats and tank rafts, models of lifeboats from the National Lifeboat Institution, and others; floating mattresses and other fittings designed to save life by enabling the possessors to keep at least their heads out of water. In this connection we may mention Hohnes's inextinguishable lifebuoy lights, which flare up when thrown into the water, and burn for about half an hour. Amongst minor inventions those exhibited by Mr. Balch, of Greenwich, deserve attention. He shows an electric sounder, which rings a bell in the captain's cabin the moment the lead drags on the bottom, the contact being made by the inclination of the head; a time-glass in a case coated with luminous paint, of use when heaving the log; and a breech-loading pistol or hand-gun for firing either signal or distress rockets. Mr. Boaz, of West India Dock-road, exhibits his tube stoppers, which have deservedly earned a high repute, as by a simple arrangement for expanding rubber discs, protected by copper shields, a tube can be stopped in two minutes without drawing the fires. He also shows a tube scraper and cleaner, consisting of two semicircular steel plates connected together in opposite positions at a little distance apart by webs which permit the passage of the refuse, and also act as guides to facilitate the return of the scraper when passed through the further end of the tube. By this arrangement the mere weight of the rod keeps the under-scraper down to its work, and forces the half disc on the upper side in contact with the top of the tube. An exhibition of this kind would scarcely be complete without specimens of anti-fouling compositions for coating the submerged parts of vessels, and Messrs. Kirkaldy, of West India Dock-road, add to the interest of their exhibit by showing a large collection of barnacles and other marine growths taken from the bottoms of iron vessels. Messrs. Suter, Hartman and Co., of Billiter-street, exhibit in connection with Rahtjen's composition some curious specimens of barnacles—one taken from a vessel sheathed with copper, and a piece of zinc sheathing showing the wear of the paint. This composition is used by the P. and O. Company, and has been applied to several of the best-known Atlantic liners. A working model of Baxter's anchor gear, with vertical windlass, which has been ordered for many of the new ironclads, deserves attention, as it dispenses with catheads and fish davits, and the anchors can be housed and stowed in about half the time necessary with the old appliances. Several good methods of stowing rowlocks are shown. In Robertson's the rowlock is carried with a stout stem in a fitting screwed to the gunwale, which has a vertical slot inboard. To stow, all that is necessary is to lift the rowlock up vertically until the thin part of the stem enters the slot, when it can be easily turned inboard. It is exhibited by Nunn and Co., St. George-street, E. In the device exhibited by Capt. Morris, of Lowestoft, the rowlock turns on a spindle and is kept in place by a simple plate catching into slots in the seating. He also exhibits sliding tholes, which are made to slip up and down in a casting, and cannot be lost, while they are out of the way when not required. Mr. Woosnam of Southend, also shows a stowaway rowlock, which is simply buried in the gunwale by lifting a plate behind it and turning it down sideways into the chamber provided. There are some curious exhibits which we cannot attempt to describe, as they are shown only in model form, including a water cycle, and a machine with buoyant wheels, which can be steered either on water or land; spiral screw propellers, the continuous or endless serpentine blade, and sundry supposed improvements in rudders. Steering gear is shown by one or two firms, and Messrs. Jessop and Co., of Sheffield, exhibit some splendid specimens of crucible cast steel in the shape of portions of vessels; Hall and Verity's patent flexible propeller shaft, and Turton's patent built-up crank shaft, showing the method of connecting the pieces and holding them together. If this group is a comparatively small portion of the Exhibition, it contains much to interest the general public, while those specially acquainted with the subject will find enough to occupy their attention for several hours.

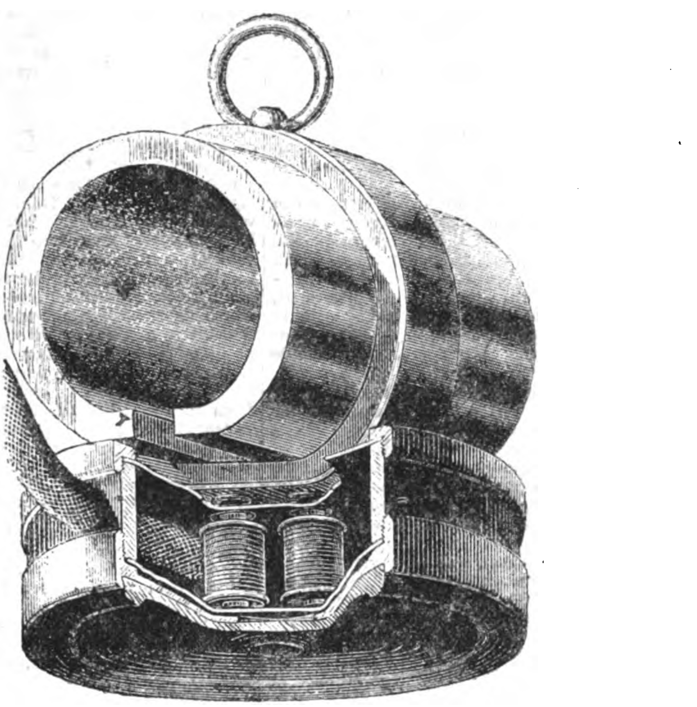
## INJURIOUS INSECTS AND COMMON FARM PESTS.

THE eighth report of Observations on Injurious Insects, by Miss Eleanor A. Ormerod, the hon. consulting entomologist of the Royal Agricultural Society, is a work which should be in the study of all practical agriculturists, and might with advantage be used as a lecture book in village schools. The annual loss from the depredations of injurious insects has long been known to many individuals, and if the assertion had been made they would probably have agreed that the aggregate loss, judging by their own, must have amounted to many thousands of pounds. Thanks, however, to the reports issued by Miss Ormerod, the fact is gradually being appreciated that the national loss from the work of insects and parasites is to be estimated by millions. The hop failure of 1882 alone involved an estimated loss of one million and three-quarters, while the turnip fly in 1881 did damage to the extent of over half a million. It may be contended that it is next to impossible to avoid occasional losses such as these; but the more intelligent amongst the agriculturists are beginning to understand that while they can do much personally, now that they know their enemies in their various shapes, a very great deal more might be done by combined action, and for that reason it may be hoped the report for 1884 will have a wide and far reaching sale. (It is published by Simpkin and Marshall, and can be had through all booksellers for 1s. 6d.) Already the correspondence has assumed such dimensions that Miss Ormerod has been obliged to make special arrangements in order that she may be able to attend to all inquiries, and to communicate with those who will make experiments and report results. The very first page of the "Observations" shows what can be done when the characteristics and life histories of the insects are known, for on it is depicted a male and female Winter Moth (*Cheimatobia brumata*), the caterpillars of which work so much havoc amongst fruit trees, especially the apple. The female has abortive wings only, and, being unable to fly, comes out at night and crawls up the trees, on the twigs of which she glues her eggs. It is obvious, then, that if some means of catching the female insect could be devised, that individual would, at least, be prevented from depositing eggs, and equally clear that by combined action the destructive Winter Moth might be stamped out of existence. One of Miss Ormerod's correspondents smeared the trunks of a number of apple trees, the blossom and leaves of which had been almost completely destroyed in previous years, and in a short time he had captured upwards of 500 females, and in the following summer was enabled to report that the trees were practically free from the "loopers," or caterpillars. Unfortunately it is not every insect that can be dealt with in so easy a manner; but there are many which can be almost stamped out by united action, and by repeated observations and experiments it is possible to learn how, at least, to fight them with some measure of success. As regards the wireworm, it has been recommended to leave infested acres fallow, ploughing frequently during dry weather, so as to prevent the growth of a single weed which will afford sustenance to the leather-jackets; but few can afford to do this. One of Miss Ormerod's correspondents made an unintentional experiment, which shows the benefit of late ploughing—that is, ploughing so late in the season that the wireworms are near the surface, and are consequently picked up by the birds. Wireworms go deeper and deeper as frost increases, and therefore the plough, when put into the ground as soon as the frost is out, brings none of them to the surface. Another correspondent has proved that Indian rape cake, so far from destroying wireworms, appears to prolong their destructive lifetime—the larval stage. With regard to the hop aphis, Miss Ormerod tells us that there does not appear to be any reason to doubt that the hop and the damson-hop aphis are merely slight varieties of one species; but if no very efficient destructive has been found, good results have followed the application of paraffin oil in any dry material by way of a dressing, and soft soap and mineral oil as a washing. Two useful notes refer to the Liver Fluke and the Warble Fly, or bot-fly of the ox. The marsh snails are believed to play the part of "host" to the Liver Fluke, and three figures of them are given, which will aid in their destruction; but more information is asked for on this point. The Warble Fly is unquestionably a source of great loss to the breeder of cattle and the dairy farmer, for the maggots bore into the skin of the beast and produce irritating sores, with a consequent loss of flesh and milk in summer, and a considerable depreciation in the value of the hide. A little table shows in a very direct manner the loss on warbled hides, for it appears that in seven weeks' supply to a firm of Birmingham factors out of 5,185 hides over one-third were warbled—the depreciation in value totalling up to £545. It is demonstrable that the maggot can be killed by any one of a number of simple remedies, but the common mercurial ointment will be found as effectual as anything, and need not cost more than twopence per head for all the cattle in the country. Tar or acetic acid is equally efficient. It is obvious that a little concerted action in the way of a combined attack on the pest for one year only would materially reduce the number of bot-flies; but it is equally obvious that a knowledge of the life-history of the insect should be widely spread before that concerted action can be brought about. For that purpose the "reports" of Miss Ormerod have a value which is not readily gauged; but it is certain that if every farmer and agriculturist would study the facts she places before her readers, and act upon the information given in the works she has already published, there would soon be an appreciable diminution in the numbers of many injurious insects, and, as we have pointed out above, the total extermination of some is within the limits of probability. It may be mentioned here that coloured diagrams of insects injurious to farm crops, prepared by Miss Ormerod for the Royal Agricultural Society, and suitable for use in elementary schools, can be had of the secretary, Hanover-square, W., at a cheap rate, and it would be of immense advantage if a set could be placed in every village school, and the teachers be induced to explain the life-histories of, and the importance of destroying, these noxious insects.

## LIQUID FUEL.

A PAPER on this subject, especially as concerns the application of liquid fuel to marine purposes, was read last Friday by Admiral Selwyn, at the United Service Institution. After reminding the older members of the institution that 20 years ago he drew attention to the enormous value of liquid fuel for the Royal and mercantile marine, Admiral Selwyn said that he had the mortification of seeing the subject, which was neglected by this country, taken up by other nations, especially by Russia. He stated that by the use of liquid fuel a vessel could carry twice as much power of propulsion as a vessel with coal; and he commented on the disadvantages which would arise to British vessels in having to meet opponents which could use double powers in escaping without the aid of resorting to a fuel station. He related the results of experiments, and proceeded to state that his object was to enforce a greater economy of fuel, which could be effected without any of that large expenditure often a necessary concomitant of radical changes. To burn liquid fuel instead of coal required no change in engines or boilers, and only such adaptation of the furnaces as could be readily carried out in each ship by her own artificers and engineers. At the same time, it removed the necessity for a whole army of stokers and coal trimmers. It enabled a ship to receive her fuel with the greatest facility at sea or in harbour, while proceeding under steam or even sail, was without nuisances of dust or ashes, and was not liable either to spontaneous combustion or deterioration by time, heat, or moisture. If the ship got on shore it could be run out to lighten her, or pumped out into lighters with a speed and facility unapproachable with coal; and, lastly, if, as he believed, 46lb. of water could be evaporated with 1lb. of fuel, full steaming for 24 days could be carried on where now it was limited to four. Thus each ship would be six times as effective as now. He declared that it was inconceivable how a nation like the British should have allowed this matter to remain dormant till another Power took it up, and he asked if it required a Caucasian to awaken this nation. In conclusion, he pointed out that the annual vote for the Navy amounted to about 18 millions, of which six millions would be devoted to the ships and their crews. If each ship was made twice as efficient—that was to say, could remain on her station twice as long as before by reason of a change in her fuel which gave her that power, this might be considered as affecting the value of the whole fleet to the extent of 12 millions per annum.

At a recent meeting of King's College Engineering Society a paper was read by Mr. Smith "On the Use of Petroleum as a Fuel." Petroleum, though found all over the world, has as yet only been successfully worked in America and Russia. Last year the output of crude oil from American wells was computed at 3,000,000 tons, ranging in price from 16s. to 32s. per ton, as against 1,130,000 tons from Baku, where it was worth from 3½d. to 2s. 6d. per ton. The Pennsylvanian oil seems to be found in strata always older than the carboniferous; while that in the Aspheron peninsula soaks tertiary sandstone, both, however being associated with metamorphism. The original source of the oil, however, is still unknown. Its use as a fuel in this country dates some twenty-three years back—a series of experiments both by private persons and at Woolwich, together with similar tests in America and France, giving most promising results, but with the effect that the price of crude oil was raised to a prohibitive figure. All this work had been done with crude oil, and it was only when it was found that the distillation, first of the lighter benzene products, then the illuminating oil, kerosine, and, finally, the separation of a valuable lubricating oil, left nearly 50 per cent. of refuse still valuable as fuel, and fuel only, that petroleum had its chance. According to the latest research Baku oil differs from American, not only in yielding some 60 per cent. of refuse instead of 15 per cent., but chemically, in that while the former is rich in paraffin, which renders it useless for liquid fuel, the latter has not yet been found to contain more than ¼ per cent. Russian petroleum refuse is a black-brown liquid of high viscosity, having an average specific gravity close upon 0·9, and an average theoretical evaporative power, from and at 202deg., of 21. The history of its use as a fuel during the last fifteen years shows that the oil was sprayed into the combustion chamber, first by an air jet in the easy burners of Bridges-Adams and Richardson, and then waste steam was added to the spray. Steam injection alone soon followed in the burners of Lentz, Karapetoff, and Hoffman, while a hollow flame supplied by a separate air injector with the oxygen necessary for the perfect combustion is the latest development, as in the burner of Anderson. The early experiments with boilers and fire-boxes designed for the comparatively moderate heat of coal soon showed by cracked plates and broken tubes the need of a fire-brick lining, and its important use as a store for heat was recognised later. First, a brick hearth, then a brick box, and



finally, in marine boilers, a complete flue lining was the result. Siemens has lately found that this lining may be broken into rings. Nobel, both for metallurgical and boiler firing, has used a trough burner, in which the oil is consumed direct without being pulverised. Experiments last year by Mr. Urquhart on the Grasi-Tsairtsyn Railway, show in locomotive practice, and the Caspian oil fleet in marine practice, its economic advantages. In England, where the crude oil exceeds £5 per ton, we must await the completion of the proposed 560 miles of pipe from Baku to Batoum on the Black Sea before refuse can be obtained.

## THE OCHOROWICZ LOUD-SPEAKING TELEPHONE.

THE following description and figure of the Ochorowicz telephone is extracted from *La Nature*. The problem of transmitting speech to a distance with sufficient intensity to be heard throughout, say, a large apartment has already been partially solved by Mr. Gower, and by Mr. Edison in his electro-motograph. Dr. J. Ochorowicz has recently presented a still completer and more perfect solution to the International Society of Electricians and the French Society of Physics. In the construction of his apparatus the inventor had especially in view the application of it to the auditorium of theatres, for which, in fact, it appears to be well adapted. The system, as a whole, includes a transmitter of variable resistance, the special arrangement of which Dr. Ochorowicz keeps secret; and of a magnetic telephone receiver, whose principal features are shown in the annexed engraving. This receiver, which is identical with Bell's, since it contains the three essential parts of that instrument (magnet, bobbin, and vibrating disc), differs from it, however, by important modifications of form, to which it owes its remarkable power. The magnet consists of a hollow steel cylinder, containing a longitudinal slit about a fifth of an inch in width. To the centre of this are fixed two small soft iron cores, upon which are placed two bobbins which are traversed by the undulatory current modulated by the transmitter. These two bobbins are inclosed in a sort of elastic metallic box, formed of two thin sheet-iron discs held parallel by their external edges upon a cylinder. The lower plate, which is firmly affixed to the magnet, contains two apertures, which allow the iron covers to pass freely. The magnetisation of these cores keeps the box thus formed in a state of tension, and the two ends of sheet iron slightly depressed and attracted toward each other. The effect of the variations in the undulatory current which is traversing the bobbins is to increase or diminish the magnetization of the cores, or, we might say, to cause the flow of force to vary. The box becomes compressed or dilated under the action of such variations, and vibrates in its entirety. Thus is explained the power of a receiver which, connected with Dr. Ochorowicz's special transmitter, has permitted speech, song, and music to be heard throughout the entire hall of the Geographical Society—a room capable of holding as many as 500 persons. The telephone receiver is capable of operating as a transmitter. Speech is, in this case, transmitted with less power, but it has still enough intensity to be easily and very distinctly heard at a yard or two from the receiving apparatus. In the microphone transmitter employed by Dr. Ochorowicz, heat appears to play a certain role, if we are to judge by the fact that all the experiments repeated before the International Society of Electricians, Feb. 4, succeeded except the last. Dr. Ochorowicz attributes this result to the fact that it is necessary for the microphone to be warm in order to be regulated. As soon as it ceases to be so, the regulation is destroyed, and is not effected again until a new heating occurs. Since, in the experiments mentioned, Leclanché piles were used, these became polarised after a certain time, and allowed the receiver to get cool. Such an inconvenience is remedied by the use of Daniell and Lalande and Chaperon piles, or of accumulators. It must be also noted that in Dr. Ochorowicz's system transmitting is done directly without the intermedium of an induction coil acting as a transformer.

## SNAP SHOTS IN PHOTOGRAPHY.

PHOTOGRAPHERS are indebted to a committee of the New York Amateur Photographers Society for the following table, which gives the conditions under which a reasonable degree of sharpness can be insured without focussing:—

To those who are using detective cameras, or taking "snap" shots, the following table will be of use, showing the number of feet beyond which everything is in focus when the equivalent focus of the lens and the relative diameter of the stop are known.

| Equiv. Focus equals | Stop. $\frac{f}{5}$ | Stop. $\frac{f}{10}$ | $\frac{f}{15}$ | $\frac{f}{20}$ | $\frac{f}{25}$ | $\frac{f}{30}$ | $\frac{f}{40}$ | $\frac{f}{50}$ | $\frac{f}{60}$ |
|---|---|---|---|---|---|---|---|---|---|
| 2in. | 7 | 3½ | 2¼ | 2 | 1⅓ | 1¼ | 1 | ⅞ | ¾ |
| 2½ | 10½ | 5½ | 3½ | 3 | 2⅓ | 2 | 1½ | 1¼ | 1 |
| 3 | 15 | 8 | 5 | 4 | 3½ | 3 | 2 | 1¾ | 1½ |
| 4 | 27 | 14 | 9 | 7 | 5½ | 5 | 3¾ | 3 | 2½ |
| 5 | 46 | 21 | 14 | 11 | 9 | 7½ | .6 | 4¾ | 4 |
| 6 | 60 | 30 | 20 | 15½ | 12½ | 10½ | 8 | 6½ | 5½ |
| 7 | 82 | 42 | 27 | 21 | 17 | 14 | 10¾ | 9 | 7½ |
| 8 | 107 | 54 | 36 | 27 | 22 | 19 | 14 | 11 | 10 |
| 9 | 137 | 68 | 45 | 34 | 28 | 23 | 18 | 14 | 12 |
| 10 | 167 | 84 | 56 | 42 | 34 | 30 | 21 | 18 | 15 |
| 11 | 202 | 101 | 67 | 51 | 41 | 37 | 26 | 21 | 18 |
| 12 | 241 | 121 | 80 | 61 | 49 | 41 | 31 | 25 | 21 |
| 13 | 283 | 142 | 94 | 71 | 57 | 48 | 37 | 30 | 25 |
| 14 | 328 | 164 | 109 | 83 | 66 | 56 | 42 | 34 | 29 |
| 15 | 376 | 189 | 125 | 95 | 76 | 64 | 48 | 39 | 33 |

As no two makers number their stops alike, and some do not number them at all, it is desirable to designate their stops in terms of the focal length of the lens. As an example of how misleading the information is obtained by giving the number of the stop, we would refer to the Dallmeyer lenses: Stop No. 3 in lens 1A is equal to $\frac{f}{32}$; stop No. 3 in lens 3D is equal to $\frac{f}{128}$. Here are stops of the same number, in lenses by the same maker, and yet one requires eight times the exposure of the other. We are confident that the small amount of trouble caused by designating our stops in terms of $f$ will be amply repaid by the aid it will give us in obtaining correct exposures.

## LIGHT AND COLOUR.

ON Tuesday, the 5th inst., Mr. C. V. Boys gave a lecture at the Royal Victoria Hall, Waterloo-road, on "Light and Colour." Colour was shown to be a property, not of coloured bodies, but of the light by which we see them. This was proved by a row of papers, coloured when seen by magnesium light, but black or grey by the light of the sodium flame. Various dyes, indistinguishable from each other, or from ink, by this yellow light, were used for painting on a screen. On the gas being turned up, bright colours became visible. The next step was to produce a spectrum, by bending aside a beam of white light by a prism. To show that this was not due to colouring matter in the prism, white light was reproduced by bending the beam back to its original direction with a second prism. The effect of red glass in stopping green rays, and of green glass in stopping red rays was shown, darkness being caused by sending the beam through both glasses. The action of the colours used in painting is like this. They reflect to the eye coloured light, because they have robbed the white light which fell on them of one of its constituents. Thus we get black by mixing paints of all colours together. When, however, we mixed coloured lights instead of paints, in such a way that one light is added to another, without anything being subtracted, we get white. This was done by rotating a disc with coloured sectors, so that before one colour had time to fade from a given part of the retina, another colour was presented to it. The result was that the disc appeared white. Mr. Boys ended by showing the effect on coloured objects of various brilliant monochromatic lights.

## ISOCHROMATIC PHOTOGRAPHY.*

By Fred. E. Ives.

IT is well known that the ordinary photographic processes do not reproduce colours in the true proportion of their brightness. Violet and blue photograph too light; green, yellow, orange, and red, too dark. For a long time it was believed to be impossible to remedy this defect; and even when it became known that bromide of silver could be made more sensitive to yellow and red by staining it with certain dyes, the subject received very little attention, because it was also known that the increase of sensitiveness was too slight to be of practical value in commercial photography. Dr. H. W. Vogel, who was one of the first, though not the first, to devote attention to this subject, announced, in 1873, that he had succeeded in making a yellow object photograph lighter than a blue or violet one, by using a silver-bromide plate stained with coraline, and exposed through a yellow glass. The plate showed no increased sensitiveness to red, and the experiment, though of considerable scientific interest, did not indicate a practically useful process.

In the spring of 1878 I became interested in this subject, and tried to discover a method of producing plates which should be sensitive to all colours, and capable of reproducing them in the true proportion of their brightness. I commenced by trying nearly all the colour sensitisers which had already been suggested, in order to learn which was the best, and then, if possible, why it was the best, as a guide to further research. Chlorophyl was the only thing I tried which was sufficiently sensitive to red to offer any encouragement in that direction; but the solution which I obtained was weak and unstable, and far from being a satisfactory colour sensitiser. Hoping to obtain a better solution with which to continue my experiments, I made extracts from many kinds of leaves, and found that a solution from blue myrtle leaves looked better and kept better than any other, and when it was applied to the silver-bromide plates they became remarkably sensitive, not only to all shades of red, but also to orange, yellow, and green. By placing in front of the lens a colour-screen consisting of a small glass tank containing a weak solution of bichromate of potash, to cut off part of the blue and violet light, I obtained, with these chlorophyl plates, the first photographs in which all colours were reproduced in the true proportions of their brightness. But my chief desire at that time was to realise a method of producing from any object in colours a set of three negatives, in one of which the shadows should represent the blue of the original, in another the yellow, and in another the red, in such a manner that transparent pigment prints from these negatives—blue, yellow, and red—would, when superimposed on a white surface, represent not only the lights and shadows, but also the colours of the object. This had already been attempted by others, who failed because their plates were not sufficiently sensitive to red and yellow. Having succeeded perfectly in my undertakings, I published my discovery in 1879, explaining how to prepare and use the chlorophyl plates, in connection with the yellow screen, for the purpose of securing correct photographs of coloured objects. So far as I know, nobody tried the process. Nearly five years later Dr. Vogel announced that, after eleven years of investigation, he had at last realised a successful process of this character, and that this new process of his was the "solution of a problem that had long been encompassed with difficulty." This publication attracted a great deal of attention, and gave me occasion to again call attention to my process, and point out that it was not only the first practical solution of this problem, but the only truly isochromatic process ever discovered. Dr. Vogel's new process was not only no better in any respect, but the plates were insensitive to scarlet and ruby-red, and, therefore, would not photograph all colours in the true proportion of their brightness.

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* A paper read at a meeting of the Franklin Institute.

My method consists in treating ordinary collodio-bromide emulsion plates with blue-myrtle chlorophyl solution, exposing them through the yellow screen, and then developing them in the usual manner. The emulsion which I have employed is made with an excess of nitrate of silver, which is afterwards neutralised by the addition of chloride of cobalt; it is known as Newton's emulsion. I now prepare the chlorophyl from fresh blue-myrtle leaves, by cutting them up fine, covering with pure alcohol, and heating moderately hot; the leaves are left in the solution, and some zinc powder is added, which helps to keep the chlorophyl from spoiling. I have a bottle of this solution which was prepared about six months ago, and now appears to be as good as when first made.* A glass plate is flowed with the emulsion, and as soon as it has set the chlorophyl solution is applied for a few seconds, after which the plate is washed in pure water until smooth, when it is ready for exposure. My colour-screen consists of a small plate-glass tank, having a space of $\frac{3}{16}$ of an inch between the glass, filled with a solution of bichromate of potash about one grain strong. I place the tank in front of the lens, in contact with the lens-mount. The advantage of this tank and solution is that it can be more easily obtained than yellow plate glass, and the colour can be adjusted to meet any requirement. The plates require about three times as much exposure through the yellow screen as without it, and may be developed with the ordinary alkaline pyro-developer. In order to illustrate the value of this process, I made two photographs of a highly-coloured chromo-lithograph, representing a lady with a bright scarlet hat and purple feather, a yellow-brown cape and a dark-blue dress. One, by the ordinary process, represents the blue as lighter than the yellow-brown, the bright scarlet hat as black, and the purple feather as nearly white. The other, by the chlorophyl process, reproduces all colours in nearly the true proportion of their brightness, but with a slight exaggeration of contrast, produced purposely by using a too-strong colour solution in the small tank.

I also made two landscape photographs, one by the ordinary process, and the other by the chlorophyl process, exposing them simultaneously. In the ordinary photograph, distant hills are lost through over-exposure, yet the foreground seems under-exposed, and yellow straw stacks and bright autumn leaves appear black. In the chlorophyl photograph, the distant hills are not over-exposed, nor is the foreground under-exposed; the yellow straw-stacks appear nearly white, and bright autumn leaves contrast strongly with the dark green about them.

To test the relative colour-sensitiveness of plain emulsion plates, plates stained with eosine, and plates stained with the blue-myrtle chlorophyl, I exposed one of each kind through the same yellow screen, giving each five minutes exposure, on the same piece of copy, which was the chromo-lithograph already described. The plain emulsion plate showed only the high lights of the picture, after prolonged development. The eosine plate was under-exposed, but brought up everything fairly well except the scarlet hat, which came up like black. The chlorophyl plate was over-exposed, brought out all colours better than the eosine plate, and gave full value to the bright scarlet of the hat, the detail in which was beautifully rendered.

Dr. Vogel advanced the theory that silver-bromide is insensitive to yellow and red, because it reflects or transmits those colours; and that it becomes sensitive when stained, because of the optical properties of the dyes. He afterwards admitted that only such dyes as are capable of entering into chemical combination with the silver-bromide proved capable of increasing its sensitiveness to colour, but he held to the theory that the optical properties of the compound were the cause of its colour-sensitiveness.

I have shown that the colour-sensitiveness can be produced by treatment with an organic compound which has none of the optical properties characteristic of dyes; and that chlorophyl, which absorbs only red light, greatly increases the sensitiveness also to yellow and green. There is, therefore, good reason to doubt if the colour-sensitiveness is ever due to the optical properties of the dye or combination. Attempts have been made to produce isochromatic gelatine dry plates which, while many times more sensitive to white light than my chlorophyl plates, shall also show the same relative colour-sensitiveness. Such plates would be very valuable but for one fact; it would be necessary to prepare and develop them in almost total darkness. Gelatine bromide dry plates extremely sensitive to yellow, but comparatively insensitive to red, might be used to advantage in portrait and instantaneous photography, because they could be safely prepared and developed in red light; but when truly isochromatic photographs are required, the time of exposure must be regulated to suit the degree of sensitiveness to red, which cannot safely be made greater than I have realised with my chlorophyl process.

## SCIENTIFIC SOCIETIES.

### ROYAL ASTRONOMICAL SOCIETY.

THE May meeting of the Society was held at their rooms, Burlington House, on the evening of Friday, the 8th inst., Edwin Dunkin, Esq., F.R.S., president, in the chair.

Prof. C. H. Brewitt Taylor, of Foo-Chou Arsenal, China, was balloted for and duly elected a Fellow of the Society.

A paper by Mr. R. A. Proctor was read, entitled "Five Orders of Meteor Streams or Comets." He referred to the importance of Mr. Denning's discovery that certain groups of meteors have stationary radiant points, which do not move amongst the stars as the earth passes round the sun. At first he doubted whether the discovery could be real, because the inference that necessarily followed was so startling—viz., that the motion of the earth in its orbit round the sun is as rest compared with the velocity of these meteors. Without assuming that the positions of the radiants can be determined with the precision claimed by Mr. Denning, it is certain that the meteors from the long-lasting radiants must travel at the rate of hundreds of miles per second. We must look for the source of these tremendous velocities to the bodies of the giant suns distributed in space. There are five sources from which the meteor swarms encountered by the earth may be supposed to spring: First, there are those which may be supposed to have sprung from the terrestrial planet when in a sunlike state; secondly, those springing from the giant planets when in a sunlike state; thirdly, those springing from our own sun; fourthly, those springing from suns of the same order as our own sun; and fifthly, those springing from giant suns of the first order.

Mr. Ranyard said: It is not necessary to suppose that the enormous velocities of the bodies coming from Mr. Denning's stationary radiants must be due to the velocity of projection. Matter thrown out from a star would have the proper motion of the star, as well as the velocity with which it is ejected, and the proper motions of some of the stars must be very large compared with any planetary motions; for instance, the star 1830 Groombridge, in the Great Bear, which has a proper motion of 7" per annum, has hardly any appreciable parallax. If we accept Mr. Denning's observations as proving that these radiants do not shift one degree in the heavens, it will be necessary to assume that the meteors from these stationary radiants encounter the earth's atmosphere with a velocity at least fifty times as great as the earth's orbital velocity.

Col. Tupman: We must all admire the fertility of Mr. Proctor's speculations; but it is quite certain that no such velocities are observed. The meteors from Mr. Denning's stationary radiants certainly do not move with a velocity anything like fifty times as great as the velocities of the meteors from the chief annual radiants which move approximately with parabolic velocities.

Mr. Ranyard: Has Col. Tupman any evidence with regard to the velocity of meteors from any one of Mr. Denning's fixed radiant points? No doubt there are many simultaneous observations made by observers in different places, of boloids and large meteors which have enabled their velocity within the atmosphere to be calculated, and from theoretical considerations the velocity of meteors belonging to the planetary swarms cannot differ very much from parabolic velocities. But these swift meteors from fixed radiants must be consumed very high in the atmosphere, and I do not know what evidence there is to show that they cannot have these enormous velocities.

Col. Tupman: There is a certain amount of evidence to be deduced from comparing the angular velocities of meteors from different radiants. If the meteors from two radiants have the same velocity, and were stopped at the same average height, the average angular velocity would be pretty much the same. There are certain radiants from which slow-moving meteors come, and others from which the motions are more rapid; but there is nothing like the difference that would correspond to a velocity fifty times as great in one case as compared with another. At 90° from the radiant the average angular velocity appears to be always about the same. If there were any with double or treble velocities, it would be noticed at once. At some little distance from the radiant the speed is usually not too great to permit of your following the meteor with your eye.

Mr. T. K. Mellor: I would suggest that it would depend very much on the part of the star from which matter was expelled, whether in the front or at the rear with respect to its proper motion, whether the meteor shot out would have the proper motion of the star, or the proper motion minus the velocity with which it was ejected.

Mr. Stone explained a paper on the Right Ascensions of the Cape Catalogues for 1850, 1860, and 1880. He said that Mr. Downing had instituted a careful comparison between the Cape Catalogue of 1880 and the Melbourne Catalogue of 1870. This comparison showed close agreement; but when comparisons were made between the Cape Catalogues of 1850 and 1860 and the Melbourne Catalogue, the differences of places due to the proper motions of the stars came in, and the comparison was not therefore trustworthy. The result of the comparison of the 1850 Catalogue with the 1880 showed that the Right Ascensions were one-tenth of a second too small, while the 1860 as compared with the 1880 gave them as too big. Taking out those stars which had a known proper motion, and making allowance for it, he had reduced the difference to five hundredths of a second in the one case, and three hundredths in the other.

Mr. Downing thought that the error in the comparisons due to proper motions might be neglected, for in comparing the 1850 and 1880 Catalogues, he had made use of the places of 3,368 stars, and with such a large number it must be supposed that the errors introduced by + proper motions would nearly correspond to those due to − proper motions.

Mr. Knobel read a paper by Mr. John Maguire on total solar eclipses visible in the British Isles from A.D. 878 to 1724. The paper enumerates all the eclipses in which the path of totality has touched the British Isles, and it contains tables showing the width of the shadow path. London has been twice visited by total eclipses during the period dealt with, first in 878 and again in 1715, Dublin twice, and Edinburgh five times. The Moon's shadow has fallen during the period named on every spot in the British Isles, except a small place on the coast of Ireland.

Col. Tupman read a paper by Mr. Denning on a peculiar variety of meteors observed on the morning of April 20. As Mr. Denning was watching the progress of the Lyrids he saw a remarkable meteor projected apparently on the stars ε and δ Lyræ; it rose upwards with great rapidity. It appeared about equal to a star of the third magnitude. Its chief peculiarity was its marvellous velocity. It appeared to be in the air only a few yards distant, and it must have travelled over 16° on the background of the sky in the twentieth part of a second.

The ordinary meeting then adjourned, and the meeting was made a special meeting, in accordance with the notice given to Fellows.

The Earl of Crawford, in moving the first resolution, said: The proposal which I have to bring forward has occupied the attention of certain members of the society for a number of years. It has been felt that those Fellows of the society who do not live in or near London are, to a certain extent, under disability in not being able to vote in electing the president and council of the society. It seems to me that the accident of their living at a distance from the metropolis should not disqualify them from taking a part in selecting the governing body of the society, whose action may have an important influence on the welfare of astronomy. I am in no way affected myself by this disability which lies on our country and foreign Fellows, for I usually manage to be present at our elections. I therefore feel that I am not actuated by any personal motive in proposing this alteration of the by-laws. I am only actuated by a desire for the benefit of the society, and a wish that our foreign Fellows, of whom we now have a great number, should take a greater interest in the affairs and action of the society. Great attention has been given to the wording of the resolutions; but I see that there is a printer's error in the first resolution, from which it might be supposed that a Fellow might hand in more than one list. It should run, "A list," not "lists," "handed to the scrutineers of the ballot on behalf of any Fellow not present at the meeting shall be accepted, if duly verified by the signature of the absent Fellow." It is proposed to add these words at the end of by-law 12.

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* I originally recommended chlorophyl extracted from dried leaves, because I had not learned how to preserve the solution for more than a few weeks, and at some seasons it would be difficult, if not impossible, to obtain fresh leaves. The tea organifier which I recommended is also a colour sensitizer, and when it is used in connection with the chlorophyl from dried leaves the plates are as sensitive to red as can be safely prepared and developed in the light of an ordinary photographic "dark-room." Plates prepared with chlorophyl from fresh leaves do not require treatment with the tea organifier to secure this degree of sensitiveness. Recently I have used the tea organifier and some other sensitisers, in connection with the solution from *fresh* myrtle leaves, and in this way have produced plates having such an exalted colour sensitiveness as to be unmanageable in ordinary "dark-room" light. Possibly, such plates might be prepared and developed in total darkness, by the aid of suitable mechanical contrivances; but I am not sure that they would work clear even then, because they appear to be sensitive to heat as well as to light.

Mr. Mattieu Williams seconded the motion.

Mr. Brett said: Lord Crawford has made one slight mistake. He has said that country members are disqualified from voting. They are not disqualified. They are only debarred by reason of their not taking the trouble to attend. When they entered the society they did so on the understanding that they would not be allowed to vote unless they were present at the meetings.

The President said: Before the discussion proceeds, I think it may be well for me to explain the action the council has taken in this matter. I think I may say that they are desirous that something to the effect of this motion should be passed to-night. At the same time they think that every precaution should be taken to prevent any irregularity in voting, and, therefore, that the lists should be forwarded by post in a closed envelope under cover of a letter signed by the Fellow, and addressed to the scrutineers of the ballot. It would not, in my opinion, be beneficial to the society that country Fellows should be allowed to send their lists to other Fellows who would be present at the meeting, and these other Fellows might hand them to the scrutineers. I have had some 40 years' experience of this society, and I hope, therefore, you will allow me to say that I believe we shall be doing the society a great deal of harm unless the precautions I speak of are embodied in the resolution.

Mr. Chambers said that he believed a large number of the Fellows of the Society would welcome the concession which had been made by the president on behalf of the council. At the same time, he hoped that Lord Crawford would not withdraw his motion, except on a very clear understanding that the council would pledge itself to propose, at an early meeting of the Society, such an amended resolution as had been suggested. At present the great bulk of the Fellows were practically disfranchised. There were 500 Fellows of the Society, and instead of the great bulk taking part in the election of the council, it practically amounted to 20 Fellows joining with the council to elect 20 who had already been selected by the old Council. The result was that the council of the society did not command the unreserved confidence which it otherwise would. In evidence of that he would point to the fact that the society did not now attract to itself the important papers which it attracted fifteen or twenty years ago.

Mr. Beck hoped that the change would not be made, for he felt that it would be throwing additional power into the hands of the council, and that the council list would always be adopted by absent Fellows.

Sir Edmund Beckett said that the proposal of the President seemed to him to make very little difference. It was merely a matter of machinery as to how absent members should be allowed to register their vote. He could hardly understand how there could be any dissentients to the proposition. It should be remembered that in voting for the council there was never any debate, and there could be no debate, about a person's character. He could see no reason against the proposition, except the jealousy of those who lived in London against those who did not live in London. He thought there was force in what had been said about the greater interest that would be taken in the affairs of the Society by absent Fellows, and he feared that he must endorse what Mr. Chambers had said about the evident decline in the interest that was taken in the affairs of the Society compared with what used to be. This was a practical reason why, if it was wished to keep the Society flourishing, they should pass this resolution.

Mr. Ranyard said that it was important that the resolution should be passed at that meeting, and should not be referred back again to the council. He thought that no great harm would be done by substituting the word "posted" for the word "handed," "to the scrutineers," though he did not see that much would be gained by it in practice, for any country Fellow would be able to send his balloting paper to anyone in London who undertook to canvas for votes, and the London Fellow might then post the lists to the scrutineers instead of handing them, and he saw no advantage in making the country Fellow sign the outside of an envelope rather than sign the balloting list itself.

Dr. Schuster said that he thought no change should be made in the method of voting. The alteration which was now proposed was only a little less objectionable than the first proposition. It would give rise to touting at the elections, and entirely alter the character of the society. A man ought certainly not to be allowed to vote without having heard the arguments which could be adduced by either side, and which might entirely change his opinion. Unless Fellows took sufficient interest in the society to attend the meetings, their votes had better not be received. He had himself come up to London after delivering three lectures in Manchester that day, on purpose to attend the meeting and vote against the proposed alteration.

Capt. Noble said that he had noticed that when there was any election for officers and council going forward there were quite a different set of faces to be seen from those which were to be seen at the ordinary scientific meetings of the society. He thought it advisable that people who took so much trouble to attend the business meetings of the society should not be allowed to outvote those who attended the ordinary scientific meetings. He thought that the proposed alteration would put everybody on the same footing, and he hoped that it would be adopted.

Mr. Knobel said he thought that a grievance had existed, and that it would be better to remedy it by allowing absent Fellows to vote; but their lists must not be signed, or it would be a distinct departure from the by-laws, which require that the election should be by ballot, that is by a secret vote. The list might be folded up and then placed in an envelope, which should be signed by the Fellow and addressed to the scrutineers.

After some discussion the following alteration was adopted by Lord Crawford and the seconder of the motion, "A list addressed and posted to the scrutineers of the ballot on behalf of any Fellow not present at the meeting shall be accepted if duly verified by the signature of the absent Fellow on the envelope." The motion was put to the meeting, and carried by a large majority.

Lord Crawford then proposed the second resolution — viz., that at the end of by-law 53, the following words be added, "Fellows of the Society may vote on the business brought before annual general meetings and special general meetings, either personally or by proxy." Lord Crawford said what he had said before with regard to absent Fellows voting upon the election of the council; applied in the same manner with respect to voting on all other subjects. The proposal, if adopted, would not allow a proxy to be appointed by an absent Fellow to vote for him on any indefinite subject of which notice had not been given for the by-laws required a month's notice to be given to all Fellows of the business which would be brought before annual general meetings and special general meetings.

Mr. Newall seconded the motion.

After some discussion it was put to the meeting, but was lost by a small majority, 35 being for the motion, and 38 against it. Several Fellows present abstained from voting.

It was decided that the evening meetings should continue to be held at eight o'clock.

**Explosion of a Safety Boiler.**—A Board of Trade report has been published on the explosion of a Howard safety boiler, causing the death of one man. Mr. T. W. Trail says:—"This explosion appears to have been caused by the local overheating of one of the wrought-iron tubes. It is thought that sediment collected in the interior of the tube and prevented the water from getting into contact with the iron; consequently it got hot, which rendered it unfit to sustain the internal pressure, and the explosion occurred. Water-tube boilers have not been very favourably looked upon in this country, and when used the feed-water should be practically free from deposit; and there are comparatively few places where such water is available for feeding boilers. It is essential that the heating surfaces of all boilers be kept clear, but where tubes are used, and almost in the fire, unless great care be taken, deposit is sure to collect, and in this case unfortunately, it has apparently caused the death of one man."

M. MORIZE, of Rio de Janeiro, has devised a selenium apparatus for measuring the relative intensities of the rays of the sun at different altitudes above the horizon. It consists of a selenium cylinder prepared according to the plan of Professor Graham Bell, thirty-eight discs of copper being isolated from each other by smaller mica discs, and the edges filled in with selenium. It is insulated by glass supports inside a glass envelope from which the air has been exhausted. The vessel is elevated in a place where surface reflection does not reach it, and the axis is placed parallel to the axis of the earth, so that the rays of the sun fall normally on the selenium cell and illuminate the same surface. Its position can be altered to keep up this condition from day to day. A constant current traverses the selenium and a galvanometer in circuit with it. From darkness to the most intense radiation of the sun is the range to be observed, and a scale is graduated accordingly.

# SCIENTIFIC NEWS.

THE death is announced of the Rev. James Charles Clutterbuck, M.A., the "father of hydro-geology." Possessed of an extensive knowledge of geology, he was a recognised authority upon all questions relating to wells and water supply, and gave his opinion as freely as it was sought. The deceased gentleman, who had reached the ripe age of 84, was a member of the Thames Conservancy, and for 55 years vicar of Long Wittenham, Berks.

Prof. Panum died recently at Copenhagen, where he filled the chair of physiology. He was president at the last International Medical Congress, and has been known for years as one of the ablest workers in the field of physiological science. He exhaustively treated the subject of transfusion of blood, and his treatise on embolism is a recognised classic. Prof. Panum long ago investigated the virus of septicæmia, and arrived at the conclusion that it was independent of the agency of living organisms. Dr. Panum was 65 years of age.

The deaths are also announced of Dr. Nachtigal, the African explorer, and of Dr. Karl Köppritz, Professor of Geography at Königsberg, and a well-known "reporter" on the progress of geophysics and African exploration.

Dr. Theodor von Oppolzer, of Vienna, announces the early publication of a very extended list of the dates of solar and lunar eclipses, which has been prepared under his direction. There are 8,000 of the former and more than 5,000 of the latter class of phenomena, all included between the years 1207 B.C. and 2161 A.D.

Mr. J. E. Gore has sent us a copy of his "Catalogue of Suspected Variable Stars," a paper read before the Royal Irish Academy, and reprinted from the *Proceedings* of that body. The catalogue has been compiled from various sources, and contains some stars which are no doubt really variable, but which need further observations to place their variability beyond question. The catalogue is accompanied by a map in which known variables are marked in red, and the suspected stars in black. It will be very useful to those engaged in this branch of astronomy.

The April part of the *Journal* of the Liverpool Astronomical Society contains, amongst other papers, one entitled "Some more Evenings in Town with a 3¼in. Telescope," by the Rev. J. H. Honeyburne, which will be read with interest by many observers.

It is stated that, in consequence of his health, Prof. Huxley is about to withdraw from some of his most active employments, in order to recruit his strength by a prolonged period of rest.

Dr. Frankland intends to resign the Professorship of Chemistry in the Normal School of Science and Royal School of Mines at the end of the session.

Mr. Omond, the superintendent of the Ben Nevis Meteorological Observatory, gave a summary last week, before the Royal Society of Edinburgh, of the results of his two years' observations on the summit of the Ben. Among other subjects alluded to were the rarity of thunderstorms; the range of temperature (the thermometer scarcely, if ever, fell below 10° Fahr. in winter); the daily variation in the average velocity of the wind, which is greater at night than during the day; the direction of the winds, which is almost always different from that at low-level stations; and the amount of rainfall, which greatly exceeds what had been expected. Mr. Omond thinks that the establishment of a fully equipped observatory at the foot of the mountain is likely to be of great service to meteorological science.

It is proposed to establish a naturalists' field club for Hampshire, and a meeting in support of the proposition will be held at Winchester on the 28th inst. Mr. E. Westlake, of Fordingbridge, Salisbury, is the hon. sec.

The spring meeting of the Iron and Steel Institute was held last week, when the inaugural address was delivered by Dr. Percy, the president, the Bessemer gold medal for the year presented to Prof. Richard Akerman, and several papers were read and taken as read. In the course of his address the president made some timely remarks about technical education, in the course of which he said he fully agreed with his friend, Mr. I. Lowthian Bell, that our metallurgists were not so incompetent as certain persons would lead the public to believe, and that with respect to skill in manipulation, ability to direct operations, and knowledge of the principles of their art, they had no reason to fear foreign rivals. Technical knowledge was acquired in the only school where it could be acquired—viz., the establishments where metallurgical processes were conducted on a large scale. It was, he thought, a matter for regret that there had been indiscreet attempts to imbue artisans with the notion that the one thing needful for them was technical education, and that this was a certain means of benefitting them all alike. Of the advantage of special instruction adapted to special artificers, in addition to what they acquired in the ordinary practice of their respective arts, there could not be two opinions; but, on the other hand, there were a large number of artisans who would not be rendered more competent by instruction of that kind. It was a gratifying sign of the times that the value of special instruction to at least a large class of artisans should be generally recognised, and that by the munificence of private individuals admirable institutions for imparting it had been established in several of our great centres of industry. Dr. Percy referred to the important question whether malleable bar iron, as used in the construction of many railway bridges in the United States, acquires in time a crystalline structure to such an extent as to become dangerous, and also mentioned the daily increasing danger from the telegraph and telephone wires now stretched over our towns. These are at last it seems to be under some kind of control; but Dr. Percy thinks that not until a political dignitary happens to be decapitated or strangled, will efficient measures to protect the public be taken.

It will interest many of our readers to know that the great influence machine which Mr. Wimshurst made for the School of Science is to be seen in the International Inventions Exhibition (South Central Gallery). Mr. Wimshurst also exhibits a smaller machine (18in.) of the latest design, and a continuous electrophorus (plates with many sectors). To assist amateurs, the parts in these machines are exhibited separately, and if our readers will state, through the Query columns, any points on which they have a doubt, Mr. Wimshurst will reply, and add to the exhibit any other feature which may be requisite to make the construction of these influence machines clear.

Another machine which has excited some little attention from our readers will be found in the north end of the Queen's Gate Annexe, where in Group VI., No. 836, is what is called an "improved form of tricycle," the exhibitor being Edwin Sturge. The machine shown differs in construction from that illustrated on p. 291, Vol. XXXIX., but no doubt it will go just as well.

The International Cholera Conference will commence its labours to-day in Rome. Sir W. G. Hunter, M.D., and Dr. T. Thorne represent this country, with Sir J. Fayrer and Surgeon-major T. Lewis for the Indian Government.

Dr. R. Koch has been appointed professor of hygiene in the University of Berlin.

A portion of the former Industrial Academy in the Klossterstrasse, Berlin, is to be fitted up as a permanent hygienic museum, at a cost of £3,000, a similar sum being spent on the arrangement of a laboratory.

The *Journal* of the Anthropological Institute for May contains the address delivered by Prof. Flower on retiring from the presidential chair. The address should be read by all who wish to understand the classification of the various forms of the human species.

Signor Narducci, the distinguished Italian palæographer, has presented to the Accademia dei Lincei some documents proving that negotiations were carried on between Sixtus V. and the Republic of Venice in reference to cutting a Suez Canal. It appears that the project was abandoned from the fear that the channel would soon become obstructed by sand, in consequence of a difference in the level of the two seas.

Large numbers of salmon fry have been recently placed in the Tay and tributary streams. The fry were obtained from the hatchery at Dupplin, belonging to the Tay Fishery Board. Previous experience had shown that a temperature of 45° hatched the fry in about 64 days, and they consequently had to be turned into the river too early in the season. Colder water has since been used, ranging from 37° to 45°, and the average time of hatching has been extended to 108 days. The total loss of ova and fry from 315,000 eggs was a little more than one per cent. Fifteen thousand fry have been retained at the hatchery, and the remainder have been distributed as mentioned above.

A new automatic brake has been tried at the Edinburgh works of the North British Railway Co. It is stated to meet all the requirements of the Board of Trade, and not to leak off until released by the driver, while it prevents skidding.

A new note has been prepared by the Bank of Scotland under the directions of Prof. Crum Brown and Dr. J. Gibson. It is printed in three colours—brown, yellow, and blue, in order to resist attempts at reproduction by photography.

M. Olzewski, in a note communicated to the Academy of Sciences of Paris on the liquefaction and solidification of formene and nitric oxide, says that by preparing products free from acetone and hydrogen, he has succeeded in obtaining a white snow-like mass. M. Cailletet used these substances in obtaining the liquefaction of oxygen.

# LETTERS TO THE EDITOR.

*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

*All Cheques and Post-office Orders to be made payable to* J. PASSMORE EDWARDS.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

> "I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original."
> —*Montaigne's Essays.*

## NEW RED SPOTS ON JUPITER.

[24219.]—IN the morning twilight of Sept. 27, 1883, Mr. Franks discerned a "faint elliptical spot" just above the S. equatorial dark belt of Jupiter. On the drawing which accompanies his letter (21900) in the ENGLISH MECHANIC for Oct. 12, 1883, p. 126, he depicts this spot as slightly past the central meridian at 5h. a.m. From the position of this object I estimate it to have been central on September 26 at 16h. 54m., or 6m. prior to the time at which his sketch was taken. The spot is further described by Mr. Franks as "a pale, insignificant patch, devoid of colour or strength of outline." On the date of your correspondent's observation the apparent diameter of Jupiter was about 33″, and the major axis of the spot subtended an angle of about 5″, so that it would be some 14° long and occupy 23 minutes crossing the meridian. It followed the red spot 1h. 59m. in the same parallel of latitude.

Now this spot detected by Mr. Franks has developed into a very conspicuous and interesting feature. It has been seen by many observers, and is several times referred to in recent numbers of your journal. I have been comparing the observations, and there is not the slightest doubt that they refer to one and the same object, which has not only retained precisely the same form as when first seen, but has, during the present opposition, exhibited a deep red colour even more intense than the old spot in its best days.

In the ENGLISH MECHANIC for Feb. 13, 1885, p. 517, Mr. E. Miller says (23818):—"Last night (Feb. 2) whilst observing Jupiter at 22h., a spot was seen on the south equatorial belt close to its southern edge. In size and shape it is the exact counterpart of the great red spot, but differing in colour, it being a deep cherry red. It was on the central meridian at 22h. 45m."—(I suppose this means 10h. 45m.; the premature use of the new time by certain of your correspondents will cause endless complications). On Feb. 2 the red spot was on the C.M. at 8h. 58m., so that Dr. Miller's spot followed it by 1h. 47m.

Mr. J. M. Offord also refers to the spot (ENGLISH MECHANIC, Feb. 20, 1885, letter 23846. He says, on Feb. 11:—"Following the red spot on the southern edge of the reddish belt, which is now the most conspicuous marking on the globe, there are several dark spots of a crimson lake colour, the first of which comes into view about an hour after the red spot has crossed the meridian."

In the *Astronomical Register* for April, 1885, p. 95, Mr. N. E. Green writes: "Following the red spot in the same latitude there is an unusually definite mark, which commenced as a straight grey line, and is now increased in size and becoming red. Its size is about half the length of the old red spot, by about one third of its width, and is on the meridian about an hour after the red spot." In the same journal for May, p. 116, Mr. Green supplements his preceding remarks by saying: "There is now no doubt about the character of the mark following the great red spot, to which reference was made in the last number of the *Register*: it is evidently a small one of the same kind. It was observed this evening (April 20) under favourable circumstances. The old red on the meridian about 7.30, and the new red following about 9h., so there is 1h. 30m. between them, and the new spot is best seen when the old one is disappearing at the limb. The position of the new spot is on the polar edge of the southern belt, and its size about half the length by one-third the breadth of its forerunner.

I now come to my own observations. Early in the present year I began to notice dark elliptical spots on the faint grey belt just outlying the great southern belt. I did not record them particularly, however, until the end of March, and then I began watching the most prominent one. It came to the central meridian at 9h. 20m. on March 27th, and I had previously noted the red spot central at 7h. 32m., so that the smaller spot followed the red 1h. 48m. I obtained many further observations in April, and estimated the spot as 14° long. Its position was 66° E. of the old red spot, and a careful comparison with Mr. Franks's observation of Sept. 26, 1883, showed the absolute identity of the two markings.

The following are the only observations I have seen or obtained up to the present time. I shall be very glad to receive notice of any others from your astronomical contributors:—

| Date. | New Red Spot on C.M. | Follows old Red Spot. | Observer. | Telescope. |
|---|---|---|---|---|
| 1883— | h. m. | h. m. | | |
| Sept. 26 | 16 54 | 1 59 ± | W. S. Franks.. | 11¼in. refl. |
| 1885— | | | | |
| Feb. 2 | 10 45 | 1 47 | E. Miller...... | 10¼in. refl. |
| Feb. 11 | — | — | J. M. Offord .. | 5¼in. refr. |
| Mar. | — | 1 0 ± | N. E. Green .. | 18in. refl. |
| Mar. 27 | 9 20 | 1 48 | W. F. Denning. | 10in. refl. |
| Apl. 6 | 7 38 | 1 50 | ,, | ,, |
| ,, 13 | 8 29 | 1 51 | ,, | ,, |
| ,, 17 | 11 46 | 1 52 | ,, | ,, |
| ,, 18 | 7 37 | 1 54 | ,, | ,, |
| ,, 20 | 9 13 | 1 51 | ,, | ,, |
| ,, 20 | 9 20 | 1 30 | N. E. Green .. | 18in. refl. |
| May 2 | 9 10 | 1 49 | W. F. Denning. | 10in. refl. |

Allowing for slight errors of observation, the spot follows the old red spot by the same interval as it did on Sept. 26, 1883; hence its rotation period is just about 9h. 55m. 39s. Mr. Miller's estimate as to the size of the new marking on Feb. 2 was evidently excessive, and Mr. Green rather underrates the interval separating it from the old spot; but these little differences are easily explained when we remember that they result from statements merely intended as rough approximations.

It is most desirable to obtain further observations of the new red spot before Jupiter declines so much as to be practically non-observable. I therefore subjoin the times (in hours and tenths) when both the old and new spots will come to the central meridian on the assumption that the latter follows the former 1h. 48m.

| | Old red spot on C.M. | | New red spot on C.M. |
|---|---|---|---|
| May 16 .... | 9·0h. | May 16 .... | 10·8h. |
| 18 .... | 10·6 | 19 .... | 8·3 |
| 21 .... | 8·1 | 21 .... | 9·9 |
| 23 .... | 9·8 | 26 .... | 9·1 |
| 25 .... | 11·4 | 28 .... | 10·7 |
| 28 .... | 8·9 | 31 .... | 8·2 |
| 30 .... | 10·6 | June 2 .... | 9·9 |
| June 2 .... | 8·1 | 7 .... | 9·1 |
| 4 .... | 9·7 | 9 .... | 10·7 |
| 9 .... | 8·9 | 12 .... | 8·2 |
| 11 .... | 10·5 | 14 .... | 9·9 |
| 14 .... | 8·1 | 19 .... | 9·0 |
| 16 .... | 9·7 | 21 .... | 10·6 |
| 21 .... | 8·8 | 24 .... | 8·1 |
| 28 .... | 9·6 | 26 .... | 9·8 |

In the current number of the *Observatory* I have perhaps rather inaptly termed the new marking a black spot, in order to distinguish it from the old red spot, but there can be no question as to the intense red tint so uniformly attributed to the new feature by its recent observers. In comparison with the adjoining belts, it certainly, however, appears very dark.

On March 28 I saw a smaller spot of similar character on the central meridian at 7h. 16m., and following the red spot 5h. 53m.; but I have not looked for this object since.

Bristol, May 8. **W. F. Denning.**

### JUPITER.

[24220.]—MR. BONE (24197) inquires if others saw dark transit of No. III.—on May 2, I presume, although he does not state date. I saw it with 9in. mirror × 275, very dark, at 9 p.m. on that date, about ¼ on disc of planet. It was not well defined, air being bad; but at the same time there was a dark spot on south belt nearly as dark as satellite, and looking much like it in the bad definition that prevailed. This other spot was exactly on central meridian at 9 p. m. No. 3 was not so dark as No. 4 on April 18th. Mr. Denning (24198) saw this as a dark brown spot. To me it was black, as if a round speck of pitch, in same position, and fully as black as shadow of any satellite ever is. May not this difference be due either to bad atmosphere causing the dilution of the blackness, or to bad films on some mirrors. I have often seen statements that the lunar shadows are not so black in reflectors as refractors, but I always put it down either to a badly-figured mirror or a thin film. I am afraid few mirrors have a sufficiently thick film upon them, and flats are worse. At any rate, I can never get a film opaque to sunlight with 50 grains of silver to a 6½in. mirror. It is obvious that any transmitted light will reduce the blackness of shadows, and that a small amount of scattered light, from badly corrected portions of mirror, will so dilute blacks as to make them brown, or, at any rate, short of deep complete blackness.

**Edwin Holmes.**

### DARK TRANSITS OF JUPITER'S SATELLITE III.

[24221.]—As Mr. Bone (letter 24197) asks for confirmation of his observation of a dark transit of Satellite III. on May 2nd, I write to say that it was observed here much as he describes. This is the third time I have observed this phenomenon this year.

Shaftesbury. **T. Perkins.**

[24222.]—THE transit of Satellite III. on Saturday evening was well seen from here, and definition was very good until 11.15, when the air became very unsteady, and Jupiter was getting low down over some houses.

I did not see the ingress at 8.3, but on looking at the planet about 9 o'clock, the satellite was seen as a well-defined, nearly black, spot on the N. equatorial belt, considerably darker than a marking a little preceding it on the S. belt.

I watched it across the disc, and did not see any variation in its shape or lustre until I lost sight of it about 11.30. After egress at 11.43 it appeared as bright as usual.

Powers 250 and 400 on 8½in. With mirror.

Croydon, May 4th. **Alfd. Roods.**

[24223.]—REFERRING to letter 24197, I observed the transit of Satellite III. on April 25th, 7h., when about an hour from egress. It appeared as a black dot, but I could not say if it was quite so dark as the shadow, there being too much daylight in the sky at the time. I looked for it at 7h. 45m., but failed to see it till it appeared as a bright speck close to the limb. I did not notice any dimunition of brightness after egress. May 2nd, at 8h. 22m. saw III. again as a dark dot at 20m. after ingress. As it neared the middle of the planet, it appeared to get gradually darker, and at 9h. 45m., when on the centre of the planet, was nearly black, and just on the S. edge of the great II. belt, Denning's great black spot β preceding it; watched it till 10h. 15m. when it was still a very dark object. Clouds coming on prevented my observing it at egress. On the 18th April observed Satellite IV. just after it had passed on to the planet. It appeared nearly as dark as the shadow of Satellite III., which was on the disc at the same time. I observed it at intervals till egress 11h. 35m., when it was still a nearly black dot. Inst. 3¼ Wray, 120.

Referring to the letter of "A Fellow of the Royal Astronomical Society," I can fully confirm what he says about the difficulty of seeing objects through what (for want of a better word) I term the "solar halo." I picked up Mercury at last eastern elongation, when the planet was just outside the reddish fringe of colour which now surrounds the sun, and of its visibility in daylight I called attention in your journal so far back as 4th Jan., 1884. I also found Venus a few days before superior conjunction, when she was in the "glare" space between the sun and the inner edge of the coloured halo. I have, however, utterly failed to pick up either planet or star in daytime, when their position was behind that of the "solar halo." What is this matter which has so long been suspended in our atmosphere? **T. R. Clapham.**

### ASTRONOMICAL DOUBLE STARS — SELENOGRAPHICAL.

[24224.]—FROM the several observations I have made during the few past months I pick out the following, hoping they will interest some of your astronomical readers, though I can give only estimations of distances and positions; 8½in. mirror:—

Oct. 23, 1884, δ Equulei, P = 230°. Seen elongated so easily that I am inclined to think that the distance has diminished since last year, and that its perihelion is past.

Nov. 8, β Delph. P = 220°, power 600. Air very fine.

δ Equulei, mean of two observations P 232°.

κ Peg., P = 140°. Hardly any elongation with power 600.

64 Peg., P = 80°. Seen elongated at once. β.'s distance in 1880, 592 = 0·34″.

$\gamma^2$ Androm., P = 95°. Very close. Est. dist., 0·50″, perhaps less.

Nov. 9, ζ Sagit., P. = 135°. Powers 600 and 735.

β 658 = B.A.C. 6762, P = 320°. Seems much closer than 0·57″. Notched with power 735.

Nov. 16. β Delph., P = 235°. δ Equulei P = 245°. The star S. of δ Equ. has a distant *comes*, P = 360°.

Nov. 29, δ Equulei, P = 240°.

Dec. 14, β Delph., P = 225°. Well seen with power 180, and with 600 elongation excessively plain before dark. Air good.

δ Equulei P = 230°. Much closer than β Delph. Power 600. Elongation easy with 735, with which I estimated position 225°.

72 Peg. Seen elongated at once with power 200, and comparatively easy with 370. Seems wider than 0·34″ in 1880, 592, β.'s.

85 Peg. After a long gazing and during a calm, I see an elongation towards 310°. Difficult, *comes* about 11th mag.

7 Tauri. Air too unsteady for any power above 200, with this just seen elongation towards 235°.

January 19, 1885. 32 Orionis. Well elongated. P = 165°.

March 2. 126 Tauri, P = 240°.

March 5. 126 Tauri, P = 240°. Power 200. Just seen elongated. Very probably the movement is retrograde.

Σ. 3121. I found elongation towards 250°; but this is doubtless wrong, as β gives 185° for 1878·2, and 199·8° for 1880·315. Are there any later measures?

ω Leonis, P. = 100°. This star has moved, as β. gave 79·8° for its position in 1879·78.

O.Σ. 234. I thought I could just glimpse a slight elongation in direction 150° — 320°, which is the position β. gives in 1878; but in 1880 he gives 170° D. = 0·18″, and calls it excessively difficult with the 18½in. refractor.

Referring to letter 24199, I think Mr. Ed. Holmes must be wrong in the position angles he gives of γ Leonis and 54 Leonis. Last night I estimated the first at 125° ± and the second at 130° ±. I also found ζ Boötis at 295°; 42 Comæ Berenicis at 130°, and 25 Canum Venaticorum at 175°. This last seems far too close as a dividing test for a 6½in. Perry found 0·31″ distance in 1882·36.

May I direct the attention of your selenographical readers to the eastern portion of the Alps, where I have found several new clefts lately? They were just within the limit of visibility of my instrument, and very evanescent. I could not take the positions of all those I saw; but so far as I could sketch them, they will be given in my map of the Moon, soon ready for the printer.

**C. M. Gaudibert.**

### STAR DISCS AND VISIBLE ANGLES — ROYAL ENGINEERS — POWER OF OPERA GLASSES — THE SPECIAL MEETING OF THE ROYAL ASTRONOMICAL SOCIETY.

[24225.]—I THINK Mr. Edward M. Nelson's difficulty (letter 24201, p. 212) has chiefly arisen from his not considering the false discs which are raised on stars viewed by a telescope. The distances separating double stars are really the angular distances between the *centres* of these false discs; and as the discs increase in size as the aperture of the telescope diminishes, it is quite evident that the actual width of dark space separating the components of a telescopic double star varies with the aperture of the telescope used, as well as with the power. Moreover, in the case of stars, such as Polaris, where the primary is bright and the *comes* faint, one can scarcely expect to see the latter when only just separated from the dazzle of its primary.

I would propose an experiment to Mr. Nelson. Let him get hold of a small telescope about 1in. aperture. Now make himself a very low power for his 4in. (I have made lots of low powers out of old microscope tubes and lenses; they are very easy to make, as achromatism doesn't matter much with low powers), and try with what power he can just divide a star whose components are about equal in magnitude—Castor for choice. Now use the equivalent of this power in his 3in. and the discs will be in contact, and with an equivalent power in the 1in. there will scarcely be elongation of the star, although its components are still separated by the same angle. In fact, the larger the telescope the lower the power required to separate a star from its *comites*, within certain limits. As to the theoretical angle which is just visible, that depends entirely on the eyesight of the observer, and the conditions of illumination. It requires very unusual eyesight to separate $\varepsilon^1$ or $\varepsilon^2$ Lyræ by the naked eye; but I think that is as much caused by their faintness as their distance; and the state of the atmosphere and the altitude of the star have much to say to their divisibility. If Mr. Nelson would grant me my own conditions of illumination, I would undertake to show him a far smaller angle than 207″. I have seen sunspots with the naked eye, which did not subtend so large an angle.

I do not think the formulæ, which he speaks of in the last paragraphs of his letter, would be of any practical use, as the size of the star discs vary more or less with the state of the atmosphere. No doubt they could be worked out theoretically by the same means as the limit of dividing power of a given aperture is found.

In answer to "F. L. B., Kew" (query 56508), his best plan would probably be to enlist in the Royal Engineers as a telegrapher. He must be 33½in. or upwards round the chest, and not above 25 years of age. If accepted, he will be sent to the Postal Telegraph Companies at Bristol and thoroughly tested and given a certificate. He is then enlisted if approved of. If he is not versed in practical telegraphy he can enter as a sapper, by special authority. The pay begins at 1s. 1½d. per diem; but "F. L. B." would no doubt obtain rapid promotion, and eventually reach the rank of Sergeant-major, drawing 6s. a day as a warrant officer. He might get a commission as quartermaster, or even as a lieutenant, but not in the R. E. itself, as both it and the R. A. are entirely officered by men who have been through the Royal Military Academy.

As to the work, "F. L. B." would be pretty sure to be employed at that which he was found best able to do, which would also no doubt be what he liked best. And if really well educated, he would have a good chance of snug appointments, with good pay, in the R. E.

If he requires further information, I would recommend him to go to the deputy adjutant-general, R.E.'s Office, Horse Guards, and inquire for Sergeant Tucker, R.E., who will give him full information and be glad to enlist him if eligible.

(Query 56534. Opera Glasses.) Let "Devoniensis" rule off a scale of equidistant black lines on a sheet of white paper, pin it on the wall, look at it with his right eye direct, and with his left through one tube of the opera glass, and by moving the latter make the two images coincide. Suppose the glass magnifies four times, then the magnified distance between any pair of lines will be wide enough to hold four of the spaces seen by the naked eye, and so on. It is very easy to do. There are other methods theoretically exact, but that is the simple practical one.

I should like to inform "F.R.A.S." that I was personally most anxious to attend the special meeting of the Royal Astronomical Society and vote with him and his; but, owing to the work that the Russian trouble has imposed upon us army men, I found it impossible to go. The motion had my best wishes, I need not say.

**Garrison Gunner.**

### ζ HERCULIS—γ AND 54 LEONIS, AND COR CAROLI.

[24226.]—THE distance of ζ Herculis (about which "Beta" inquires in letter 24165, page 187) is now about 1·60″, and the position angle about 89·0°. The companion will remain at about its present distance until 1891—1892, when it will again begin to approach its primary. The following are some of the measures of this interesting binary since 1876:—

| | | | | |
|---|---|---|---|---|
| De. | 139·60° | 1·366″ | $7^n$ | 1876·56 |
| " | 133·85 | 1·357 | $8^n$ | 1877·53 |
| " | 126·66 | 1·381 | $7^n$ | 1878·58 |
| Hall | 120·75 | 1·498 | $4^n$ | 1879·46 |
| β | 114·12 | 1·368 | $5^n$ | 1880·49 |
| " | 110 60 | 1·532 | $5^n$ | 1881·45 |
| Sch. | 101·55 | 1·473 | $11^n$ | 1882·60 |
| Pe. | 99·50 | 1·495 | $4^n$ | 1883·52 |

In 1882 Mr. Simms found it clearly separated with 3¼in. aperture on his 4in. Cooke, power 225. The distance of the *comes* of δ Cygni is about one-tenth of a second of arc greater than that of ζ Herculis at the present time; but the magnitude of the companion of δ Cygni is somewhat less than that of ξ Herculis. The position angles measured by Mr. Holmes (letter 24199, page 212) are all too small, possibly owing to the stars having been measured off the meridian (?) with a reflector. For γ Leonis Küstner found 114·26° : 3 46″ : 1883·36, as the mean of seven nights' measures with the 10·1in. Merz at Hamburg; the angle should now be about 115·5°. Hall gave 107·20°; 6·41″ for 54 Leonis in 1879·24; in the case of this pair the increase in angle is very slow, the distance remaining unaltered. ♅ found 99·2° : 6·41″ : 1781·63. The measure in Webb is Smyth's, epoch 1839·33. Cor Caroli has remained unchanged during the last 100 years, although a common proper motion has carried both stars through 25″ since the first measures of ♅.

**H. Sadler.**

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## SMALL REFRACTORS AND TESTS.—ERRATUM.

[24227.]—For "*a* Lyræ, power 46½, aperture reduced to 2in. (*comes* held steadily)," read *a* Lyræ, power 46½, aperture reduced to 2¼in. (*comes* held steadily).

**Edward M. Nelson.**

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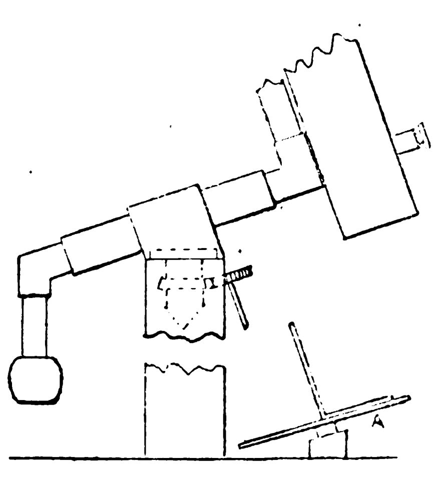
## CHEAP TELESCOPE STANDS.

[24228.]—I read with interest Mr. Vallance's description (May 2) of his method of mounting his telescopes. "Montmartre" in the next letter suggests a plan by which this ingenious method could be combined with an equatorial movement. His plan (that of a stepped floor) seems to me, however, to be unnecessarily cumbrous; and I send sketch of a much simpler one, which suggests itself to me.



The sketch explains itself to those who have read Mr. Vallance's letter. The pulley arrangement is left out for simplicity. A is a graduated circle, the index hand of which is connected with the axis of the movement. A driving clock can easily be applied.

**H. Ritchie.**

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## THE DOUBLE TELESCOPE.

[24229.]—The scheme proposed by "Montmartre," in your issue for May 1, 1885, p. 189, No. 24171, of using a pair of 10in. or 12in. mirrors, with two pairs of flats, for bringing the axis of vision within range of the two eyes of one observer, would involve the distortion of the resulting image to a very surprising extent to any one who has not had any analogous experience.

The effect of separating the two points of view for binocular vision to an extent exceeding the natural distance between the centres of the observer's eyes, can be easily studied by taking pairs of photostereographs and viewing them in the ordinary stereoscope.

In general terms, the resultant effect is to materially dwarf the mental image perceived, so that the observer fancies he is regarding a small model of the subject under examination; but incidentally there is also introduced a curious distortion by exaggeration of the apparent distances of the objects, or part of an object situated at different distances from the eyes. Owing to excessive displacement of the objects in the foreground, as compared with those in the distance, the latter look as if they were much further and relatively larger than they should be; and as one of our contributors, when discussing this question with the writer, in the early days of the telescope, aptly remarked: one could easily arrange a stereoscopic portrait so as to make a man's face present the appearance of a hatchet or a pickaxe, and stretch his nose to a yard in length.

Without asserting that I have actually made the nose appear exactly a yard in length, I have tried the experiment, and brought it (the nose) to look very like the point of a pickaxe, and to be a good proportion apparently of the said yard in length.

**Gamma Sigma.**

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## EVOLUTION.

[24230.]—"Pre-Adamite's" difficulties with regard to evolution (letter 24202, page 212) are typical. Like many others, he appears to have read enough to know that the doctrine is now generally accepted by those who are in a position to appreciate the evidence for it—those whose professional studies make them acquainted with the details of comparative anatomy and its kindred sciences, or those who unprofessionally have considered the subject of sufficient importance to make them undertake the study of the evidence for themselves. People like "Pre-Adamite" either cannot or will not undertake this study, but expect to have every difficulty that occurs to them cleared up in a few sentences; and the task of those who attempt to enlighten such people is not made easier by the fact that first of all the misconceptions as to what evolutionists believe and teach have to be corrected. Seals and whales are not regarded as links between fishes and mammals, as "Pre-Adamite" supposes. Seals and whales are mammals which have become adapted to an aquatic mode of life, and there is plenty of evidence to show that they have descended from four-footed land mammals. The whalebone whale, for example, has no hind limbs, but it has a rudimentary pelvis (representing the bony girdle to which the hind limbs are attached in quadrupeds), and there is also a rudimentary femur or thigh-bone, and a cartilaginous tibia, representing the leg bone. The same animal has no teeth, but the unborn young animal possesses teeth which, however, are absorbed, and never cut the gum. As some one has suggested, these rudimentary organs may have been created for the purpose of misleading men of science, and of making them believe in evolution, to their confusion. On the creation hypothesis, we know, all things are possible; but, on the whole, it seems more reasonable to believe that rudimentary structures are remnants of structures which were useful to the animal's ancestor. There are many structures possessed by animals which might, perhaps, as well be explained by design as by the theory of descent with modification. Useless rudimentary organs cannot, however be explained by design, but can be very reasonably explained on the supposition that the conditions or surroundings of an animal's life having changed, certain organs are no longer useful, and therefore tend to become aborted. On the principle of heredity both useful and useless organs are reproduced, but the former are developed by use, the latter tend to abort from disuse.

"Pre-Adamite" wants to know what reason there is "to suppose that a fossil creature, half-bird and half-lizard, or other recognised intermediate link, is so in reality?" The evidence for this depends on the comparison of the structure of allied forms living and extinct. As I have no doubt others will supply "Pre-Adamite" with information on this point, I will not attempt to do so at present; but should no one else write on the subject, I will undertake, with the Editor's permission, to give the evidence in another letter.

In conclusion, I think "Pre-Adamite" should not find it difficult to imagine such a change in the environment of a parrot as should necessitate the disuse of its beak for climbing. Let him suppose the district inhabited by the parrot to become destitute of trees, and I think his difficulty on this point will be at an end. Geology affords evidence of changes in the surroundings of animals, which must have produced effects on their habits quite as remarkable as would the one I have suggested.

**Rex.**

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[24231.]—"Pre-Adamite" has, I am afraid, rather confused ideas on the subject of evolution. If a lizard is quite a distinct creature from a bird, and there exists another creature which is half lizard and half bird, that other creature is evidently half-way between the two, and may, therefore, be called a "link" (there may be some other creatures which are three-quarters one and one-quarter the other).

"Pre-Adamite" says: "Suppose the seal to die out of existence, it would, I presume, be called a link between mammal and fish." The fact of its "dying out of existence" would have nothing to do with it (besides that, we have fossil mammals far back in geology). Evolution says fish were the ancestors of mammals; and creatures half fish and half mammal are, therefore, the descendants of creatures which were descended from fish, but are not necessarily like those creatures. Speaking of the bird with teeth, "Pre-Adamite" says, "I see no reason why the creature should not have been so made." What *does* this mean? Of course it was "so made." The question is "How?" Evolution says by a gradual development from creatures similar, and not from nothing. The theory of special creation teaches that the ancestors of a creature were all very nearly like it and each other. This leads us back to inquire where the first came from; and in that the one theory, that of evolution, is far more explicable than the other; it is the one accepted by the mind (the will has nothing to do with it) which grasps most firmly that which it can most readily understand.

Again "Pre-Adamite" asks why a creature should cease to use a limb. He seems to have the idea that the disuse of the limb is begun by one creature, and that none of its descendants ever use it. This is as far from the case as possible. The cause of disuse is external to the animal *always*. But there are so many causes that it is useless to try and explain, except, perhaps, by an example. Take the case of the parrot, spoken of by "P." at the end of his letter. Suppose that in a thickly-wooded country there is a race of parrots which have strong beaks, which they use to a great extent in climbing, and suppose that, for some reason, part of the race is driven out of the country (the cause may be various, such as a change in vegetation, the aggression of hostile animals, the increase of the tribe itself, &c.), and, not finding another so woody, settles down in a thinly-wooded district; the tendency to climb is less, and that to fly and walk greater; the strength of the beak is of little use, not being required to find food. Birds with weak bills have as much chance, in the struggle for existence, as those with strong, while wings and other limbs (being more required now), being stronger in some of the birds, give them a better chance, and they become healthier, increase more rapidly, and in some generations' time, parrots with powerful wings and beaks of little greater strength than those of other birds, will have descended from a race with comparatively weak wings and beaks strong enough to enable the bird to use it to climb with (and which may still be in existence).

Now, why not add many such changes together? It is far more likely that there is a continual change of this sort than that there is none at all (in the country there certainly is the change which has always been going on on the earth's crust, and which is the indisputable, except to those who know nothing about it, evidence of geology); but the geological change is far more slow than the one I have supposed, and is, therefore, far more powerful.

There is no living thing which is so totally different from all others that all life cannot be formed into a rough chain from the lowest to the highest forms; but it must be borne in mind that the highest living form has not been evolved from the lowest living form *now* in existence, but both from something else, and this is one great reason why the chain of *living* forms is not perfect.

**Crumby.**

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## MYSTERY GOLD.

[24232.]—The following paragraph will explain what is meant by "mystery gold," referred to by "Sigma" on p. 193:—

"An alloy containing enough platinum to enable it to resist the action of nitric acid is now being extensively used as a means of defrauding buyers of trinkets, and Mr. W. F. Lowe, who has analysed the alloy in question, gives, in the *Chemical News*, the following particulars. The alloy, after the gilding had been scraped off, had about the colour of 9-carat gold. Qualitative analysis proved it to consist of platinum, copper, and a little silver; and quantitatively it yielded the following results:—

| | |
|---|---|
| Silver | 2·48 |
| Platinum | 32 02 |
| Copper (by difference) | 65·50 |
| | 100·00 |

Strong boiling nitric acid had, apparently, no action on it, even when left in the acid for some time."

When thickly-plated this alloy is said to pass muster for gold of high quality, and many pawnbrokers and others are said to have been deceived by it. Considering the difficulty of alloying the platinum and the cost of the latter, it can only be by gilding that a sufficient profit can be obtained; but perhaps some of your readers can give the relative value as compared with 9-carat gold—which is worth £1 11s. 10½d. per ounce. Alloys of silver, copper, and platinum have long been employed on a small scale in jewellery and watchmaking; but is there any proof that they have been successfully used in the production of imitation sovereigns?

**Nun. Dor.**

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## CHEAP SET OF RESISTANCE COILS.

[24233.]—Will you kindly allow me to point out to my fellow readers of the "E.M." that the Wheatsone bridge described by Mr. Bottone last week has been on show at Kensington Museum, in Prof. Guthrie's set, for *some years*, and forms part of the cheap set of apparatus manufactured by J. J. Griffin and Sons for the Science and Art Department?

**J. Edgington.**

95, Vauxhall Bridge-road, S.W., May 11.

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## SUBDIVISION OF THE OHM.

[24234.]—After the letter of our able correspondent, Mr. Bottone (24212), "How to put up a set of Resistance Coils," it occurred to me that some of our amateur electricians, who are constructing small dynamos, would like to subdivide the ohm, enabling them to measure low resistances.

Measure one ohm of German silver, No. 16

B. W. G., with a Wheatstone bridge, carefully divide into ten equal parts, and at each division a copper wire is soldered, which enables tenths of an ohm to be used. For hundredths, a brass wire one-tenth of an ohm of No. 18 gauge may be taken and treated in the same way; No. 10 brass wire for the thousandths of an ohm.

The bridge described by Mr. Bottone is quite suitable for this purpose, except when measuring the hundredths and thousandths, it would be advisable to insert between the two spaces of the long and short strips of copper coils of equal resistance with the standard and wire to be measured. Trusting that the above may be of general interest.

West Dulwich. **W. Habgood.**

## THICKNESS OF COPPER PLATE FOR MODEL BOILERS.

[24235.]—In some experiments on the strength of brazed copper tubes, it was found that they rapidly lost strength with the lapse of time.

Pipes which, when new, burst with 10,000lb. stress gave way, after three years' use under steam, with less than 5,000lb. stress per square inch.

In no case did the joint give way. Taking 5,000lb. as breaking stress, and allowing a factor of safety of 5 the working stress will be 1,000lb.

Assuming 20lb. per square inch as a fair working pressure for model boilers, we get the rule—Thickness = ·01 D, when D = diameter in inches.

It is not easy to make a good joint if the plate is very thin, so we will say that the plate is never to be less than 20 B.W.G., or ·035in. thick.

By plotting these results in a diagram, the following rule is arrived at for brazed cylindrical copper boilers with a working pressure of 20lb. per square inch above the atmosphere.

Thickness in inches = $\cdot 035 + [\,(D - 3\tfrac{1}{2}) \times \cdot 01]$.

Thus, a boiler 6½in. diameter would be $\cdot 035 + [(6\tfrac{1}{2} - 3\tfrac{1}{2}) \times \cdot 01] = \cdot 035 + \cdot 03. = \cdot 065$ or 16 B.W.G. thick. **Glatton.**

## NEW MIDLAND ENGINES.

[24236.]—Your correspondent "Midland" commences his letter, p. 217, by expressing some very decided opinions against the new Midland engines, and goes on to say that the fault is "shortness of heating surface." He then concludes by asking if no one will come forward "and do battle for them"; and appears astonished that, as I some years ago defended the 800 engines, I have not entered into the present discussion upon the 1667 class.

Every word that has been said in praise of the 800 design of Midland engines is, I believe, perfectly true and well merited. I defended these engines in your columns some years ago, and should feel perfectly justified, by facts, in doing so again if necessary. Unfortunately, I am not able to say as much for the new 1667 design; for this reason, as "Midland" says, I have not entered into the discussion.

Your correspondent, in the last line of his letter, refers to large "cylinders" and "Joy's gear," as if under the impression that these were in fault; other correspondents have implied that the drivers were to blame.

I can, therefore, state that the 19in. cylinders are right, the Joy gear is perfectly true and correct, and that no fault whatever rests upon the drivers, who are experienced men.

I am extremely glad to see that within the past week or so the big engines have been doing rather better, and doubtless, if they had had larger boilers with about 300ft. or 400ft. more heating surface, they would have been very grand engines, and numerous correspondents would have been conscientiously able to accept the challenge to "come forth and do battle for them"; but in view of facts, as they are at present, I fail to see how they can be expected to do so.

**Clement E. Stretton, C.E.,**
**Hon. Mem. A.S.R.S.**

40, Saxe-Coburg-street, Leicester, 9th May.

## BRAKE POWER ON THE NORTH-EASTERN RAILWAY.

[24237.]—Will any of our North-Eastern friends tell us what brakes are in use on that line? Are those through trains from King's Cross to Glasgow worked over the North-Eastern with the *air* brake or the vacuum? I see some of the engines fitted with two brakes and the carriages as well; I suppose they don't employ both at once; if not, which do they use. Now this line has all its carriages with the air brake. I don't just see what use those 13 engines are with the vacuum only. What trains can they work? Perhaps "Meteor" or Mr. W. J. Grey could throw light on the matter.

I may just remark the quantity of carriages on English lines which have *two* brakes, it would be interesting to have a table showing the amount of *double fittings*. I expect it is the only way to arrange for exchange of carriage, but it is an expensive one, in place of one brake for the whole land; do not your readers think so? At Stratford, I see a number of Great Eastern engines and carriages having the vacuum brake taken off; how is this? What brakes are now in use on that line?

**Anxious to Know.**

## CRANK AXLES.

[24238.]—It seems that these crank axles break through the webs, and it also appears that the iron is the wrong way of the fibre. Now would it be possible to forge a crank so that the fibres all run in the right direction? Could not the iron be built up and then welded into one mass?

If, as we have been told, the chief cause of breakage is the pinching action of the rails, it seems to me we require more elasticity in either the wheels, the axles, or the rails. Could not there be a system of rail key to give a little amount of elasticity to the side play. I see in "Scientific News," p. 210, last week, that the Railway Servants Society consider that axles should be taken out when they have run a certain mileage. This is a very good idea indeed. **Locomotive.**

## INTERCHANGEABLE MANDRELS.

[24239.]—We have now got rid of the suggestions as to coning the chuck-bearing surfaces of the mandrel-head, and a few more letters should wind up the discussion, if we take up one point after another.

"Tubal-Kain" (24206), page 215, gives us a careful drawing of a mandrel-head, with some good points. But the nose is too long. So long a nose does not assist in eliminating "angular variation," inasmuch as that is got rid of by the wide face, and as I have said at page 104, the eccentric variation is efficiently got rid of by a concentric cylinder-fitting, as thick as a florin. If the angularity of "Tubal-Kain's" thread, or its cylindrical top or bottom, can be made to centre the chuck, show us how this can be done so as to meet the requirements which Dr. Edmunds has pointed out. I think that "Vulcan," "F. A. M.," and the "Doctor," are perfectly right in saying that no screw can be made a sound practical means of concentric fitting. In all the fine compound chucks used in ornamental turning he always fits concentric work together by means of combined cylinder and face fittings, and there is no screw fitting which could be made to maintain the necessary truth. The transfer chucks used in ornamental turning act upon these principles, and could not otherwise be made to answer. These transfer chucks were carefully examined, and fully explained by Dr. Edmunds in some papers written by him for the ENGLISH MECHANIC (July and August, 1884). In these papers the transfer chucks used by Mr. Henry Perigal and General Clarke for their beautiful geometric works were figured and fully described. If "Tubal-Kain" will refer back to ENGLISH MECHANIC No. 1009, page 453, and study that paper and others which follow it from Dr. Edmunds's pen, he will see that while a screw-nose may, with very excellent workmanship and extreme care in using, be made interchangeable, the construction is not sound workshop practice. The very mandrel-head now figured by "Tubal-Kain" depends for its truth upon the long screw-nose, and if that got damaged by some accidental knock the mandrel would be ruined. No doubt the screw-nose might be "judiciously touched up again in a strong screw-cutting lathe by an efficient workman," and would again run true; but then all the ornamental chucks would be too large, and would be useless. At page 189, Dr. Edmunds, referring to "J. K. P.'s" proposed screw centring, among other questions, asks: "Why is it that in accurate tool-making the old screw fittings for shifting head-stock and mandrel back-centre have been superseded by cylinder fittings?" Perhaps those who still advocate screw fittings will answer these questions before going on to write more.

I find that my own lathe centres are turned up to a cone containing 6°, and for 15 years I have kept to this 6° taper as my standard. Our own lathes get a full thwack of hard labour, and this taper for the centres is satisfactory; I have never known one injured when made to this taper. This is turned up by simply setting the slide-rest to 3° on the quadrant. A more acute taper would, I think, frequently get set fast in both mandrel and poppet cylinders, either of which would be liable to get forced open or enlarged to a perceptible extent. The small drills which I make to contain 3° hold so tight as not to need any set screw, although we put a set screw into the spindle when made to carry side or bent cutters, or an eccentric cutting frame.

My measurements also make the American cones for chucks and twist drills to contain 3° only. I was unaware previously of this coincidence, but the fact shows that the standard taper of 3° for a long cone of this kind is reliable, and I think that the taper of twice the above—*i.e.*, to contain 6°, is also reliable for exchangeable lathe centres. Lathe centres have to bear heavy end pressure, and they must come out readily. In the Edmunds model mandrel they may, of course, be knocked out from behind, and there would be less risk of injuring the cone inside the mandrel-nose, but if because of the advantages of the tubular arrangement a more acute cone was used, there would still be the risk of enlarging the mandrel-nose unless it was made still larger in diameter; in fact, since writing previously upon the interchangeable mandrel, and taking into consideration the value of the eight pitch 50° angle screw nose, which I then mentioned as having been brought to my notice by Dr. Edmunds, I have constructed a mandrel which I consider embodies the Doctor's views on the subject. I will shortly send a clear outline sketch, full size, which I trust will convey to our readers a thorough knowledge of what Dr. Edmunds has endeavoured to bring to perfection in the interests of amateur turners throughout the world.

Griffin Works, Norwich. **Edward Hines.**

## CUTTING SCREW-THREADS WITH A REVOLVING CUTTER.

[24240.]—I should like to say a few words upon this much-debated subject, if our worthy Editor is not tired of the controversy. There seems to me to be too much confounding square threads with V-threads. Now, I believe no one asserts that a square thread can be cut or finished with a revolving wheel or cutter, but the case is entirely different with V-threads, and this I purpose showing in a few plain words.

Taking a square thread first, let us take a revolving wheel-cutter with face and sides exactly to match the groove of thread, set it accurately to the rake of thread; but before putting it into actual cut let us consider the points at which it will do so. Now, our wheel possesses two flat and one cylindrical surfaces, and its points of contact with the work will be two surfaces and one line, as everyone must know that two cylinders, or two cones with their axes in the same plane, can only touch upon a line, this line being also in the same plane; but the two surfaces forming the sides of a square thread are not flat, but curved (in fact, a helix), and a moment's consideration will show that by no possibility can our wheel fit the screw groove before us. If it be put into cut, the resultant thread will not be a square thread, but will be narrower at the top than at the base, and with hollow sides, more or less, depending upon the size of the wheel and rake of the thread. The bottom of the thread groove would also be slightly hollow; but if the cutter be correctly placed, the thread will be upright upon its base and true in other respects.

Now, when we come to V-threads the case is entirely different; here the cutter acts upon two lines only, meeting each other at the bottom of the groove (for here we have four cones touching in pairs), and as soon as each point in the surface of those cones has come into contact, the convexity of their surfaces immediately carries it out of the way, and the groove cut by such a V-cutter will be an exact counterpart of that cutter; if with 50° angle of cutting faces, the groove cut will be exactly 50°, neither more nor less, "providing it be measured at right angles to the rake of the threads not parallel to the axis of the screw blank." This I do not doubt has misled several of our correspondents, for if we wish to cut a thread of 50° measured parallel to the lathe centres, we must have a revolving cutter of slightly more than 50° This will depend entirely upon the pitch of the thread, and to do so we must have a separate cutter for every different pitch; but if we measure at right angles to that pitch, the same wheel or rotary-cutter will answer equally well for any pitch, and be in each case strictly accurate.

**Hadah.**

## CUTTING SCREW THREADS—LATHE MATTERS, &c.

[24241.]—I have gone carefully through the recent correspondence, including the Dr.'s last. I have not relied solely on "my mind's eye" for my statement; in fact, Dr. Edmund's will find that organ not too reliable in mechanical matters, though the questions before us are of course mainly theoretical and in statics, and therefore, by the general rule, for the most part competent to be dealt with deductively.

A lawyer would say there was no error in all or any of my letters. Strictly speaking, there is not; though on writing my first note on Mr. Wenham's *fiat*, I had not paid any great attention to Dr. Edmunds's thread in particular, nor exactly understood its more minute or claimed properties.

On page 60 I wrote, "if a *thread* were cut," whereas the question was of a *groove* in ordinary language. It was read over several times before being called a misstatement, which to the general reader it would no doubt appear. The note itself just escaped being recalled.

I like the 50° thread very well; but I am not just at present prepared to give an opinion on the *best* methods of dealing with a nose. If a nose is hard, the hardening should grow lighter towards the shoulder, and not exist for about one turn in advance of centring: otherwise the nose will lack holdfast strength. The sum of the stresses on all the threads is borne by the cylinder area at junction with centring, growing lighter to 0 at outer end of nose.

On a soft nose, taking alone the results obtained by "J. K. P.," there does not seem much fault to be found with fixed edge tools. For a hard nose, a revolving Tanite or other emery grinder seems a likely tool for trueing; but perhaps for the best work Dr. E.'s own process will turn out the best.

There is not much analogy between a square and a V-thread cut by discs. In the former case the question is of surfaces, in the latter of lines; and in this case, also, of lines that can be made easily to any desired form by legitimate processes.

But the case of the cedar pencil, as was also that of the "skew-gear," was correct; and an inclined cutter, normal or abnormal, must be accurately on "lines of centres," as it is generally termed. It reads strangely in par. 7 (24172), the argument against the need of this aligning, as in par. 11 it is pretty clearly explained why it should be on line of centres—i.e., on account of longitudinal component.

Once set in its bearings and frame to proper position—this is not difficult to do, and the angle, instead of adding to trouble, offers a delicate means of adjustment by traversing spindle in its bearings—it is always there, and there is not trouble as with grinding V-points.

A cutter in a frame with a divided head that could set it to various rakes, would cut abnormal non-reversible threads *ad lib.*; but the degrees of departure from the normal would vary with the angles—the more upright, the less. I send a diagram of such a cutter set for a quick screw, but at a maximum off centre—below screw. The angular set goes entirely to deform the thread, and its original purpose is gone, as the cutter has no inclination left to the pitch of the thread, but is at right angles to axis of screw in plan.

Cutters made for one angular inclination (all ways) of a thread, and having their edges or contacts on an axial line as to screw, would only as strict practice be used for such angles; if used, as they might be for slightly more or less angular pitch on reduced diams., such as they would clear, they would still have to keep their position as fixed, or they would produce abnormal threads, their action then being off the axial line. If of small diam. themselves, they would clear slight variations of pitch in larger or the same diams.; but strictly, they would only do for one number of threads on a given diam., and that, I take it, is what "J. K. P." means. On different diams. they would cut accurately any number of threads that required the same angular set: 10 per inch, 20 per ½in., and so on, as in a decimal system.

For a uniform degree of abnormal nature, the inclined-acting cutter or lap would also have to maintain its original angle.

I have gone over par. 8 several times, and am not satisfied on it yet. There is nothing more misleading than to begin reasoning from a plane to a cylinder in screw threads. The reason is this: that when the question of traverse enters the thread, a cutter that cuts grooves of the axial section of the screw thread on a flat will not fit any section whatever on a true cyl. screw; neither the normal nor the axial section, as it cuts *normally* on the flat, or *obliquely* to what becomes the axial section when the plate is wound round a cylinder, and the normal section on a cyl. is bent away and curved in winding the plate round it; the section that becomes axial is of course wider at base than the original cutter working on the flat. To produce the proper groove on both cylinder and flat, the cutter must act on its edges obliquely to its rotation axis, and in the plane of the supposed screw axis.

To proceed as in par. 9 would result in satisfaction and some interesting models for exhibition.

In par. 10 the thread is said to increase in angle as it approaches the axis till it coincides with it, becoming a straight line. A ship's propeller is about the best illustration of this.

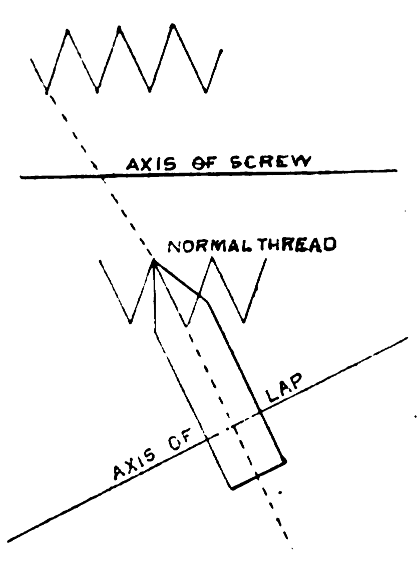
That Mr. Wenham was right so far as saying that an already true thread—i.e., a symmetrical one—would be deformed by a lap of its axial section set angularly and to work upon it, is and has been quite evident; but I should like to say a word on his challenge. He appears to forget, in the first place, his remarks on "self-constituted authorities," and the benefit accruing to any one answering the gage is not conspicuously evident. The trouble and expense involved seem definite enough, as the challenge is carefully worded to include both revolving cutter and grinder as well as the screw.

Nevertheless, a little hunting-up would probably unearth the articles, and in the ordinary way of business it seems very likely that they will at any rate be shortly forthcoming. The quotation of "J. K. P." reads falsely or without meaning. A cutter or grinder made and set to a decimal or other system would do for many numbers per inch on different diams.; in fact, they would work throughout up to the full depth of their cut on systematised screws—ten or other number of turns in their own diams. always needing the same angles.

"J. K. P." is only right as to number of threads on one diam. of screw, and that is not what his sentence, as quoted, implies by any means clearly. The note of mine to which "J. K. P." refers was promiscuous, and only partly for himself.

The writer whose advice heads our columns ended his page with "Que scais-je?" Rather a startling difference between it and the "impressive" announcement. Hence some of my "sarcasm," so called.

My ideas on the cylindered mandrel are clear and decided, and I believe in it. The screw nose must, of course, be true and well finished, hard outwardly; but I am "not going to bother myself" getting up such a *large, complex, worked upon and exposed*, surface to such pitch as I think a centring should be finished to, as I know it would not endure if I did, and that I should be mechanically foolish to attempt it when I know that a *small, simple cylinder, well-protected*, and comparatively quite *free from travel and stress*, is all that is needed.



As for the talk about de-centred noses, it is simply holding up to ridicule, by experience apparently, the degenerate state of general workmanship, and is a re-echo of the "foreign competition" note just restruck alongside.

Returning to stereometry and the normal section, the principal points that strike me in connection therewith, from my own points of view, are that in reversible threads—*i.e.*, threads in which the axial section is bisected throughout by a radius cutting its apex on the centre of its summit—the only tool that can work on the normal line is an edge formed by hacking off a nut-thread that has been cut on top to normal lines, and was made on a list of the exact size of the finished screw. The customary chaser is cut by a hob of larger diameter than the screws cut to give clearance; but their edge is in an axial plane, and they have a false section if edged out of that plane.

Nor yet again can any revolving, inclined tool work upon the normal section truly, as the axial section projects beyond it, and would be cut away thereby. If such a disc is attempted to be fitted to a normal line on a symmetrical screw, it will be found to be only possible to fit it to the axial section; when working, it will, of course, produce a true normal section. An upright parallel disc of sufficiently small diameter to clear might be cut to operate on the normal section of a V-thread; but I would rather be excused from either attempting to make one accurately, or even to define the nature of its curves.

In par. 9 is not "stereotomy" a misprint for stereometry?

What we are writing about seems to me to be something of a "worm that dieth not." Several correspondents have settled it, or scotched it, in their several letters, yet it flourishes apace. I fancy the general reader will now have about lost sight of its two extremities, and will relegate it to the transcendental mathematics, politely speaking.

Vulcan.

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## THE PRODUCTION OF SCREW-THREADS.

[24242.]—I THINK Dr. Edmunds and Mr. Hines are mistaken in the view they take of one branch of this subject—viz., the trueing up of V-threads by means of revolving lap-wheels. The theory as expounded by the former gentleman (24172) is that, "by the use of a revolving V-cutter, or V-grinding wheel, traversed by means of change-wheel arrangements, and having its axis tilted for the pitch of the thread, the most perfect thread possible can be trued up with ease and certainty" (some may be inclined to doubt the utility of "trueing up" a thread, which is already as perfect as possible).

Fig. 1 represents a double V-threaded screw; a section of the thread made by a plane passing through the axis of the screw, being represented by Fig. 2. Here I may say that in taking this form of thread I have been guided only by convenience. A E B will then represent the position of the revolving lap-wheel, being at the angle which the top of the thread makes with the vertical. C E D, at right angles to A E B, is then the axis of the lap-wheel, the point E being in the same horizontal plane as the lathe centres. Then a section of the thread taken along line C E D, and in such a direction that point E passes through the axis of the screw (that is horizontally), is as shown at Fig. 3. Therefore a lap-wheel with a V edge, the sides of the V being straight, would grind the sides of the thread hollow, the error being smaller the smaller the pitch and the larger the diameter of the screw, but always existing.

FIG. 2.

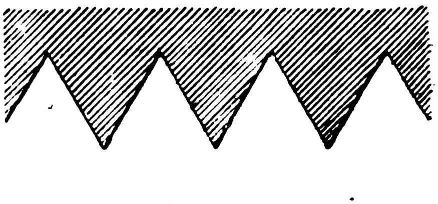


FIG. 1.

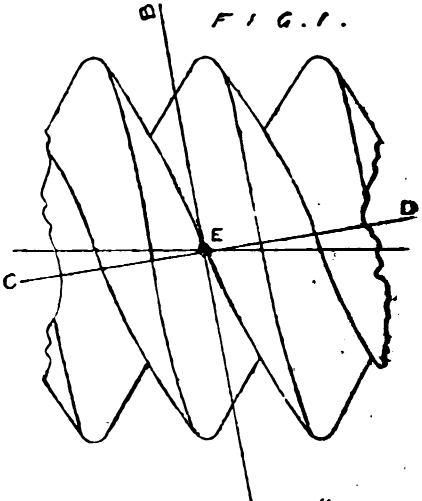
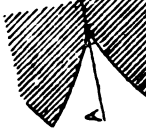


FIG. 3.



It may be asked: Why not make the sides of the lap hollow? But leaving out of account the difficulty of determining the exact curve *and* maintaining it, each different screw would require a different curve.

I had intended adding a few notes on the inapplicability of the chaser, excellent workshop tool though it be, when screw-threads of a high degree of accuracy are required, as it has several inherent defects besides those mentioned by Dr. Edmunds; but I fear I have already occupied too much of your valuable space.

May 6. Canmore.

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## LATHE MATTERS.

[24243.]—CIRCUMSTANCES have prevented me replying before to the letter of Mr. Hines (24111), and I have only time to say that if he will turn to letter 24072, col. 2, p. 124, and to the first part of letter 23975, p. 60, he will see that I have taken account of the distance travelled by a chuck over the cylindrical portion of a mandrel; and on p. 83, letter 24027, column 3, line 23, he will see the question of time so occupied has not escaped my notice, though this latter being of less importance than centring properties I did not enlarge on it, and therefore these are not new elements. Mr. Hines, in the same letter, also says: "And I have already said that as we extend our bearing surfaces, so we diminish pressure and lessen abrasion." I have tried to prove this on more than one occasion, but I have failed to find any such words in any letters signed by Mr. H., and it seems to me that he has unwittingly quoted from myself; and how Mr. Hines can reconcile this admission with his statement in letter 23838, to the effect that, "if the cylinder-fit was a long, parallel one, as some have suggested" (myself included, I presume), "the wear upon the front portion of it, combined with the wear on the chuck, would be sufficient after a time to render its centrality imperfect," I should like to hear. First, he says that by employing a long cylinder we introduce sufficient friction to wear the parts out of truth after a time; but by using Dr. E.'s short cylinder there would be no real wear. Then he says that by extending the bearing surfaces we lessen abrasion, implying that there was abrasion in a smaller surface, and which might be advantageously decreased by extending the bearing surfaces, and which an increased length of cylinder accomplishes. I hope this criticism will not tend to make Mr. H. abstain from favouring us with his, in many ways valuable, contributions; and if I am shown to have committed an error, I shall be only too pleased to acknowledge it as politely and straightforwardly as Mr. H. has done in letter 24111.

I am very sorry not to have been able to answer Dr. Edmunds' remarks on p. 148 before, and turning to my Fig. 5, p. 83, I think, as mentioned in my letter 24027, that if we take A as a centre about which angular variation takes place, we should find that the opposing surfaces to motion in an upward direction or the reverse of that represented by the hands of a watch are indicated by the lines A B and A C; and if the centre about which variation in truth took place was removed to a point corresponding with A in the cylindrical surface opposite A C, and the motion was in a downward direction or corresponding to that of the hands of a watch, surfaces of exactly similar dimensions would offer opposition. If, however—returning to A—the motion, as in the last case, instead of in an upward had been in a downward direction, surfaces A B and A C would not act; but the opposite cylindrical surface to A C would resist slightly, and A D would do so fully, and precisely similar parts would act in the same way if the motion was an upward one and the drawing turned upside down.

If the centre of motion was at B or D, the whole of B D would or would not act according to the direction of the motion; but whichever way it was, both A C and its corresponding opposite cylindrical part would resist, but only slightly so. If the centre was at C, A D and A C would oppose an upward motion, same as watch hands, and A B and the opposite cylindrical part to A C would oppose a downward or reverse motion, so that there are six points about which variation can take place, and these are in a pair of three each, and the effect of motion upwards or downwards about either three is truly typical of the effect produced by contrary motion about the opposite three. I fail to see that I am wrong, or that Dr. Edmunds has corrected me; but I beg to thank him for his very scientific letter on "Cutting Screw-Threads."

The Laurels, Westbury-on-Trym, E. J. S.
May 5.

## LATHE MATTERS.

[24244.]—In the middle column of p. 190, there is a paragraph commencing, "In 'J. K. P.'s' valuable contribution (p. 149) it is stated," &c. I beg to say that the sentence, as it stands on p. 149, exactly expresses what I meant at the time, and what I still consider to be correct. A cutter is he or that which cuts, and the portion of a cutter that is out of action cutteth not, and for our purpose need not be considered as a cutter at all. Fig. 1 is an illustration of my meaning; *a*, *b*, *c*, being three different positions of the cutter relatively to level of centre line, or, as I commonly call it, centre line, the first-named only being on that line; in which case my contention is not disputed. I also give a sketch or two in illustration of some things that to me appear to take place when using circular cutters, or their equivalents, for shaping different objects. Take, for instance, the action of a cutter, C, cutting a groove in a flat surface, S (see Fig. 2). It is clearly indifferent to the action of the cutter, whether the material, or, say, the work, is drawn along under it from *b* towards *a*, or the cutter itself is drawn along in its supporting frame (not shown) from *a* towards *b*, and supposing the spindle of the cutter to be at right angles to *a b*, the groove at *g*, as shown in elevation, will be a counterpart of the cutter.

Next (see Fig. 3) let the path of the cutter-frame or of the work be still on the line *a b*, but the cutter be inclined to *a b*, at some small horizontal angle, see what occurs. Examining it in elevation, as before, the edge of the cutter, instead of appearing as a vertical line, is changed into an ellipse, and instead of its cutting a sharp V-groove, a counterpart of itself, is producing one with a curved bottom—anything but its own counterpart. It is plain, too, that the larger the cutter, and also the greater the inclination of the cutter to the line *a b*, the greater will be the width of the groove for any particular depth, and, in fact, going to extremes, if the cutter were placed square with *a b*, and gradually sunk up to its axle, it would eventually remove a complete semi-cylinder.

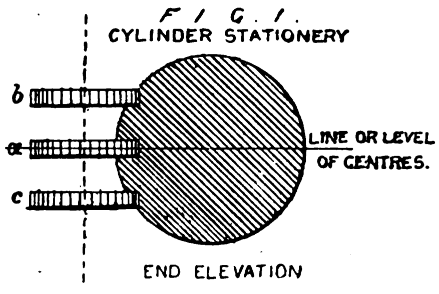


FIG. 1.

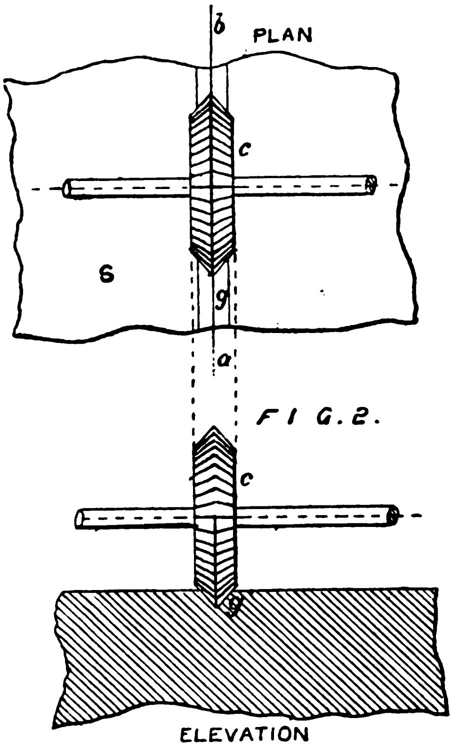


FIG. 2.

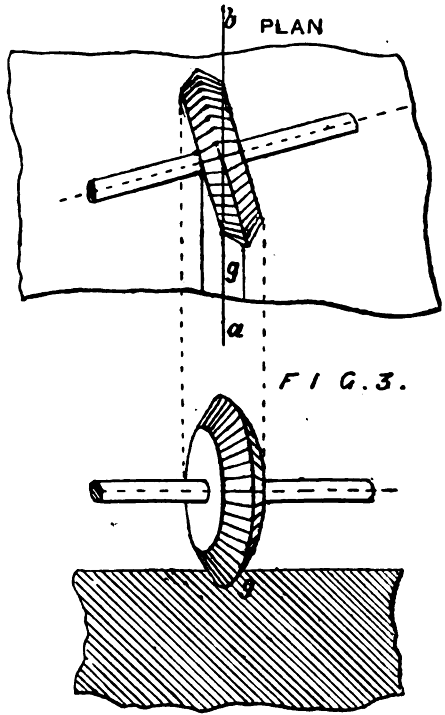


FIG. 3.

In cutting screws by means of circular cutters or grinders of any kind, the above widening of the groove seems to require attention. If you use a V-edged cutter, with its spindle in the plane of the axis of the screw, you will get a groove with its bottom somewhat rounded out, as in Fig. 3, and the section of the thread will be hollowed on the sides. In this case the height of axis of cutter as to centre line needs no attention.

Much less distortion is the result of placing the cutter inclined at the mean angle of the rise of the screw thread, and then I have reason to believe that the diameter of the cutter used is a matter of entire indifference, as to its clearing the cut: that it may not only be made of an infinite diameter, or become a straight cutter, like a file, but may be curved the reverse way, and be as an annulus with internal teeth, and even reduced in diameter, till it assumes the form of a pair of ordinary screw-dies.

In answer to the question on p. 189, near the bottom, "will 'J. K. P.' kindly explain?" Yes, with pleasure, next week. I have got the drawing ready, but it is too rough for engraving, and I could not make a fair copy in time for the present issue.

I think I have already said all required to answer the preceding paragraph, except the last question, to which the answer seems to be this—viz., because the cylindrical fittings are unquestionably better, stronger, and handsomer, and generally more suitable for those particular purposes, whilst it does not appear necessarily a sequitur that they should be the best for all purposes.

In p. 190, half-way down the first column, I can hardly imagine a difference of opinion to exist. Unless I totally misunderstand the subject in dispute, I should say that Mr. Wenham is correct; yet, as I refuse arguing, I am possibly going too far in even expressing my notions on the point.

J. K. P.

[24245.]—I have no desire to maintain a trade squabble with an angry maker of small lathes, as it brings no useful information. Mr. Hines' sense might well remain indicated on the merits of his last letter; but as I am imperatively called upon for some reply, I will answer briefly.

Reverting to the origin of this correspondence as to the circular cutter and grinder for finishing screw-threads, I may say that I have had no reason to deviate from my statement, or "find courage to set myself right." I have consistently stated this cutter to be impracticable and a blunder, and the pertinacity with which it is maintained confirms a doubt of the comprehensive faculty of the proposer. To put the case differently: take a turned rod 1in. in diameter on which a spiral is to be marked, having 8 threads per inch. Now, if a rotary cutter having the width between the threads is set just to scrape the surface, it must be set exactly at the angle, for if either more or less, it will trace a pathway wider than the cutter. Now, if we take another turned cylinder just the diameter reached by the bottom of the V-thread also having 8 threads per inch, a line has to be traced on this with an edge cutter of the same diameter as before. This must be set at a greater angle to the axis; but still it must be exact, or neither more nor less, else, instead of a line, a dimension in width will be the result. It would never make good work to try and give the cutter-edge a twist to meet these two angles, and it is easy to see that every pitch of thread or screw would need a different cutter to get, after all, an imperfect screw-thread. "J. K. P." has pointed this out. It is all very well for Mr. Hines to give him a pat on the back to induce him to see if he cannot alter his statement. As an admirer of his practical sense, I could do this; but I am sure that he has well thought of this before he made the remark, and so the "straw" remains for me to "catch at." Do not be quite so absurd, Mr. Hines; but perhaps your conscience tells you that such remarks are not your own diction.

As to the impracticable and useless mode of grinding up a screw-thread for a finish by a rotary grinder, even if the edge of this is formed so as somewhat to conform to the curved or spiral contour of the thread, we cannot rapidly traverse it to and fro, as is usually done with a free grinder, on account of the backlash of the guide screw of the lathe. The grinder must be entered and readjusted for every run and by the time that it has gone over a thread or so, its line and form will be altered. The admirably terse way in which "Tubal Kain" has put the case in only six lines at the end of his letter in page 215 of last issue, so as to be comprehensible to everyone, leaves but little further to say on this point.

There is no reason why I should not accept the statement that certain makers leave their mandrel-noses soft; I can only remark that I regret that it is so.

To assert that I have "appropriated" a suggestion about tempering mandrels is rather cool. I tempered mandrel-noses this way when this claimant was not out of school, and as mandrels were hardened before I was born, drawing the temper by a hot iron would be on this plan, which any workman would adopt. At the time that I was in business as a maker of machinery, every lathe in my workshop had a hardened mandrel. What kind of lathes? some might say. For screw-cutting lathes I had an 18in. centre, by Smith, Beacock, and Tannett, weighing about 10 tons. A 12in. ditto, by Scriven, and two others for screw-cutting for a 6in. and a 3in. So these were no toys.

I pass over the trade matter in Mr. Hines's letter, and the bounce about the £1,000 challenge, which, having now retired, he is sure I cannot entertain, and for the additional reason that I never made a bet in my life. Diamond-cutting tools act just like any others in the hands of those who know how to use them. As required, I give the names of the lathe-makers who do so. The first is H. Walz, 55, Wallstrasse, Berlin; another is H. Seidel, 158, Linienstrasse. Private inquiry appeared to me to be the proper course; but this was denounced as a "paltry excuse" by a monger in coarse expletives. Further, if any intending purchaser is satisfied with the appearance of these lathes, as shown by the illustrated price lists, I will enable him to see them in use.

And now to "run away" (as they would say) from this peddling drift of the subject. I refer to the letters of "J. K. P." and "Tubal Kain," both evidently practical and familiar with workshop production. I quite agree with their statements, that after all that has been said about the vaunted "model mandrel" (with which we have been so persistently haunted for the past two years) it ends in this, that the angular thread alone, without any cylinder fitting, is the best and truest centring agent, and retains its truth after considerable wear. The threads act as a series of reverse cones, which always bring the chucks in place. The inference is, I suppose, that such screws cannot be cut true: this is a mistake, for with a good screwing lathe they can be made quite as true as any cylinder work. If the finishing cut is taken with a chaser having only three or four teeth kept well sharpened, and used with a very slow speed, even with the back gear on, and fed with oil or suds, the screw will turn out with a brilliant polish, and be made to fit the gauge nut far more accurately than can be effected by any grinding process. At one time I should have made no hesitation in taking the contract for a gross of mandrels, every one of which, when screwed into a test chuck finished in the lathe, should have the free or tail end running absolutely true; as I have said before, there are plenty of light turners who could be trusted with this simple job. Of course, something must depend upon the sort of screw-lathe employed. If this has been unfairly used, and principally for short work close to the mandrel, that part of the leading-screw will have worn progressively, and have an irregular or losing pitch; few old screw-cutting lathes will stand the following test:—Cut a screw on a short piece of metal close to the mandrel end; cut another screw on the end of a rod as long as the lathe will take. If there has been much wear, the threads of these two screws will not fit into each other. My old friend, Andrew Muir, was one of the best screwcutters that I have known; his practice with his own lathe was to have a tie-bar connected with the rest, which enabled him to slip the nut on any part of the screw, and he shifted it periodically, so as to equalise the wear throughout the entire length. **F. H. Wenham.**

### POWERFUL OPERA GLASSES.

[24246.]—Replying to G. Dickson (24217), page 218, I regret to know that he and others have been put to needless trouble and disappointment in the matter of obtaining the powerful glasses provided for them at 117, Victoria-street. It has been caused by the factor so often met with in kindred establishments—popularly known as red tape. The optical department were ready to carry out their part. The secretarial department interposed the law quoted by G. Dickson, not perceiving that I had provided against it by a general order given on behalf of all readers of the "E. M.," to be supplied through my account. I believe, however, that if future orders quote the number 35,462, they will be duly honoured. **Montmartre.**

### THE NEW TIME.

[24247.]—For months and months I have scanned every reference to "new time," as it is called, with the hope of learning the practical utility of the change. At last, we are told, on what I suppose must be confessed to be the sufficient authority of "F.R.A.S.," that the benefit is in the "simplicity of the new mode, and the absolute immunity it affords of all confusion between a.m. and p.m." I do not quite know what "immunity of confusion" may be; but does not that phrase remind you of a well-blown soap-bubble—precious little inside when you have got there? Simplicity! To have 39 figures (Arabic) to look at on a clock-face instead of 15. No one has ventured, so far as I have seen, on Roman figures, always used on account of their plainness. "Immunity from confusion!" (I venture on a correction.) Fancy trying to catch the last train, and wondering whether you had just heard 22 or 23 o'clock striking. Ten or eleven you might have counted and been sure, but with each additional stroke comes increased liability to error. But, oh! dear, to common, ordinary bodies what endless confusion there would be! And all because a special class, whose *forte* is in abstruse calculations, cannot bring themselves down to ordinary life. Didn't Newton sit with his legs in the chest of drawers, and think he had put his trousers away? And is it not on record that he made one hole in the barn-door for the cat and one for the kitten? But we have not thought it necessary to make changes in trousers and barn-doors on account of that little amiable weakness. And can we really think that a man who breakfasts on logarithms and dines on formulas with a little light algebraic refreshment thrown in at intervals during the day, can't find his way about Bradshaw. Surely he must have what he speaks of later in his letter—a craze—to talk like that. Would it be used and sold as it and other railway guides are, if so misleading? By all means, if astronomers find it convenient, let them use their 24 hours; but pray leave us what we consider our sweet simplicity still.

I do hope, Mr. Editor, that you will give me an opportunity of saying so much. I really have waited so patiently to see the advantages of the advocated change, and now I have seen them at last, they seem so very chimerical and unreal, I cannot help expressing an opinion on the other side. **Civicus Olim.**

### MOUNTING BACTERIA.

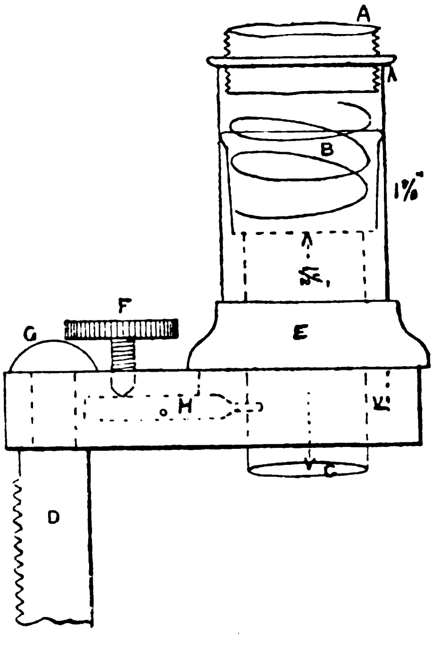
[24248.]—F. Grant, in his very interesting and exhaustive article upon the above subject, appears to assume, as a proved fact, that the B. tuberculosis is contagious. He gives most elaborate instructions for destroying any trace of sputum containing the bacillus upon the instruments used, and to prevent its inoculation upon cuts or the breaking of the cuticle by pricks of needles, &c. Now, I am not one of those who deny that tuberculosis may be contagious; on the contrary, I furnished two cases occurring in my own practice to the Collective Investigation Committee of the British Medical Association, where I believed that the contagion of tubercle had been conveyed to others; but then they were persons who, while in bad health themselves, were for months in constant attendance upon and occupying the same rooms as the invalids, and it must be recollected that out of the large number of replies put in to the query of the Collective Investigation Committee: "Do you believe in the contagiousness of phthisis?" the majority answered "No"; and to the second question asking for particulars of cases proving the affirmative, but a small proportion of the answers could be considered as even approximately conclusive. In fact, any impartial person reading the evidence offered for and against the theory in these replies, must return a verdict of Not Proven. I am aware that tuberculosis can be communicated to some of the lower animals by inoculation, e.g., guinea pigs, but it is not yet a proved fact that the bacillus itself is the *materies morbi*. By many competent observers it is considered that the bacillus will only grow upon a suitable soil, and that no amount of exposure would induce tubercle in a human being who was not, either owing to temporary lowering of the system from other causes, or from a constitutional or hereditary tendency, liable to contract tuberculosis. Whether the bacillus is the cause of the disease or not, the facts hitherto ascertained go to prove that it is invariably associated with it. I should not have troubled the readers of the "E. M." with these observations were it not that it appears to me the precautions suggested by your correspondent, which are right and proper as regards the bacillus of anthrax, and that supposed to cause diphtheria, may convey unnecessary alarm to those of your readers who may have relatives and friends suffering from that dread disease pulmonary consumption, and through them to a larger circle; haunting them while in the presence of the sufferers with the fear of infection, and torturing the minds of the sufferers themselves with the fear that they may communicate the disease to those dear to them. In fine, the balance of evidence at present is to the effect that pulmonary consumption, if communicable at all from one individual to another, is only so under certain combinations of circumstances which rarely occur, and that with proper attention to ventilation and cleanliness, there is no fear of it whatever. Thousands of persons are in daily attendance upon sufferers from consumption, and must, from various causes, both inhale and swallow daily myriads of the bacilli and their spores, and yet of the few hundred medical practitioners who stated they had seen cases where they considered the disease was communicated, hardly any were able to furnish more than one or two such instances out of the many cases they must have attended in the course of their practice. Further on, F. Grant states that the double stain for B tuberculosis with magenta and aniline green is Heneage Gibbes' stain. I shall be glad to be corrected, if in error; but I was always under the impression this was Erlich's, and that Heneage Gibbes recommended solution of chrysoline as a differential stain after first using the magenta. I must say I never found it satisfactory. In conclusion, I must thank F. Grant for the many very valuable suggestions in his paper.

**Medicinæ Doctor.**

## REPLIES TO QUERIES.

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[54721.]—**Micro. Adjustment.**—"Sempervivo" will find the inclosed sketch of a fine adjustment for microscope the simplest and easiest made. The lengths of tube are marked the exact sizes. I shall be pleased to give any other information if he will advertise his address in the "Sale" column.



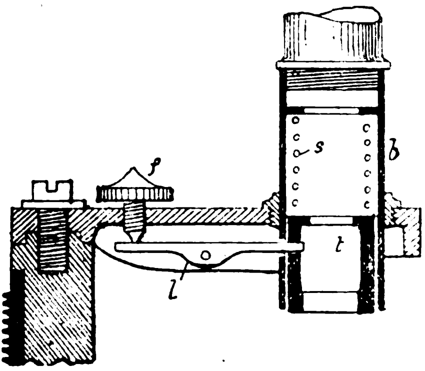
I may say almost any microscope maker will supply the tubes ready screwed if that is a difficulty. A casting screwed both sides, one into body and the other into fine-adjustment tube; B, a tube fitting inside; C, tube for screwing objectives into; F, fine adjustment milled head; E, ornamental base piece; H, lever acted on by F and spiral spring B; D, bar of microscope.—Meniscus.

[54825.]—**Salt, &c.**—"Dens" is surprised why I introduced the "geological strata." Because the lowest forms of men, such as "cave men," river-drift men," the famous "Néanderthal skull," the bones of man recently discovered in the excavations at Milford Haven, &c., are to be found in the "strata." These being, as far as our present knowledge goes, "primitive man," the same strata should show traces of "higher" cultivation or civilisation; while, on the contrary, all we find are "lower" traces—*i.e.*, nothing but chipped flint implements. For if man was created civilised in his primitive state and subsequently deteriorated, became more and more savage, it follows that the tools and implements found along with his remains should be more perfect in the older strata or formations than in the newer. In fact, as we traced up man we should find the scale of cultivation an ascending one, and not as we in fact find it, a descending one. Therefore, it seems to me more in accordance with common sense to believe that all the more perfect forms of life now existing have developed from previously existing lower forms, including man, beast, and plant; in short, that nature's law is uniform.—F. W. H.

[55700.]—**Strength of Shaftings.**—I am glad that the stupidity of the remarks made by "Bacchus," in last week's issue of the "E. M.," has been so neatly exposed by being placed next to the courteous recognition by "Glatton" of my demonstration of the strength of shafting, and my corrections to what I perceive were mere slips of the pen.—G. O. T.

[55700.]—**Strength of Shafting.**—It never occurred to me that the book might be wrong. "That which is in print *must* be true," you know; but I see that it is. Of course, if the strength of the 6in. shaft were nine times that of the 2in. one, they would vary in strength as the squares of their diameter, and not as their cubes, as I have proved they do. It will be noticed that as, before breaking, the outer fibres move through the same distance, *a b* (see Fig. 1, page 174), the smaller shaft moves through a larger angle than the large one, and in designing a long shaft this has to be taken into account, and the shaft made stouter than is required to resist breaking strain, in order to diminish this angular springing.—Glatton.

[55819.]—**Microscope Fine Adjustment.**—I give a rough sketch which will explain the principle of one form: The object-glass screws into the shaft tube *t*; this is made a sliding fit in the body *b* of the microscope, a spiral spring S abutting on a flange in the body pushes *t* downwards. It cannot come out, as a lever *l* holds it up. The screw *f* moves the lever, and with it the object-glass; *c* is the rack for coarse adjustment.—Glatton.



[55835.]—**Workmen's Time Check.**—I cannot find it in my copy of their catalogue; but I believe I have seen the very thing you want in one of Messrs. Bailey's advertisements. Write and ask them. As far as I recollect, a tall clock had a slit in the lower part of its case, through which the men drop their time checks. Beneath this is one of a series of compartments or boxes, which are made on the edge of a small disc or table, which is turned round by the clock. One box is wanted for each period of entry or exit. Of course, when the time is up, the next box is presented to the slit, and receives the "too late" checks.—Glatton.

[55857.]—**Pressure for Stamping.**—Your best plan is to try an experiment. Without that, I can only make a very uncertain estimate. Assuming that the lead crushes with a pressure of three tons per square inch, and that as the die sinks this pressure is increased to, say, four tons, the requisite pressure would be $6 (4 \times 1\frac{1}{2} \times 1\frac{1}{2}) = 54$ tons.—Glatton.

[55875.]—**Cupola Blast.**—To "Invicta."—I have looked in vain for a reply to "Blow Hard's" query. I hope "Invicta" will give the particulars asked for, and, if possible, an estimate of the steam used per ton of iron, as compared with the consumption with a blowing engine. What was the pressure of his steam, and size, and shape of injector?—Glatton.

[56041.]—**Gun-metal.**—Prof. Bloxam, who was lately professor of chemistry in the R.M.A., Woolwich, and in the department of artillery studies, says in his book:—Gun-metal is an alloy of 90·5 parts of copper with 9·5 of tin, especially valuable for its tenacity, hardness, and fusibility. In casting cannon (erroneously called *brass* guns) the mould is placed perpendicularly, &c.—A. R.

[56278.]—**Wood Filler.**—There is nothing better than glue or size, and it must be papered down before applying the varnish.—E. G. M.

[56279.]—**Tennis Grounds.**—Properly laid tar paving will do, but it feels soft in hot weather, and is liable to be broken by the vapour arising underneath unless the ground is well drained and a thick bed of brick or cinder rubbish put under the tar asphalte.—N. E. Child.

[56291.]—**Wheatstone's Bridge.**—To Mr. Barter.—Many thanks for your reply to this query; it has just escaped the U.Q. list. I am afraid I have not made myself understood. What I want to know is this: The least number of Leclanché 7in. cells to measure or balance 500 ohms, having 5 ohms in each left-hand opening of the bridge. Then, how many would do to balance 1,000 ohms, using 10 ohms in each left-hand opening? Not only is it a question of economy, but correctness of result. It is the heating of the coils you mention I wish to avoid.—M.M.I.Sc S.

[56297.]—**Musical Bells.**—How are these bells hung or fixed? That is most likely the place to look for the cause.—F. L. C.

[56309.]—**Parallaxes of Stars,' &c.**—In the reply on p. 197, for "Œltyen" read "Œltzen"; for "ε Eridani" read "e Eridani." The declination of Spica should be − 0° 9'.—H. Sadler.

[56323.]—**Finishing Silver-Plated Goods.**—I was not aware I had promised instructions on this subject. When the articles are removed from the plating bath, they should first be rinsed in clean water, when, if to be left dead white or mat, wash with plain soap and hot water applied with a soft brush, rinse well, and throw into a vessel containing boxwood or other non-resinous sawdust until dry, when beware of fingering the plated parts. There are two other ways of finishing the plated surface—by burnishing with an agate burnisher (made in various shapes and sizes according to requirements), well wetted with soap and water, until quite bright, then finished off with rouge on a leather or wool buff, or on the naked hand. These buffs usually revolve on a lathe. Or the surface may be scratch-brushed, for which I gave full instructions some time since. This produces a bright but dead appearance, and in connection with the bright polished surface looks very well. Or, again, oxydising or gilding may be introduced. If you want any more hints, please state in what direction you require them.—Goldsmith.

[56332.]—**Optical.**—Many thanks to "T. H. L." I think his reply to this, on page 176, answers my query, No. 54318, page 499, Vol. XXXIX., and I conclude that it is impossible to adjust my Abney's level so as to be correct in more than three positions. As the formula is rather a long one, perhaps "T. H. L." could tell me without working it all through, at what angle I should take $\phi$ in his figure in order that $b$ may be about the mean of the position it may assume, while $\phi$ varies from 0° to 45°. Also if it varies from 0° to 90°. It looks as if A $b$ must cut the vertical line between D and Y if it is normal to an ellipse, the minor axis of which lies along D$x$, which, I suppose, it must do if D is the centre and B the focus. Perhaps it is normal to the further side of the ellipse.—Glatton.

[56340.]—**Query Meaning.**—The error is a very common one, and is caused by looking at the figures the wrong way. Thus, if B. makes an article for £50 which A. makes for £100, B. is apt to say that his is 100 per cent. cheaper, because £100 compared with £50 is 100 per cent. advance, whereas of course he should say that £50 is only half of £100, and therefore the article is only 50 per cent. cheaper—or what is more likely, lower priced.—F. C. A.

[56365.]—**Flat Foot.**—I sympathise with "Flat Foot," having myself suffered in the same way for two or three years; but now I may say I am quite well, except when going down a bank or having walked more than usual, but have a good deal of walking every day. The way I got my trouble was by lacing my boots too tight. When the bone-setter got hold of my foot he asked how long I had suffered, and I said about seven months. "Over long," said he. He then said there was a small bone had got out of place, and it would now be bad to get in and keep it so, as it was where a bandage could not well touch it, and his being a cotton cloth one, it would be of little or no use. I had water run on my foot, and other such things, but to no purpose. I at last got some elastic webbing and fastened it round my ankle, which gave me a little benefit, but found the tapes to fasten it round my ankle prevented me getting the use of the elasticity, which I found was what I wanted. I afterwards took off the tapes and put on some hooks and eyes to fasten the bandage, and with a tape stirrup to go underneath the foot. After wearing this out I went to buy more. However, I got this time some "indiarubber band," about 3in. wide, not webbing, about a yard long, for 2s. 6d., which I found to be the best thing I could get or use. When I first put it on I was delighted. I put this bandage on thus: One end on top of the foot, and brought the other part over it and round the ankle twice, then again round the foot, and finishing off on the top of the foot; not too tight, but the weakness being near the under part of the ankle, I used to pad it a little with cotton wool. The elastic band did not require anything to fasten the end, as it was adhesive enough, and I got the full advantage of the elasticity. I wore it daily, and often at night also; at first I could not sleep without it. I used it thus till I was quite freed from pain, &c., and now do without it altogether. I have since worn shoes only, but not made in any extraordinary way. Hope this may be of service.—J. D.

[56379.]—**Bichromate Battery for Lighting.**—If the leakage is of no consequence, why not remove the partitions altogether? In my opinion it is one of the two causes of failure. By uniting the two liquids in the ten cells, it converts the whole into one large cell, the useful elements being the two to which the wires from the lamp are connected; all the rest are wasted. "Accumulator" says we should get more current than one cell would give. Why? By having ten times the thickness of liquid between the plates, we should get ten times the resistance of an ordinary cell, and consequently only one-tenth of the current; but, besides this, the wooden partitions tend to further increase the resistance, as the only useful electrolyte is that passing through the leaks—which I take to be very small—thus reducing the current to a very small fraction. I should like to hear "Accumulator's" reasons for this statement. "In the Dark" asks "whether the carbons, being larger than the zincs, are not sufficient?" &c. It does not matter about the carbon being larger, as only that portion of it which stands exactly opposite the zinc is sensibly acted on; so that by using two carbons he would get double the useful surface. This is advisable; not necessary. There are so many different bichromate solutions, that it is difficult to say which is best. The following, I think, is fairly good:—"To every pint of saturated solution of bichro., add one fluid ounce of sulphuric acid. Assuming that each of your cells will give 1·8 volt E.M.F. (which I question) and that the resistance per cell is ·5 ohm; at the best, you can get 16·2 volt-ampères (watts) useful energy, which would mean, taking 2½ watts per candle, about 6 candle-power. This would be when the resistance of the lamp equalled the resistance of the battery, so that 50 per cent. of the total energy would be expended in the battery.—Frank Broadbent, Cadby Hall Works, Hammersmith.

[56383.]—**The New Station at Birmingham.**—I should be greatly obliged if H. W. Hudson (p. 177) would say how long the platform is at the new station, Birmingham?—A. B.

[56387.]—**Medical Coil.**—Yes, you can charge with the bichromate solution; but you must take out the zincs from the liquid when not in use, as the solution acts upon the metal, whether the cell is at work or not. If your plates are fastened to the cover of the cell, you can easily lift the whole arrangement out without trouble. The solution should be composed of ¼lb. bichromate, ¼lb. sulphuric acid to 1 pint of water, and not as printed in my previous reply. As the surface of the elements is very large, the current may be too great for your purpose. If so, you can dilute with a larger quantity of water.—C. D. R.

[56393.]—**Steam.**—With steam more than 12lb. pressure above the atmosphere, the weight that will escape from an orifice one square inch area in 70 seconds, is just equal to the gross pressure in pounds per square inch. Then for a pressure of 50lb., and an orifice of 2½in. diam., the weight of escape per minute will be—70 : 60 : : 65 = 55·7lb. per square inch area of orifice, and 55·7 × 4·9 = 273lb. escape per minute.—Yama.

[56404.]—**Overflow in Water-waste Preventer.**—The best thing will be to send the waste preventer to the maker, as I fancy the outlet valve has got loose, or that it is improperly fitted; perhaps the ball valve is out of order, or if it is a siphon waste preventer, probably it is air bound—viz., the supply pipe to closet may form a trap below the closet seat, which would have the effect of continual leaking.—P. J. Davies.

[56404.]—**Overflow in Water-waste Preventer.**—I asked for information how to remedy overflow in water-waste preventer which was trying to run cistern dry by perpetual waste. As the w.w.p. is likely to become a necessary institution in every household by Act of Parliament, I will (in the absence of reply from any expert) answer my own query myself. The reported overflow not only continued, but was supplemented, first, by a constant waste-stream through the pan as well, and finally by a third unascertained manner of overflow, which came down through the house in spite of the overflow pipe. At this stage, I forced down the feed ball cock about half an inch, so lessening at same time the power of the flush-charge by decreasing its quantity, but effectually curing all three forms of overflow. Our readers may possibly think it natural that the maker should be applied to to remedy the defect. It is, therefore, well they should know that by the rules of the trade the wholesale maker is forbidden either to remedy a defect himself, or to supply the name of a plumber who understands the instrument! Messrs. Bolding, the makers in this case, are my authority for this curious fact. Householders are thus forced, as I was, to send to promiscuous plumbers, who will "send a man to see." I tried three firms in succession, and paid three bills for unsuccessful services, before I wrote to the "E. M." for relief. I presume there is a regulator to effect what in my ignorance I attained by force. This answer is, therefore, unsatisfactory, though it is better than silence.—Montmartre.

[56461.]—**Pressure on Sides of Tank.**—The pressure on the sides or ends of a tank or vessel is equal to the area in feet multiplied by the height of the centre of gravity in feet, then multiplied by the weight of a cubic foot of water. For example: Find the pressure on the sides of a tank 10ft. deep and 12ft. long.

Area of side 10 × 12 = 120 sq. ft.

Now, since the centre of gravity is half the height (5ft.), and a cubic foot of water weighs 62·5lb.—

$$\therefore \text{ Pressure on sides} = 120 \times 5 \times 62{\cdot}5 = 37{,}500\text{lb.}$$

$$\therefore \text{ Average pressure on the square foot of side} = \frac{37{,}500}{120} = 312{\cdot}5\text{lb.}$$

If it be 8ft. wide, the pressure on the end is—

$$= 8 \times 10 \times 5 \times 62{\cdot}5 = 25{,}000\text{lb.}$$

—C. E., jr.

[56446.]—**Cement for Rainwater Pipe.**—Paint the pipe and get a piece of zinc two or three inches longer than the crack in the pipe, and also paint that, then with some red lead putty, bed the piece of zinc closely on to the cracked pipe and tie it on with string or wire, after which paint the zinc to match colour of pipe. This, if properly done, will last a long time, and not look unsightly.—P. J. DAVIES.

[56464.]—**Ammeter.**—By tapping the key before permanently closing the circuit, the violent swing is avoided. A little practice only is necessary.—F. BROADBENT, Cadby Hall Works, Hammersmith.

[56476.]—**Incandescent Lamps.**—The reason that the carbon filament is consumed is that the carbon combines with the oxygen of the atmosphere to form a gas, carbonic dioxide (carbonic acid).—FABER FABRUM ADJUVET.

[56476.]—**Incandescent Lamps.**—The filament being only about the thickness of thread, would naturally be consumed almost immediately in air. This is why the lamp is exhausted.—FRANK BROADBENT, Cadby Hall Works, Hammersmith.

[56479.]—**Surface Condenser.**—The proper temperature at which to keep the condenser is as near as possible 100° Fahr., or 38° C. At this temperature the steam is sufficiently condensed, while the air-pump has relatively the least quantity of water to raise, or with a maximum amount of useful condensation we have a minimum amount of water to lift. The condenser being maintained at the above temperature, and the condensing water at 10° C., we get the amount of water required for condensation by the following calculation: The total amount of heat in a given unit of steam is 637·2 units C. The amount imported to each unit of water is $38 - 10 = 28$ units C. of the 637·2 units of heat in each unit of steam, it must give up $637{\cdot}2 - 38 = 599{\cdot}2$ units. ∴ The units of water required—

$$= \frac{599{\cdot}2}{28} = 21{\cdot}4,$$

or a cubic foot of steam, as it is produced (very nearly) by a cubic inch of water, will require 21·4 cubic inches of water to condense it. More, however, is always allowed, because it is impossible so to arrange the condenser that every drop of water shall at once consume its allotted amount of heat. The area of the condensing surface per I.H.P. is from ·2 to ·25 square feet.—C. E., jr.

[56483.]—**Linkwork for Slide-Valve.**—I inclose a sketch of Webb's patent link-reversing motion (L. and N. W. R.) The peculiarity of this motion is in the link, which is straight instead of being in concave or convex curves to the driving shaft, like the Stephenson and Gooch links respectively. On moving the lever A (see Fig. 1) in th direction indicated by the arrow, the lever B moves forward, turning about the fulcrum C, and this motion given to D causes it to move another lever E, to which the arms G and F are rigidly fixed; the whole of E moving about the fulcrum H. Thus, when E moves forward, the arm F is lowered and G raised, causing the rods K and L respectively to fall and rise. Now, L is attached to the link M, and K to the connecting rod N, which is hinged to the valve rod, and, therefore, when K and L are lowered and raised respectively, the link M is raised while the connecting rod N is lowered. Locomotives can be reversed when in motion; but when this is attempted, the framing of the engine is subjected to very great strains; for an engine, going at even the lowest speed, will have a certain amount of inertia, and will not, therefore, "pull up short" by itself directly steam is cut off. But now, if steam be not cut off, and the engine be reversed, steam is admitted into that end of the cylinder towards which the piston is being forced, due to the inertia of the engine (see Fig. 2); *a*, *a* is the steam entering the cylinder, and *b* is the force which is pushing the piston back, due to the inertia of the engine. Therefore, it is evident that the whole frame, and especially the piston-rod, is being subjected to very heavy strains; in fact, the engine may be said "to be working against itself," and, therefore, it is not advisable to resort to this mode of stopping the engine, except under the most pressing circumstances. With regard to "Linkwork's" observation of the driver pulling the reversing lever while the engine is in motion, it is quite possible, and very probable, that he would do so if the engine were going at full speed, because less steam is then required to keep up that speed than was required to start the engine and get up such speed; he would, therefore, move the link into mid-gear, so that the travel of the valve should not be so great, and, therefore, less steam would be admitted. In other words, he would be economising his steam. I think, too, that in this case "Linkwork" would have observed that the driver did not move the reversing lever from one extremity of the quadrant to the other extremity, but only moved it about half-way. But, on the other hand, if the engine were only being used for shunting, the driver might already have shut off steam when "Linkwork" observed him to reverse his engine; in which case there would be no strains whatever acting upon the piston-rod, &c —W. J. A. W.

FIG. 1.

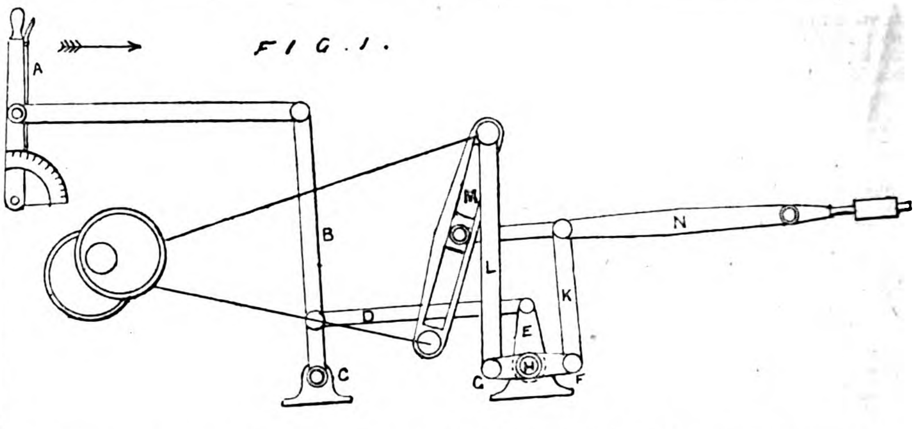
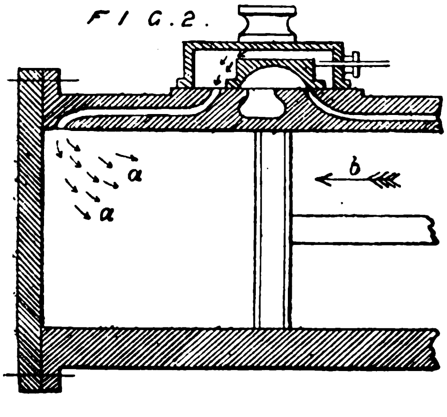


FIG. 2.



[56484.]—**Varnished Wall Paper.**—To endeavour to clean "dirty, smoky wall paper" with a rag and paraffin oil is simply nonsense. "Nun. Dor." should read queries before he attempts to reply. Wash well with strong soap-and-water, rinse with clean, and wipe off with a wash-leather, and avoid all streaky marks. You might as well clean dirty windows with paraffin oil as dirty wall paper.—C. D. R.

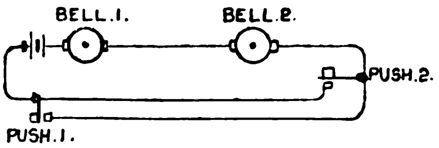
[56485.] —**Model Boat.** — Many thanks to "Invicta" for answer, which told me the very thing I wanted. I may state that the boat must be rather strong than elegant. Some "notion," assisted by spring and clockwork, is expected to make it go at the rate of eight miles an hour. I shall be glad if it does.—VIRAGO.

[56488.]—**Zinc Battery.**—Using zinc cylinders instead of rods would decrease the resistance of the cells, and they would, therefore, give you more current.—FRANK BROADBENT, Cadby Hall Works, Hammersmith.

[56488.]—**Zinc Battery.**—What do you mean by chloride of zinc battery? Is it the cell with chloride of zinc as the excitant, and bichromate of potash and hydrochloric acid as the depolariser? No matter what cell you construct, the negative element should be of larger dimensions than the positive. If, therefore, your carbons are small, the increase in the surface of zinc over and above them is simply waste.—C. D. R.

[56491.]—**Long Distance Electro-Magnet.**—The query is very ambiguous. Explain what you require the magnet for.—G. D. R.

[56499.] —**Electrical.** —The simplest (and I think the only) way would be to connect the bells as in the diagram. Two wires are necessary, unless you can put one to earth. Both bells will ring together.—FRANK BROADBENT, Cadby Hall Works, Hammersmith.



[56500.]—**Gravity Leclanche.**—I think this would be an excellent cell, both as regards cheapness and efficiency. I do not think the carbon wants insulating at all—in fact, the more exposed the better. Look at it for a moment as a zinc carbon element: the carbon in this case produces (so to speak) current; insulate it, and the cell would be useless. The carbon, mind you, must not touch the zinc, or it would be short-circuited. It would be very easy to clean (this cell) by upsetting the peroxide of manganese and crushed carbon into a jar, well washing, and repacking; new surfaces would be exposed. I never saw cells of this pattern, but shall make some shortly. Meantime, I hope we shall have the opinion of an authority—such as "Sigma."—M.M.I.Sc S.

[56502.]—**Faulty Dynamo.**—To MR. BOTTONE.—Will this correspondent kindly explain the last sentence of his reply to this query on page 222? What do M and A represent? If they are the resistances of field magnets and armature, what is R?—WM. JOHN GREY, F.C.S., Analytical Chemist, Newcastle-upon-Tyne.

[56510.] —**Extra Strong Magnets.** —The formula for finding the lifting power *p* of a magnet whose weight is *w*, is given by Ganot and Guthrie as—

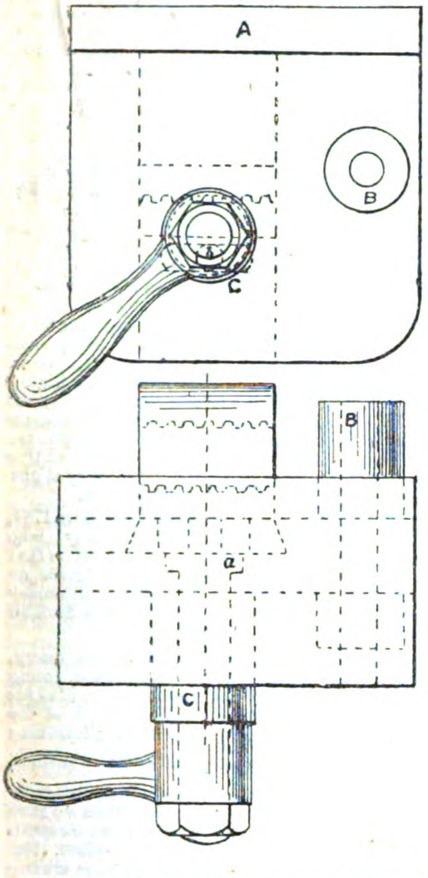
$$p = a \times \sqrt[3]{w^2}.$$

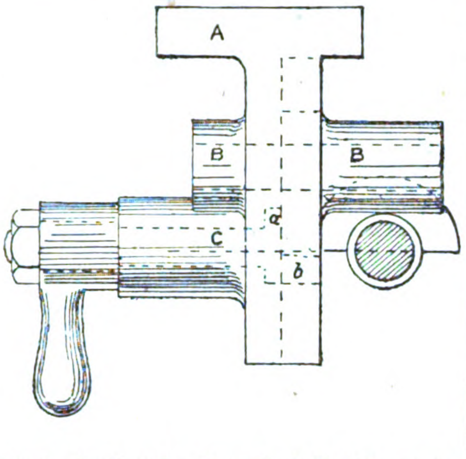
Where *a* is some constant whose value varies considerably for different kinds of steel. It may be as high as 23, so a magnet which lifts only ten or fifteen times its own weight would not be anything extra. Guthrie remarks that this formula requires confirmation, and Silvanus Thompson reverses the indices, which alters the expression entirely. The last-named scientist states that the pull of an electro-magnet on its armature may amount to 200lb. per square inch.—WM. JOHN GREY, F.C.S., Analytical Chemist, Newcastle-upon-Tyne.

[56512.]—**Diamond Tools.**—"T. W." asks for particulars of a machine wherein to use a little piece of carbonado to dress a millstone. The expired patent of Young, A.D. 1868, Feb. 12, No. 475, carried this out. Young described his tool as "what is ordinarily called the black diamond, or carbon, and is met with in Brazil, Siberia, and elsewhere in the form of small rough, dark or 'dull-coloured' stones." I know that many machines were worked, but whether used now or not I do not know.—R. S. T.

[56512.]—**Diamond Tools.**—The dividing frame used for traversing the diamond for refacing or "cracking" the surface of millstones consisted of a dividing and traversing slide at right angles, worked by screws like a slide-rest; this was clamped in place by a cross-bar extending over the stone; the rest did not have to stand much stress from the work done by the diamond, as this acted by the momentum of rotation, just in the same way that a fly-cutter turning on hardened centres is used for grooving. The way in which the diamond was securely held in order to perform the enormous amount of work that it had to do was peculiar. Want of time prevents me from going into the particulars of this just at present, but in my promised article on the use and means of setting diamond turning tools accurately I will explain fully. In the mean time I see by the leading article in the last issue of this journal, on "The International Inventions' Exhibition," that the Waltham Watch Co. use sapphire cutters for making the teeth of their escape wheels. This, though inferior in hardness to diamond, would still maintain an almost everlasting keen edge on steelwork, and a great advantage in both diamond and sapphire tools is that they do not get softened and lose temper at quick cutting speeds, like hardened steel does.—F. H. WENHAM.

[56506.] —**Pattern Making.** —The annexed figures illustrate a plate adapted for use with your slide rest; but the centres and depth will be regulated by the position of your leading screw and rack in reference to each other, and to the bed, and not knowing the section of your bed, I forbear to give dimensions. The flange A affords the means of attachment to the under part of the saddle. The





boss B is for the spindle of the rack pinion. The boss C is for the spindle which moves the half-nut. The spindle is prevented from slipping out by the collar *a*, and the pin *b*, set eccentrically with the spindle, slides in a slot in the plate which is attached to the half-nut, and moves it up sufficiently to clear the screw. The rack should be 7-16in. or $\frac{1}{2}$in. pitch, and screwed under the front bed vee with stove or cheese-headed screws. You can reduce the shape of their teeth from Fig. 59, on p. 161 of of the present volume. The usual set of engineers' change wheels runs from 20 to 120, advancing by fives, which, with one duplicate, makes 22 in all.—J. H.

[56513.]—**Chemical.**—I should imagine that the sample of hydrogen peroxide which jellifies on the addition of ammonia, contains barium chloride in solution, derived from the barium peroxide from which it has been made, and which ought to have been removed from it by the maker.—G. H. HURST, Salford.

[56515.]—**Lead Burning.**—I cannot understand your chamber being full of acid. I generally stop my leakages with china-clay putty, or to stop the fume leakages I take some stiff brown paper covered with pitch. See page 70, Davies's "Plumbing Work."—P. J. D.

[56516.]—**Disabled Marine Engine.**—If one engine was damaged, the disabled one should be disconnected, and proceed with the other. But it sometimes happens where there is much lead upon the slide-valve, that the single engine on being started cannot be got to turn the centre if there be a strong opposing wind and sea; the piston going up to very near the end of stroke, and return again without clearing, or being able to turn the centre. In such cases it is necessary to turn vessel's head sufficiently from the wind to enable some sail to be set, and if once there is way got upon the vessel, the engine will begin to work properly, and will continue to do so, though the vessel be put head to wind as before. If the crank-pin breaks in a paddle vessel with two engines, the other engine must be made to work one wheel. In a screw vessel the same course may be pursued provided the broken crank is not the one through which the force of the other engine is communicated to the screw. A very good book on the marine engine can be had for 6s. by Ainsley: it is called "Ainsley's Engineers' Manual of the Local Marine Board Examinations."—I. H. E.

[56520.]—**Gasoline Generator.**—In reply to "E. C.," the quantity of gasoline taken up by air varies according to the temperature of the air, and also of the gasoline. Under ordinary average conditions, about 250 cubic feet of air will take up one gallon of gasoline. I have no data at hand which will enable me to give the required quantity of air to make this into a perfectly explosive mixture, but should think that the quantity of air will be nearer ten than five times the bulk of the vapour.—T. F.

[56521.]—**Jupiter's Transits with 3in. O.G.**—With a 3in. achromatic telescope, power 200, I have witnessed the transit of Satellite III. and its shadow; my eye was kept at the telescope the whole of the time the Satellite was crossing the disc of the planet, but not quite to the end of the shadow. Satellite and shadow were perfectly visible and sharply defined during the course of their transit. The most satisfactory answer to this query is for "E. P. B." to try for himself what can be done in this respect with his $2\frac{3}{4}$ o.g. My own experience is that a moderately low power is better for these details than a high power.—S. S., Southampton.

[56530.]—**Pallet Holes for Harmoniums**—If this querist had stated what sized reeds he intended to use, a more definite answer could be given; but as a rule two-thirds the length of the vibrator and just clear in width will do. In practice, of course, the smaller reed holes are cut much wider than they need be, because it is too much trouble to change the bits. Here are the usual dimensions for 16ft. and 8ft. reeds. For 16ft., 1st C $1\frac{3}{4}$in., 2nd C $1\frac{1}{2}$in., 3rd C $1\frac{1}{2}$in., 4th $1\frac{1}{8}$in., 5th 1in., 6th $\frac{7}{8}$in. Drill all the bass holes with $\frac{1}{4}$in. bit, and clear out for lowest notes; drill treble with $\frac{3}{16}$in. bit. For 8ft. 1st C $1\frac{1}{2}$, 2nd $1\frac{5}{16}$, 3rd $1\frac{1}{8}$, 4th 1, 5th $\frac{3}{4}$, 6th $\frac{5}{8}$in. Pallet apertures for 16ft. set may be from $\frac{1}{2}$in. to $\frac{1}{8}$in. shorter, ranging from lowest note to top; for 8ft. about $\frac{3}{8}$in. to nothing shorter, all graduating in between. Reeds should be screwed firmly to pan with the tip of vibrator just clearing the end of hole. The American organ valve action was illustrated in No. 1027, and in many other back numbers.—N. E. CHILD.

[56534.]—**Powers of Opera Glasses.**—"Devoniensis" asks how the powers are ascertained. By putting one barrel only to one eye and comparing the size of the image shown through it with the size of the same object as seen by the other eye at the same moment. Thus a ten-power glass will show through one barrel directed upon a thermometer across a room, one degree of its scale, in exactly the same space as ten of the same degrees occupy as seen by the other eye at the same moment. By a little care and practice the two pictures may be brought side by side at once, or one may be superposed on the other, so that if the power of the glass happened to be either $9\frac{1}{2}$ or $10\frac{1}{2}$ instead of 10 exactly, the difference would be at once observed. In the same way different opera-glasses should be compared with each other for power by placing one barrel of each opera glass to the two eyes simultaneously, when the great difference between the powerful and ordinary glasses will be appreciated as the two different-sized resulting pictures appear side by side. I once walked from St. Paul's to Charing-cross and compared the 4, 7, and 10 power glasses with the stocks of the opticians on both sides of the road without finding one single glass to approach them in power.—MONTMARTRE.

[56537.]—**Railway Distance.**—The actual distance between Lime-street and Euston (viâ Crewe and Runcorn) is 193 miles 49 chains.—H. H. B.

[56541.]—**Experiments with Magnetic Machine.**—The only experiment to try with this machine now you are tired of it is to endeavour to convert it into something else through the medium of the Sixpenny Sale and Exchange Column.—C. D. R.

[56541.]—**Experiments with Magnetic Machine.**—These machines, as usually made, cannot be used for any other purpose than giving shocks. They will neither fire gunpowder, nor light the smallest lamp, nor work models. They won't even ring an ordinary bell. Of course, we can hardly blame the machine, as these are purposes for which it is never made. If you are anxious to show your friends a few beautiful experiments, use an induction coil or an ordinary plate-glass machine.—BOBADIL.

[56543.]—**Carpenter Brake.**—The Carpenter brake is practically the Westinghouse *without* the triple valve. This absence of triple valve renders the movement of a large quantity of air necessary, and causes it to be slower in its action.—BRAKE.

[56544.]—**Coulomb or Weber.**—There is no difference: the Weber is the old name for Coulomb, and equals $10^{-1}$ C.G S. units.—F. L. T.

[56544.]—**Coulomb or Weber.**—A coulomb is a unit of quantity, and a weber is (or at least was) a unit of current. A unit current is now called an ampère, and transmits a coulomb of electricity per second. It is the current yielded by a potential of one volt through a total resistance of one ohm.—WM. JOHN GREY, F.C.S., Newcastle-upon-Tyne.

[56544.]—**Coulomb or Weber.**—The weber is an absolute unit, and has been supplanted by the coulomb, the unit of quantity of electricity passed in one second by one volt through one ohm, and the ampère the unit of current at a rate of flow of one coulomb per second. Each is equal to $10^{-1}$ or $\frac{1}{10}$ of an absolute C.G.S. electro-magnetic unit.—EUGENE BROWN.

[56544.]—**Coulomb or Weber.**—There has been some confusion in the use of the term "weber." Sometimes it stands for one-tenth the absolute unit of quantity, and sometimes for one-tenth the absolute unit of current on the electro-magnetic system of units. It is best to keep to the terms "coulomb" and "ampère," as is now generally the practice.—L. EDMUNDS.

[56545.]—**Real Name.**—The baptismal name is the legal name. I say this because a form is supplied to effect the alteration of the entry in the registrar's books when a mistake has been made or a change is desired. A name given at baptism in the Church of England cannot be altered except by the Bishop at Confirmation.—VICAR.

[56545.]—**Legal.**—So far as the legality of the registered name and the christened name of a child (when they differ) is concerned, the registered name is the legal one, and parents should call the child by the latter to avoid future trouble; but suppose the child has grown up, and is and has been all along known by the christened or any other name, that will be now the legal name. If for the purpose of insurance or legal documents it is necessary to connect the registered name and the now "habit and repute" name, affidavits will require to be got from parties who can testify that both names apply to the same person.—B.Sc., Plymouth.

[56546.]—**Magnetic Moment.**—Everett's definition is perfectly right, and means this: The magnetic moment is equal to the product of the intensity or strength of either pole into the distance between the poles. The strength is measured in dynes, and the line in centimetres. So we have, Moment = 3 × 10 × 10 = 300 c.g.s. units.—F. L. T.

[56546.]—**Magnetic Moment.**—G. Park will find a complete and clear explanation of the terms that puzzle him in the supplement of the new edition of Guthrie's "Electricity and Magnetism." The supplement is written by C. V. Boys. S. P. Thompson's "Elementary Lessons in Electricity and Magnetism" may be mentioned as another good book to consult.—T. JONES.

[56546.]—**Magnetic Moment.**—The magnetic moment of a magnet is expressed by $m\,l$, $m$ being the strength of one of the poles, and $l$ length of magnet. In the formula $m\,l\,H$, $m\,l$ is the moment of a couple tending to turn the magnet into the magnetic meridian, H being the horizontal component of the earth's magnetism. The answer 300 would be obtained thus: 1 decimètre = 10 centimètres; 3 × 10 × 10 = 300. The units being dynes and centimètres.—EUGENE BROWN.

[56546.]—**Magnetic Moment.**—Maxwell says, "The product of the length of a uniformly and longitudinally magnetised bar magnet into the strength of its positive pole is called its magnetic moment." As a matter of fact, it is only in the limiting case of a very long and thin bar of iron that a near approximation to uniform and longitudinal magnetisation is made. The magnetic moment of a magnetised bar of iron is, however, a quantity independent of the strength of the poles, which we scarcely ever know or are able to determine with much accuracy. It may be found by experiment. The magnetic moment we then find is the couple which a uniform field of unit intensity would call into play when the bar magnet is placed perpendicular to the lines of force in the field. There is some mistake in the question which relates to a magnet of which the pole strength and distance between the poles is supposed given. The magnetic moment is 3 × 10 = 30; but the couple acting on the magnet when at right angles to the uniform field of force of strength 10 is thus 30 multiplied by 10.—L. EDMUNDS.

[56546.]—**Magnetic Moment.**—The moment of a magnet is very much the same thing as the moment of a "couple" in mechanics, and is the product of the strength of a pole by the length of the magnet. According to the C.G.S. system of units, the length is measured in centimètres, and the strength of the pole is given with reference to the unit pole, which is of such a strength that when placed one centimètre from an equal pole it repels it with a force of one dyne. A dyne is the force which, by acting on a mass of 1 gramme for 1 second, would impart to it a velocity of 1 centimetre per second. A gramme is equal to about 981 dynes. In the question given, the magnet is 100cm. long, and its poles being 3 units, its moment is of course, 300. The field intensity has nothing to do with the matter. Moreover, the intensity of a field cannot be expressed in dynes, because the dimensions are different. A dyne is a unit of force, and its dimensions are $M L T^{-2}$; but a field intensity is equal to a force divided by the strength of a pole, and its dimensions are $M^{\frac{1}{2}} L^{-\frac{1}{2}} T^{-1}$.—Wm. John Grey, F.C.S., Analytical Chemist, Newcastle-upon-Tyne.

[56547.]—**Geometrical.**—Call the four lines *a*, *b*, *c*, *d*, respectively; then, taking them three at a time, we get the four triangles formed by *a*, *b*, *c*; *a*, *b*, *d*; *a*, *c*, *d*; *b*, *c*, *d*. There are no other triangles possible.—L. Edmunds.

[56547.]—**Geometrical.**—"J. C.'s" difficulty will vanish if he regards the sides of any quadrilateral plane as being the bases of four triangles formed by four lines drawn from any point in that plane. Of course, he will now at once see that Todhunter's enunciation amounts to this: If in any quadrilateral plane four triangles be drawn having a common apex and the sides of the plane for their respective bases, then show that the circumscribing circles of these four triangles will pass through the common apex. This, from the construction, is self-evident; but may be proved by the method of "reductio ad absurdum." — Ex-Blacksmith, Gorton Brook.

[56548.]—**Ferro-Prussiate Copies.**—In reply to "W. T. B.," I have used the above process to copy various articles, such as lace, leaves, flowers, &c. I have never noticed anything of the kind with my blue photos. After exposure I simply wash the prints in cold water for about five minutes, and then dry between blotting paper.—Prussiate.

[56548.] — **Ferro - Prussiatic Copies.** — "W. T. B." probably stops the printing too soon; if so, he will obtain a light blue print, pleasing, but fugitive. After exposure to light the paper should have a greenish-blue tint, then a light brown, afterwards a darker brown, changing to olive. If stopped at the greenish-blue or light brown the colour will fade; but I have not found it do so when washed from the dark brown or olive tint.—Acier.

[56549.]—**Bronzing Iron.** — Why not paint them with varnish, and then dust on some bronze powder when the varnish is all but dry.—Lustre.

[56550.]—**Sawing.**—To "Alabama."—"Alabama" does not mention what kind of sawing it is that he has been trying to do; but what I can see of it it must be pit sawing, according to the way he asks his query. He is very likely a wheelwright by asking the other query on repairing old wheels. If he is, and he thinks of starting to cut his own stuff, he will find his mistake out, and be at a loss. For instance, suppose you have a log of ash 20ft. long, and 2ft. through it, and you plank it, and there is 480ft. of sawing in the log at 6s. per 100ft., and that is a very good price, as I have known my father cut it at 3s. 6d. and upwards, and I myself have cut thousands of feet at 4s. 6d. per hundred, and that would amount to £1 2s., so that if your ash was worth 9d. per foot for 2in. plank, and you spoiled only one plank at 2ft. deep, that would be £1 10s., that would be 8s. more than paying a good price for someone to do it well, so that if "Alabama" will take my advice he will let it alone, as it is no amateur's job. There requires more skill in pit sawing than any trade I know of. If a good machine sawyer takes to it he would not manage it unless he has done some before, because he would find that the sharping would not do, and it would not do for the vertical frame only, for being cottered up tight, and an engine to do the labour, and yet some of them will say the engine has not enough power. What I want to know is—how is it that two men have enough power? as I have worked where there has not been enough power till I have gone, and then it would drive an extra bench. But, as "Alabama" says, we get on all right for about 12in., and then hollows ½in.; he is wrong, for it will be inclined to go from the start, and if he will pull the saw back, so that he can see down the cut, he will see that it starts from the beginning, and it is sure to twist as long as it hollows, and it is no fault of the saw, unless the saw is buckled, nor yet the men; but it is the man's fault that is on the top, as he does not put the saw to work proper, and that is a difficult job for an amateur, and a great many professional workmen. I don't wonder at it being hard work when it hollows ½in., when it is hard work if it is hollowing only $\frac{1}{16}$in. If it hollows only $\frac{1}{16}$in. a man cannot do a day's work, which is from 100ft. to 200ft. per day. As I am cutting, and have cut, some of the largest English timber that has grown, and will give some information to "Alabama" if he will state what he is cutting, and what depth of top, length of saw, gauge of saw, and space of teeth. Please advertise your address, and I will do what I can for "Alabama."—J. M., a Sawyer.

[56558.]—**Lincoln Cathedral.**—The beam referred to is a long, slightly-arched, slender beam of stone, which transmits the thrust from one of the arches to a part which can take the thrust. The astonishing part is this: if you walk upon it, it gives under the foot almost like a board, so great is its elasticity, yet it continually withstands a thrust equal, I suppose, to many tons.—T. Jones.

[56560.]—**Eight-Inch Spark Induction Coil.**—1. If the secondary wire is wound in about 36 sections, each section being of the depth and width named in my letter of Jan. 4th, 1884, one disc of No. 24 ebonite, of good quality, will be enough in each place. 2. Yes; the spark is prevented from passing beneath the partitions, at those points where such a tendency exists, by the interposition of layers of paraffin. The melted wax may be applied with a camel's-hair brush, and, if necessary, the film may be rendered uniform by treatment with a heated iron wire, as I have before described. It is important that this insulating of the bottom of each section should be well done. The thickness of paraffin in each of the central divisions should be about ⅛in., increasing to about $\frac{3}{16}$in., as the ends are neared; and in the last few divisions at each end of the coil, the thickness may be fully ¼in. A narrow strip of wood makes a useful and simple gauge for measuring the depth of wax in any section. The employment of paraffin in this way is somewhat troublesome, and ebonite rings or washers cemented with shellac, are preferred by the principal instrument makers; but the washers are expensive, and the wax, if carefully handled, is a thoroughly efficient substitute, as was first pointed out in these columns by Mr. Brown, of Belfast, to whom we are all indebted. 3. "About 7s. per pound" was stated as the price of the uncut ebonite. The discs would be rather costly if made to order. On page 339 of Vol. XXXVII. of this journal, under the heading of "Cutting Round Holes in Tin-plate," is a sketch and description of the convenient tool which I have used in preparing my own discs. 4. A continuous-current dynamo capable of delivering at the primary terminals the precise equivalent (in E. M. F. and Current) of five Grove cells of the quart size, would, no doubt, work the coil satisfactorily; there is, however, reason to suppose that the character of the spark would be to some extent changed by this alteration of the source of power. I have had no opportunity of making the experiment.—Ernest Baugh, Haverfordwest, Pem.

[56561.]—**Electric Pen Battery.**—You say that you are using a 4-cell Fuller, and then ask, Would it be advisable to use bichromate salt? What do you charge it with if not with bichromate? You cannot expect the cells to last for ever. Perhaps you require too much from it. It should be changed as follows: Inner porous cell, zinc rod in mercury, excitant sulphuric acid 1 in 12 of water; outer carbon in solution of bichromate potash.—C. D. R.

[56562.]—**Medical Battery.**—Do you want to take the current direct from the battery, or through the medium of a coil? If through a coil, one Fuller will give you all you require.—C. D. R.

[56563.]—**Medical Coil.**—A great many books on this subject do not explain what is meant, because the writers themselves do not know, and it would puzzle them to tell you.—C. D. R.

[56563.]—**Medical Coil.**—The terms "positive and negative" as applied to currents are often confusing. A current is described as a current of positive electricity which leaves the battery by the wire connected with the carbon or copper plate; while the current which leaves the battery by the wire connected with the zinc plate is called the negative current. The former is called positive, because, in a feeble degree, its qualities are the same as the positive electricity of the glass plate in an electrical machine: the latter is called negative electricity, because it feebly resembles the electricity of rubbed sealing-wax. The zinc, though the positive plate or element, is the negative pole; and the carbon, though the negative plate, is the positive pole. When your book refers to the negative current, it will likely mean the current from the wire connected to the zinc of the battery.—Bobadil.

[56564.]—**Wooden Sink for Dark Room.**—Soak the wood of which you propose making your table or sink in melted paraffin wax; it will then resist both water and acid.—S. Bottone.

[56565.]—**Dynamo.**—1st. Yes. It takes nearly twice as much current to charge a "made" accumulator, as you will be able to get out of it. 2nd. It is not absolutely necessary to have inside cogs. See illustrations at p. 220 of this volume, for details as to mode of joining to commutator. The covering of the wire on the armature is an insulation; the hub of the driving shaft is of boxwood, or other hard wood, soaked in paraffin wax, and is also insulating. See also No. 1007 of "E. M."—S. Bottone.

[56567.]—**Wooden Sink for Dark Room.**—I should advise "Hereward" to line his sink with, say, 5lb. sheet lead, and have the angles "or joints" burnt up. This, however, he will perhaps find a difficult job to do himself, and if he will advertise his address, I will put him in the way of getting one at comparatively a small cost.—A. B. C.

[56567.]—**Dark Room.**—A table and sink to be impervious to chemicals cannot be fitted up with wood. I would recommend "Hereward" to be at the expense of a fireclay or stoneware sink highly glazed (I have bought the former for 10s.). For the table, he should look out among the plate-glass dealers for a second-hand piece the size he wants; the more scratched it is the cheaper, and bed this on plaster of Paris on his table with a very slight slope towards the sink.—B. Sc., Plymouth.

[56568.]—**Violin.**—Thomas Kennedy, born 1784, died 1870, was the son of John Kennedy, who wrought from 1730 to 1816. Davidson states that they were very prolific makers, but gives no opinion of the quality of their work. Alexander Kennedy, London, 1750, he states was a Scottish maker of good repute.—T. Lisle.

[56569.]—**Pressure in Boiler.**—This query, in its present form, is somewhat vague; but, seeing it has been addressed to me, I will answer it as far as it is practical to do so. The strength of the shell will be expressed in the following formula: $\frac{2 T \times C}{D} = B P$, T equals thickness in inches, C = 44,800lb. as strength of plate per square inch, and D = diameter of boiler in inches; then we have 2 × ·437 × 44,800 = 3,915·52, which represents the strength of a strip of the boiler-plate, 1in. wide (·437 being multiplied by two, as there are two sides of the boiler), therefore the strength of the plate divided by diameter will give pressure per square inch necessary to burst plate, and 39,155·2 divided by 85in. = 460lb. pressure to burst the shell-plate. But here we are minus an important item, viz., riveting of longitudinal seams, which "Sammy" does not give. Single riveting is only equal to 56 per cent. of solid plate, and double riveting 70 per cent. of solid plate. We will, therefore, assume it is single riveted, and multiply 460 × ·56, which gives bursting pressure as 257lb. per square inch, double riveting would give 460 × ·70 = 322lb.; these, divided by the margin of safety, will give the safe working pressure. No doubt other correspondents may answer the other queries; but I think it safest not to attempt, as I assure "Sammy" answering boiler queries without full particulars, is only misleading. If he will give following particulars, I will tell him something reliable about his boiler: Age, maker, what kind of seams in furnace, distance of first cone tube, number of cone tubes, how are ends stayed, &c.; or, better still, give me sketch of boiler. The amount of deterioration can only be assumed after an inspection.—Boswell.

[56569.]—**Pressure of Boiler.**—"Sammy" omits some important elements in his data. He does not say whether his boiler is a single or double-riveted one; nor does he say at what pressure it has been working during the last 15 years. Now, I think that a boiler that has been working during that time should be carefully examined to see if *channelling* has not taken place along the joints of the plates, and that no part of the shell or firebox has become thinned through scaling, &c. "Sammy" may take the following for what it is worth:—Cut with a hollow drill, say ¾in. in diameter, two or three discs from the shell and firebox. Of course, these discs will give the present thickness of the metal at the places from which they were taken. Now place one of the discs in a strong vice, and a sharp blow on the projecting part will determine whether the iron has become crystalline; if so, the sooner the boiler finds its way into the scrap heap the better. "Sammy," judging from his name, is doubtless a young man; if so, it is a pity that he will not spend half a dozen hours (and more is not necessary) in mastering algebraic formulæ. Now, for the boiler in question, suppose it to have single-riveted joints, the diameters of the rivets being ¾in., and the pitch, as stated, 2in., then it is clear that every inch run of the boiler shell would have an amount of metal resisting rupture equal "in plain figures" to (1in. − ⅜in.) × $\frac{7}{16}$ × 2 = $\frac{35}{64}$ inches; then taking the strength of best Bowling plate at 25 tons per square inch section, this would give for every inch run of boiler $\frac{35}{64}$ × 25 = $13\frac{43}{64}$ tons = 30,625lb. Now, as the bursting pressure on 1in. long of boiler must be equal to 30,625lb., and as the boiler is 85in. in diameter, therefore 30625 ÷ 85 = 360⅜lb. nearly = pressure on each square inch of safety-valve, when boiler would be at bursting point; but for safe working the pressure should not exceed ⅛th of this, or 60lb. Molesworth's formulæ would give about 63½lb., and for double-riveted joints the working pressure would be 80lb. per square inch.—EX-BLACKSMITH, Gorton Brook.

[56570.]—**Brazing.**—"W. J." will find it no easy matter to braze ¼-thick copper plate with gas. He will probably need a Root's blower driven by power, a 1½in. gas supply, and a blowpipe in proportion. When work of this kind is done by gas, it is usually supported on a bed of burning coke, the greater part of the heat being obtained from the coke, and the gas is used only to finish melting the spelter, and to lead the greatest heat just to the point required. The fuel value of coal-gas is so small in proportion to its bulk, that an enormous supply is required, with an efficient blower to concentrate the heat when any large work is to be done at a high temperature. If the bulk of the work is heated to dull redness with coke, a comparatively small blowpipe will then finish the brazing in first-rate style, with much less trouble and risk than if the fire is depended on alone.—T. F.

[56571.]—**Electrical.**—In decomposing a given quantity of water, two volumes of hydrogen gas are obtained for every volume of oxygen.—BOBADIL.

[56571.] — **Electrical.** — Four cells, Bunsen 1·75 volt E.M.F. ÷ by the resistance in ohms gives the amount of current in ampères. This multiplied by ·0000896 the weight of a cubic centimètre of hydrogen at 0° C. in grammes; two volumes of hydrogen are given off for one of oxygen; by weight one of hydrogen to eight of oxygen.—J. H. E. D.

[56571.]—**Electrical.**—The current given by four or five Groves or Bunsens depends on their condition and on the size and distance of the electrodes in the water. But supposing that you placed your electrodes at such a distance as to get 1 ampère of current, then in 25½ hours nearly you could decompose 9 grammes of water and produce 11 litres of hydrogen and 89 litres of oxygen.—S. BOTTONE.

[56571.]—**Electrical.**—The quantity of water decomposed by a current of one ampère per second is ·0000945 gramme = ·1764 cubic centimètre, setting free ·0000105 gramme of hydrogen, ·1176 cubic centimètre, and ·000084 gramme oxygen = ·0588cc. The volumes being at the standard pressure of 760mm., and temperature of 0° C. The internal resistance, and consequently the current from a cell, depends upon its size. Four Bunsen cells coupled up, two in series and two parallel, would probably, taking into account the counter E.M.F. and resistance of electrolyte, send about 2 ampères through the circuit, and set free about 838 cubic centimètres per hour.—EUGENE BROWN.

[56571.]—**Electrical.**—The time in which a given quantity of water will be decomposed may be calculated from this formula: $t = \frac{Q}{C \times \cdot 000094}$, where $t$ = time in seconds, $Q$ = quantity of water in grms., and $C$ = current in ampères. And the current produced by, say, five Grove cells, may be obtained from this: $C = \frac{E}{R + r}$, where $E = 5 \times 1\cdot 97$, $r = 5 \times \cdot 3$, and $R$ = resistance of voltameter. Then, having got C, you can obtain values of $t$ for any value of Q. One gramme of water, when decomposed, yields 1·24 litre of hydrogen, and ·62 litre of oxygen, or 1·86 litre of mixed gases.—X. Y. Z.

[56573.]—**Chronic Rheumatism.**—To "B.Sc., Plymouth."—If he can, I would recommend "A Many Years' Subscriber" to go to Buxton for a month, and take a course of warm bathing. If this is not available, he should take warm salt-water baths at about 100°; but what I would rely on most to effect a cure would be electricity, using the induced or Faradic current, and brushing the skin with the electric brush at the parts where the pain and cold clamminess are felt. He having been so long afflicted, will probably have tried many medicines. The only prescription I would recommend is the following: R.—Potassii iodide, 30gr.; potassæ bicarbonatis, 60gr.; tincturæ hyoscyami, 3 fl. drs.; infusi cinchonæ flavæ, ad 8 fl. oz. Mix; one sixth part three times a day. Another thing I have seen of great service in cases like his, is to keep the parts which ache and are covered with cold clamminess always covered with cotton-wool (medicated with iodine, if he can obtain it).—B.Sc., Plymouth.

[56577.]—**Soap.**—Hard soap can be made from cotton-seed oil which has not been deprived of its stearine. A great deal of the cotton-seed oil now sold has had the stearine extracted so as to make it more fluid and less liable to solidify in winter. It is largely used in America for soapmaking, both alone and in conjunction with tallow and other solid fats.—G. H. HURST, Salford.

# UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

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# QUERIES.

[56580.]—**Tricycle Pedals.**—Can any cyclist, who is a mechanic, tell me the best way to prevent my tricycle pedals from rattling? They are simply plain ones in cast iron halves, and having worn at the ends they slip sideways when working and make a very nasty clacking noise. I have tried packing them with collars made of leather boot-laces, but they soon push them aside, and I cannot tell what plan to adopt. I can easily tighten them to revolve stiffly, but it is lengthwise where the mischief occurs. Is there any plan of putting spring washers on?—C. CALVERT.

[56581.]—**Warming Room.**—Some few months ago you inserted diagrams and a description of an apparatus for warming a room with some sort of oil. Can any of your readers, who have tried the plan, tell me how it acts? I have a room without a fireplace, which I wish to make sufficiently warm to read in. It is a second-floor room, and has a chimney running through it from the room below. I should be very glad of any information as to the best way of attaining my object. Oil, if it can be managed, is perhaps the most preferable way.—T.

[56582.]—**Safety Couplings.**—Would some kind reader please give sketches of the safety couplings for railway waggons, now exhibiting at the Inventions Exhibition, with, perhaps, a short description? I am sure it will interest others as well as—A SHUNTER.

[56583.]—**Chloride of Zinc Solution.**—How can I make a solution of the above, free from lead, as nearly neutral as possible, and of 20deg. strength? To make it from pure fused chloride of zinc is too expensive: it is the solution used in the Gaiffe Clamond cells.—OLD READER.

[56584.]—**Silvering Solution.**—Will some obliging fellow reader tell me how to make the above that only requires gently rubbing on the articles of brass, German silver or copper, with a little fine whiting, to give a bright silver surface? Tome twenty years since it used to be sold by a Mr. Smith, in the narrow part of the Strand—it is an odourless and clear solution. I have tried cyanide solutions, but they do not give such good results.—OLD READER.

[56585.]—**Boring for Water.**—Will someone who knows kindly give the approximate depth and cost of boring to water, and fixing pump, &c., in red sandstone rock where water lies on the surface all the year round, at about 400 yards off and, say, 20ft. lower level? Any information will oblige one who is—ENTIRELY IGNORANT OF THE SUBJECT.

[56586.]—**Brick Setting.**—Will someone who knows kindly say the difference in cost (per 1,000) of bricks set in Portland cement and ordinary mortar?—IGNORANT.

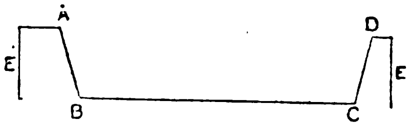
[56587.]—**Telephone System.**—I see in your issue of the 24th ult., in Replies to Queries (56361), Telephone System, there appears a diagram showing how a number of telephones can be fixed with only one wire running into an intermediate office, and there using earth (according to diagram), instead of a return wire. I should esteem it a favour if "R. F. S." would enlighten me how the current passes from A. through the intermediate office to B.—T. J.

[56588.]—**Generator Gas Explosive Force.**—Will anyone please send results given by gas-engine when generator gas (such as gasoline, benzoline, &c.) was used? Particulars required are, (1) Length of stroke and diameter of cylinder? (2) Proportion of ordinary air mixed with the gas before ignition? (3) If a compression engine, number of pounds pressure before ignition? (4) Maximum pressure of explosion, and (5) mean average pressure? These results will no doubt interest many in the gas-engine world besides—E. C.

[56589.]—**Cost of Cottage.**—I am thinking of joining a building society, but have been persuaded to save money enough to buy a piece of building land before doing so. Would someone kindly tell me what I should be likely to have to pay a building society to build me a cottage of four rooms about 12ft. square and 9ft. high, with small washhouse at back about 8ft. square, closet, well, &c.; bricks are in the neighbourhood, no drains to lay or gas to fit, being in the country?—O.

[56590.]—**Soap for Hard Water**—Wanted a soap or preparation able to easily produce a good lather in very hard water, from a limestone source? Ordinary soap is almost useless for ablution.—M. C. H.

[56591.]—**Lee Boards to Boats.**—I have a boat 15ft. long, flat bottomed and double ended; I want to



fit lee boards on each side. Will any one tell me what the dimensions of each should be? A, B, C, D, represent a section of the boat, E E position of lee boards.—O. A.

[56592.]—**Electro-Motor.**—I have made a small electro-motor, in which the armature (a plain bar of iron) revolves above the pole of the electro magnet; but when the armature gets at right angles to the poles of the magnet, it stops. Would it be better if, instead of a plain bar of iron, I had one in the form of a cross? If so, how many contacts should I have on the spindle; and also, which is the best way to connect up so as to get the greatest power out of the electro-magnet?—M

[56593.]—**Roofing.**—I shall be much obliged if some one will tell me how to calculate the number of slates (say slates 20in. by 10in.) required to cover a roof of given dimensions; also, what will be the average weight on each square foot of surface when ordinary N. Wales slates of that size are used?—RAFTER.

[56594.]—**Lime-Light.**—Would "Excelsior," reply 56045, kindly explain how limelight can be produced for lantern purposes "at less cost than the four-wick refulgent lamp," by bringing "a small amount of ingenuity and patience to bear upon it"? I would be glad to apply my entire stock of both to secure so desirable an end; and have no doubt the lime-light would be far more extensively used if brought within the means of lanternists whose purses are not very plethoric.—TYRO.

[56595.]—**Spectroscope.**—I shall be very thankful to anybody who will tell me how to make "a spectroscope out of paper tubes, cheap lenses, a few pieces of glass, and a little bisulphide of carbon at a total cost of 5s., which will divide the D sodium line," see p. 182, present volume of "E.M."? My spectroscope cost six times the sum stated, and will not divide the D line. An efficient spectroscope is one of the most engaging instruments a person of scientific mind can have; but the high prices of good instruments too often prevent their use, at least by English or Irish mechanics.—E. B. FENNESSY.

[56596.]—**Leaky Dark Slide.**—I have a double dark slide which lets light in through a crack in the sliding shutter; the slide is otherwise perfect. What is the best way to fill up the crack to prevent it leaking?—A. R. F.

[56597.]—**New Midland Engines.**—Will someone kindly tell me in what number of the *Engineer* illustrations of the new Midland engines (No. 1675 class) appeared?—IRON HORSE.

[56598.]—**M. S. and L. Single Engines.**—Will W. H. Thurlow kindly give dimensions and particulars respecting the M. S. and L. 7ft. 6in. single engines, as he kindly offered? Also, how many have been built of them?—IRON HORSE.

[56599.]—**Photographic Plates.**—Have any of our amateur photographers used the Archer dry plates, as I have, and cannot obtain good negatives at all? I have tried long and short exposures, besides weak and strong developers. Hints as to the above will oblige—PERSEVERING.

[56600.]—**Focal Distances of Images.**—Will one of our optical contributors oblige by giving the rule, not by algebra, for calculating the focal distances of concave and convex mirrors, also for double convex lenses? Supposing a lamp is placed 20ft. from a concave mirror of 3ft. focal length, I want to find the image.—A. H. K.

[56601.]—**Building Construction.**—I am very desirous to pass the elementary stage of the Government exam. on the above subject. Can the subject be learnt well enough by private study? Are any other books of use besides the first vol. of Rivington, or are any diagrams published that would be of assistance? Any information regarding a course of study would be greatly esteemed by—A STUDENT.

[56602.]—**Cassegrain Telescope.**—To DR. ROYSTON PIGGOT.—I feel greatly interested in your articles on the Cassegrain; they are invaluable, and I hope will be continued. In the No. 3 paper, you speak of the convex being of the exact size of the hole in great mirror. Does this apply to all the convexes of different focus? If so, then the shorter focus will be of larger diameter than the cone of rays from the large mirror, will they not? Can a Cassegrain be constructed of 26in. aperture with as low a power as 30 diameters? If so, will you please give the foci of large and small mirrors? I care not how short it is, the telescope being designed for comet work. —CASS.

[56603.]—**Spinning Wheel—Loom.**—Would some one tell me how to make a spinning wheel, and also how to spin with it? Could any of the readers of the "E.M." tell me how to make and work a loom?—R. MECHANIC.

[56604.]—**Differential Equation.**—Will some one oblige me by giving a solution to the equation $\frac{d^2y}{dx^2} - a\frac{dy}{dz} = 0$, or in what book a solution may be found?—H. H.

[56605.]—**Waggon Wheels.**—I have two waggons, the frame of one being (inside) 6ft., and the other, 5ft. 11in. I am breaking up the latter. Can I use the wheels under the former?—i.e., will the wheels that come from under the 5ft. 11in. waggon, answer for running under the 6ft. frame, and what alterations will be necessary to enable me to do this?—COAL MERCHANT.

[56606.]—**Ink for Rubber Stamps.**—I wish to make some preservative ink for use with a rubber stamp, and should be much obliged for directions for making it in small quantities, and red or blue in colour.—Faber Fabrum Adjuvet.

[56607.]—**Lighting with Battery.**—Will Mr. Bottone, or some other kind correspondent, please answer the following? I have four cells of a bichromate battery, plates, 5in. by 8in., a zinc in porous pot, and two carbons to each cell. I wish to be able to light a small incandescent lamp with this. What solutions ought I to use to get the best result, and what sort of lamp should be employed?—Faber Fabrum Adjuvet.

[56608.]—**Legal.**—On taking over a house from a present occupier, could any kind reader inform me at what time of the coming quarter day I am legally allowed to take possession? What I require is, whether 12 o'clock at noon, or 12 o'clock at night?—A Tenant.

[56609.]—**Analysis of Asbestos.**—What is the composition of asbestos? Do different kinds differ in analysis? Where is it found? How is it the Italian asbestos, usually sold at 4s. a pound, cannot be had now? Would Mr. Allen or Colonel Ross kindly say if it would be possible for anyone possessing but a slight knowledge of chemistry, to make a reliable analysis of such a material, starting with the assumption of entire ignorance of the chemical composition of such material?—Murano.

[56610.]—**Alloy for Watch Bearings.**—In the *Mechanics' Magazine*, for Nov. 13th, 1830, is an account of an alloy made by Sir (then Mr.) John Bennett, for watch pivot holes. It is gold, 3dwt.; silver, 1dwt. 20gr.; copper, 8dwt. 20gr., and palladium, 1dwt.; in colour, reddish brown, and takes a good polish, and is not affected by nitric acid. It fuses below temperature required for gold; it is nearly as hard as wrought iron, but could be drawn into wire; rather brittle; fracture finer than steel. The *M.M.* editor said of it "it seems to us that there can be but little doubt of the general adoption of this alloy, in preference to any substance which has yet been employed for pivot holes." Diamonds and rubies are shown in the same article to be "perfectly awful" things to put in a watch, as they grind the end of the pivot away. Are not the latter now used in watches, in preference to anything else? Had the alloy in question any real merit over phosphor bronze or Babbitt's metal, and is it ever used now?—Murano.

[56611.]—**Junket.**—Will any reader inform me how to make a junket, such as eaten in Devonshire?—Akreophagist.

[56612.]—**Copper Band.**—Will some kind reader oblige by informing me how the two halves of a copper band are worked up, so that the seams are at the sides, and what tools are used for hammering on? A sketch of band would oblige.—Plate Worker.

[56613.]—**Apparent Enlargement of Celestial Objects.**—To "A Fellow of the Royal Astronomical Society."—May I ask where the pamphlet by M. Paul Stroobant, on "The Apparent Enlargement of Celestial Objects, as they Approach the Horizon" is published, and by whom?—and if the above is not the title, what is? It is spoken of in letter 23918, on page 30 of this volume.—James W. Fraser.

[56614.]—**Trespass.**—Will any of our legal friends kindly say if a trespass is committed by walking in estates in the pursuit of entomology, botany, and microscopy? I have seen this question repeatedly asked in various papers; but have never noticed a satisfactory reply, with reference to penalties incurred, &c.—Ento.

[56615.]—**Air Pressure at High Temperatures.**—I wish to find what the pressure of, say, a cubic foot of air would be, if heated to different temperatures, from 100° Fahr., to 1,000° Fahr. (or Centigrade equivalents). Air having been confined hermetically at any temperature, though 60° Fahr. or Zero Fahr. or Centigrade would be most convenient. I am aware that the confining substance would include more at a high temperature, than the cubic foot of a lower temperature, but that would not affect my purpose; expansion of the internal capacity could be allowed for. Is there any guage for ascertaining hot air pressure?—how do hot air engines manage?—Murano.

[56616.]—**Greek.**—Will some Greek scholar kindly say how the diphthong ωυ is to be pronounced in Greek words as εωυτου for εαυτου, and ωυτος for ο αυτος in Herodotus, and Ionic Greek?—L. C.

[56617.]—**Stained Skin from Wearing Black Stockings.**—Will someone tell me of some soap or other means of removing the objectionable stain? Ordinary soap and hot water avail but little; please help.—Bunthorne's Bride.

[56618.]—**Salicylic Acid.**—I bought some salicylic acid. It is fine and feathery in appearance, and always crystallises in fine needles after solution, it is very sparingly soluble in water. "Haydon's Scientific Dic." says, sal. ac. is soluble in water, and crystallises in large four-sided prisms. Can anyone show why there is such a difference in what I read of, and what I buy?—Rob Caus.

[56619.]—**Oxy-hydrogen Blowpipe.—Steel Furnace.**—Could I use this for melting experimental lots of metal, say half a pound (or double) of iron?—if so, how should one be made? A sketch would no doubt be valued by others than myself. Would an oxy-hydrogen blowpipe be expensive to use? Any information welcome. How also could I construct a convenient furnace to melt 1cwt. of steel? How should I produce the blast, and what materials should I use, and what sort of crucible would be required only for experiments?—Murano.

[56620.]—**Steam Carriage.**—I am desirous of having a small steam carriage for use instead of a horse, on the public road; but am told the restrictions under which they are allowed to run, are practically prohibitive. I shall be very much obliged for any information on the subject? Also what sort of machine is best to have, and the probable cost of one strong enough to carry two people up a stiff hill? Of course it must be silent, and show neither smoke nor steam, and be as little like a steam-engine as possible. I have thought it should have rubber tires, and the general outline something after the style of a brougham.—Steam Roadster.

[56621.]—**Electric Light for the Optical Lantern.**—Would Mr. Wright, or any of "Ours," who have had practical experience, kindly advise as to the best arrangement for using an arc light of from 2,000 to 3,000 candle-power, as I have been experimenting with the same, and find the heat so great as to crack the transparency or negative? Would an alum cell placed between the light and condenser be best for cutting off the heat rays? A rough sketch of best arrangement would be esteemed.—Arc Light.

[56622.]—**Lightning Conductors.**—What precautions are necessary, or the things to be guarded against, in erecting a lightning conductor on a building? Is it best to insulate the conductor with glass, or to allow the conductor to rest in contact with the iron supports or holdfasts? What are the best forms to use—the tape or the solid round wire, or the round hollow tube form? What area will a conductor 80ft. high protect? Assuming that a conductor protects a circular area around its base, what would be the radius of the circle in this base, when its height from the ground is 80ft.?—R. S. B. H. B.

[56623.]—**Polishing Steel.**—I have a lathe and a 4in. by 1in. emery wheel; but when I grind flat steel it comes off in waves, and requires draw-filing and much labour to flatten it again. Can someone kindly explain how to grind a flat surface, say 12in. by 1in.? Also what sort of polishing wheel and powder I should use, to follow the emery wheel, in order to produce a fine even polish on such surfaces?—Acier.

[56624.]—**Newmarket Direct Railway.**—Can any reader give me any information respecting the railway from Chesterford to near Six Mile Bottom? The earthworks seem to be complete, and some bridges are built. When was it started, and why given up?—East Anglian.

[56625.]—**Steam.**—Will some kind reader show the working of the following problems:—A pound of steam is led into 11lb. of ice-cold water, what is the temperature of the mixture? Also ½lb. of steam is led into 12lb. of water at 20° C.—what is the temperature of the mixture?—Hot Water.

[56626.]—**Fermentation in Horehound and Hop Beers.**—Would any of our kind readers help me out of my difficulty? Being in a small way of making horehound and hop beers, I find that in, say, three or four weeks after bottling there is a kind of mildew on some of the bottles, and others with a dark brown substance adhering to bottle neck, which makes it look very unpleasant to the eye, and unpleasant to drink. Anyone showing how to remedy the above, would confer a great boon on a—Poor Brewer.

[56627.]—**Thoma Microtome.**—I should be obliged if any reader will give a description of this microtome which is said in your Scientific News column, of May 1st, to be able to cut sections of 12,500 to the inch?—R.G. L.

[56628.]—**Heliograph.**—I should feel obliged if any of "ours" would explain the mode of working the heliograph? The point I find a difficulty about is to understand how the flash of reflected sunlight is thrown with certainty upon a spot miles away from the operator. I should also like to know if the signals are dashes and dots as in telegraphy?—Magister Artibus.

[56629.]—**Hydraulic Ram.**—Will any of our kind practical mechanics tell me how I can make a small hydraulic ram? I want it to force a jet of water 5 or 6ft. high. A rough sketch, with dimensions, will greatly oblige—A. L.

[56630.]—**Brake Failures.**—What number of actual failures, under Class 2, are recorded in the Return, and is any information given as to the number of times any brake has been applied on any one day?—Brake.

[56631.]—**Photographic.**—To Mr. Lancaster or Others.—Can I use with the ¼-plate camera, Le Meritoire, one of Dallmeyer's ½-plate W.A. lens, also, will the camera require any alteration? I should like to be able to use either lens if possible, and should be glad to hear of a simple and effective method of fitting the lens.—C. F. G.

[56632.]—**Water Line.**—In draughting the hull of a vessel of 3,000 tons, or, say the *Himalaya* for instance, which is about 3,440, how shall I calculate for placing the water line? Should be glad if any kind reader can inform me?—Verax.

[56633.]—**Hay and Corn.**—Would some kind and able reader of "Ours," acquainted with the hay and corn business, kindly give me a few hints in the same? How to tell the weight of a hay rick by measurement. I shall be retailing it in small quantities? Any information will thankfully be received by—Perseverance.

[56634.]—**Piccolo.**—Will any reader be kind enough to give me particulars relating to a Boehm piccolo? 1st, The length of each part of it; 2nd, the size and position of every hole; 3rd, the width of bore throughout?—S. R. P.

[56635.]—**Clamp Burning.**—Will some of our London readers help me with burning clamps? Having a lot of bricks made and clay mixed on the above system, the man slipped off, and I am left to do the best I can? Should breeze or cinders be put in the scintles underneath the three layers or strata? and when they are burning should the clamp be plastered at the sides and earthed in tight on the top as it burns?—One in a Fix.

[56636.]—**Australia.**—What are the prospects for electrical engineer, telegraph, telephone, or electric light going out from this country to Melbourne? What things are dear there, and what should one take—tools, clothes, books, are they dearer than here? Any advice will oblige—A.

[56637.]—**Electric Lighting by Batteries.**—I intend lighting up a house with two or three Swan 10-c.p. lamps of 10 volts each. Would any of our readers tell me how many cells of the Daniell or Bunsen form I should require to keep the lamps burning brightly for four or five hours per night, and what kind of solution to charge them with, and how many volts will a quart Daniell give off? I have five cells of the Daniell form which, when not in use I remove zincs and coppers, and when I leave them for a day or two the tops of the porous pots are covered with a kind of a metallic salt. Will any of "Ours" tell me how to remedy this?—Young Beginner.

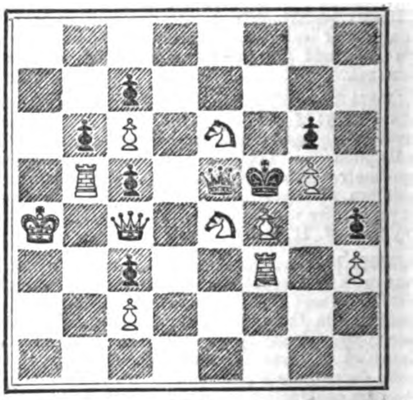
[56638.]—**Cleaning Glass.**—Would someone inform me, through the medium of your valuable paper, the best thing to clean glass negatives, windows, &c.? I have some shop windows, and have so far been using whiting and now and again water; but somehow I cannot clean them without leaving them, more or less, cloudy and dull looking. I think somehow there must be some composition or something that I could buy, that would make them look bright after cleaning. I was told some time ago that photographers used something for cleaning their negatives called clouding; have asked for it in several places but cannot procure it; perhaps I am wrong in the name.—W. J. Blakemore.

## CHESS.

All Communications for this department must be addressed to J. Pierce, Langley House, Dorking.

### PROBLEM DCCCCXXXIX.—By Idem.

*Black.*



*White.* [11+8

White to play and mate in two moves.

Solution to 937.

| *White.* | *Black.* |
|---|---|
| 1. R-Q 4 | 1. Anything. |
| 3. Q or R mates. | |

(Five variations.)

### NOTICES TO CORRESPONDENTS.

Correct solutions to 936 by Exon (a real beauty), A. S. Olver, V. S. Pochin (Black too confined, consequently very easy), G. J. Slater, T. L. Robins, and F. O'N. H.

To 937, by A. W. Orr, Rev. W. Anderson (Old Romney), F. A. Vincent, A. A. E. Leoluse, F. B. Webb, G. J. Stingfellow, R. A. Bennett, E. Stanley Follwell (neat, pretty, and easy), A. S. Olver (very good), V. S. Pochin, G. J. Slater, T. L. Robins. That by Exon is wrong, as 1. K-B 5.

Correct solutions to 938 by Streetgate (first move a little puzzling) and E. S.

Raymond.—We are sorry you are unable to go on with the competition.

G. R. W.—We do not know to what problem you refer. Please send the number with the two solutions.

J. Russell.—Thanks for game.

**Resistance on Railway Curves.**—What the precise effect is of a difference of gauge on curve resistance—and in fact, of all other modifying conditions—is still a matter of doubt, but theory and experience combine to indicate that, all other conditions remaining the same, the curve resistance is directly as $\sqrt{\text{gauge}^2 + \text{length of wheel-base}^2}$; from which it follows that a reduction of either the gauge or length of wheel-base alone will not materially modify the resistance; but if both be reduced together, so that the rectangle of the wheel base remains always "similar," the curve resistance may vary very nearly as the gauge. Approximately this condition obtains with standard and narrow-gauge rolling stock as now designed, but whether or not practical conditions make it necessary or expedient that it should be so, so that it is a legitimate, instead of merely accidental, advantage of the narrow-gauge rolling stock, it is profitless to inquire, because the *Railroad Gazette* says the direct loss of power and wear and tear from curve resistance is comparatively a trifling matter, and any assumed difference in hauling capacity—which is not often a very serious consideration, however, for light traffic roads—may be easily compensated for by a slight increase in the rate of compensation for curvature—an increase which will have far too trifling an effect on the average gradient to make any measurable difference in the location or profile.

## ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

### HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

*** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, May 13th, and unacknowledged elsewhere :—

J. ROBERTS.—W. F. Stanley.—W. H. B. and Co.—F. W. Greene.—Gilford Mills Reading Room.—J. Gillott and Son.—Pfeil and Co.—H. Murphy.—Sanitas Co.—J. and H. Grace.—Camera.—T. H. L.—Sammy.—Sand Rat.—An English Mechanic.—Hemisus.—Rob. Crusoe.—B.—Edward M. Nelson.—S. Stokes.—A Fellow of the Royal Astronomical Society.—An Amateur.—W. Hardie.—Upholsterer.—S. Beeching.—W. D.—Telegraphist.—Theo.—Quantum Libet.—Millwright Apprentice.—Albert Turner.

A. DOBER. (For methods of treating sciatica, see pp. 412, 436, Vol. XXXVI.; for syrup of phosphates, you must apply to the maker; but you will find something about it under the head of Chemical Food in back numbers. See p. 73, Vol. XXXIV., for instance.)—OLD SUBSCRIBER. (They must be bleached either by careful washing over with weak solution of chloride of lime or peroxide of hydrogen, or by exposing to the fumes of burning sulphur.)—MECHANIC. (Rather doubtful if ringworm. You should consult a medical man, who will be in a position to form an opinion when he sees them.)—A. G., Putney. (Geometry and mathematics, mechanics, electricity, steam, heat, &c. We cannot say about "taking you for a time without a premium." You will have to enter as an apprentice in the ordinary way, or as a "gentleman apprentice," and in the latter case a premium will certainly be asked.)—S. GREENWOOD. (We have frequently stated that entrance is obtained by ballot on the recommendation of a certain number of Fellows; but you can obtain all information on application to the secretaries of the societies.)—AKENAWAKA. (Possibly the portions specked were not thoroughly covered. 2. Varnish black or japan black. See advertisements of dealers in such materials.)—S. T. KLEIN. (If the query was received it was noticed in some way. We do not remember the book mentioned; but if there is a work under that title you might find it in the British Museum Library.)—TRITON. (We do not know that it has reached a second edition, but the English publishers, Messrs. Macmillan, could probably tell you. The query is scarcely of sufficient interest to occupy space in our columns.)—C. M. HOWARD. (We know of no work of the kind; but as you will see by the advertisement columns, you can now procure the membrane telephones. All the information needed is to be found in the back volumes.)—GRAPHO. (Messrs. Trübner, Ludgate-hill, supply any American paper to subscribers—not single copies. We dot know where the photographs can be obtained.)—R. S. T. (Scarcely worth while repeating the statement. The Britannia Company's stand is at the West-end of the Middle Court. 2. No, we should call them more or less impure alumina.)—J. G. HODGSON. (G. Bower, St. Neot's, Huntingdonshire.)—AMATEUR. (See the indices; the stopping depends on the kind of wood used, but as a rule, it is "size" after the staining. See p. 371, Vol. XXXVIII.; pp. 16, 64, 186, Vol. XXXVII.)—APPRENTICE. (Glatton's letters on the Slide-Valve Diagram were in Nos. 995, 999, 1039, 1041.)—J. STOKER. (See Hints No. 5. It is a Railway Sub-office in Somersetshire, and appears as such in the Postal Guide.)—T. MAC. (Black's "Treatise on Brewing," Longmans; that is the work recommended by the correspondent named. Herbert's "Art of Brewing," published by the author at Burton-on-Trent, is a useful work. There is also a treatise by Levesque, and another by Tizard.)—W. HOWELL. (What engine do you mean? Surely the dimensions have been given.)—F. G. T. (See Hints No. 4. Asbestos can be obtained, as a rule, of those who sell gas-stoves.)—EDWIN HOLMES. (There is no doubt the man is a rascal. We do our best to weed out swindlers; but from time to time they evade us, and by change of name and address, succeed in again defrauding readers. We are glad you had sufficient sense not to be caught. Readers should in no case part with money to unknown correspondents before they get their goods, and should in all cases remit by P.O.O. made payable ten days after date, and then, if the goods do not arrive, stop payment of the order.)—AN ENGLISH MECHANIC. (No good is done by detailing the defects of the brakes, and then asserting in general terms that a brake exists which avoids them all, and that if Mr. Stretton likes you can give particulars. You can do this privately if you like—he appends his address to many of his letters; but it is probable he knows it already; or you can send us a sketch and description, and if there is really any good in it, we will publish them.)—E. T. B. (Your only course is to patent the invention, and then seek the aid of some capitalist through our advertisement columns or those of some other newspaper.)—G. R. POSTLETHWAITE. (In type.)

## USEFUL AND SCIENTIFIC NOTES.

**Shrinkage of Paper.**—At a meeting of the North of England Institute of Mining and mechanical Engineers, a paper "On the Shrinkage of Paper," was read by Mr. C. C. Leach. It contained an account of experiments upon the shrinkage of different kinds of drawing paper made under various conditions, and shows how very capricious is the behaviour of this material under the ordinary conditions to which it is subjected as a medium of plotting and mapping. The mode employed by the writer in showing the variations was to mark off accurately upon the paper experimented upon distances from a scale representing 120 chains, a wooden scale being chosen as much less liable to alter in length than an ivory one. The following are the conclusions arrived at by the writer:—That machine-made papers vary less, and less unequally, than hand-made sheets. That mounted paper varies much more than unmounted. That new paper, and especially new mounted paper, varies more, and more unequally, than older, and older mounted plans. That papers, mounted or not, and irrespective of age, continually vary. No two plans vary alike. Daily and yearly variations are similar for all plans. Making a scale on the paper, as an accurate standard of measurement, is all but useless, as different parts of the same plan vary in size so differently at most times. The very uneven and changing alterations in the sizes of plans, which twist the base lines and otherwise affect their general accuracy, are of sufficient importance for the extent to be ascertained, and, if practicable, for some means to be devised for obviating these variations.

THE contract for the supply of telegraph instruments and batteries for the next twelve months to the Manchester, Sheffield and Lincolnshire Railway Company, has been secured by Messrs. Blakey, Emmott and Co., of the Northern Telegraph Works, Halifax. This firm have just issued an illustrated catalogue in three parts, Part I. containing list of railway-signal apparatus, resistance coils, and general testing apparatus; Part II. electric bells, &c., and part III. electric-light machinery.

**Every Workman connected with the Building** Trades requiring a Situation should advertise in "THE BUILDING NEWS," published every FRIDAY, price Fourpence, at 332, Strand, London, W.C.

"THE BUILDING NEWS" is the Principal Journal representing Architects and Builders, and has the largest circulation of any Professional Journal in the kingdom.

Every Workman should insist on seeing "THE BUILDING NEWS" every week at his Club or Coffee House. He will find more "Lists of Tenders" for new work in it every week than in any similar paper, and can thus judge where work is likely to be had. He is also specially invited to make use of "Intercommunication" if he wants to know anything about his trade; to write to the Editor if he has any suggestions to make, and to advertise in the paper when he wants work.

The charge for Advertisements for Situations is On Shilling for Twenty-four Words, and Sixpence for every Eight Words after

## TERMS OF SUBSCRIPTION.

### PAYABLE IN ADVANCE.

6s. 6d. for Six Months and 11s. for Twelve Months, Post-free to any part of the United Kingdom. For the United States, 13s., or 3 dols. 26c. gold; to France or Belgium, 13s., or 16f. 50c.; to India (via Brindisi), 15s. 2d.; to New Zealand, the Cape, the West Indies, Canada, Nova Scotia, Natal, or any of the Australian Colonies, 13s.

The remittance should be made by Post-office order. Back numbers cannot be sent out of the United Kingdom by the ordinary newspaper post, but must be remitted for at the rate of 1d. each to cover extra postage.

Messrs. JAMES W. QUEEN and Co., of 924, Chestnut-street, Philadelphia, are authorised to receive subscriptions for the United States for the ENGLISH MECHANIC, at the rate of 3 dols. 26c. gold, or Thirteen Shillings per annum, post-free. The copies will be forwarded direct by mail from the publishing office in London. All subscriptions will commence with the number first issued after the receipt of the subscription. If back numbers are required to complete volumes, they must be paid for at the rate of 1d. each copy, to cover extra postage.

Vols. IV., VII., XXVI., XXVIII., XXX., XXXII., XXXIII XXXIV., XXXV., XXXVI., XXXVII., XXXVIII., XXXIX. bound in cloth, 7s. each. Post free, 7s. 9d.
Vol. XL. now ready, price 7s. Post free 7s. 9d.

All the other bound volumes are out of print. Subscribers would do well to order volumes as soon as possible after the conclusion of each half-yearly volume in February and August, as only a limited number are bound up, and these soon run out of print. Most of our back numbers can be had singly, price 2d. each, through any bookseller or newsagent, or 2½d. each, post-free from the office (except index numbers, which are 3d. each, or post-free 3½d.)

Indexes for Vols. I., VI., VII., VIII., and IX., 2d. each. Post free 2½d. each. Indexes to Vol. XI. and to subsequent vols., 3d. each, or post free, 3½d. Cases for binding, 1s. 6d. each.

## NOTICE TO SUBSCRIBERS.

Subscribers receiving their copies direct from the office are requested to observe that the last number of the term for which their subscription is paid will be forwarded to them in a PINK Wrapper, as an intimation that a fresh remittance is necessary, if it is desired to continue the Subscription.

**Epps's Cocoa.**—Grateful and Comforting:—"By a thorough knowledge of the natural laws which govern the operations of digestion and nutrition, and by a careful application of the fine properties of well-selected Cocoa, Mr. Epps has provided our breakfast tables with a delicately flavoured beverage which may save us many heavy doctors' bills. It is by the judicious use of such articles of diet that a constitution may be gradually built up until strong enough to resist every tendency to disease. Hundreds of subtle maladies are floating around us ready to attack wherever there is a weak point. We may escape many a fatal shaft by keeping ourselves well fortified with pure blood and a properly nourished frame."—*Civil Service Gazette.*—Made simply with boiling water or milk. Sold only in packets, labelled—"JAMES EPPS and CO., Homœopathic Chemists London."—Also makers of Epps's Chocolate Essence

## CHARGES FOR ADVERTISING.

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| Thirty Words | 2 | 6 |
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ADVERTISEMENTS in EXCHANGE COLUMN—for

| | s. | d. |
|---|---|---|
| Twenty-four words | 0 | 3 |
| For every succeeding Eight words | 0 | 3 |

ADVERTISEMENTS in the SIXPENNY SALE COLUMN.

| | s. | d. |
|---|---|---|
| Sixteen words | 0 | 6 |
| For every succeeding Eight Words | 0 | 6 |

*** It must be borne in mind that no Displayed advertisements can appear in the "Sixpenny Sale Column." All advertisements must be prepaid; no reduction is made on repeated insertions; and in cases where the amount sent exceeds One Shilling, the publisher would be grateful if a P.O.O. could be sent, and not stamps. Stamps, however (preferably halfpenny stamps), may be sent where it is inconvenient to obtain P.O.O's.

The address is included as part of the advertisement, and charged for.

Advertisements must reach the office by 1 p.m. on Wednesday to insure insertion in the following Friday's number.

**Holloway's Pills** are particularly recommended to persons of studious and sedentary habits, who gradually fall into a nervous and irritable state unless some such alterative and restorative be occasionally taken. Nausea, headache, giddiness, and mental apathy quickly yield to them, and they regulate alike capricious appetites and all bowel irregularity.

## OUR EXCHANGE COLUMN.

*The charge for Exchange Notices is 3d. for the first 24 words and 3d. for every succeeding 8 words.*

**Good Value Offered** (cash or instruments) for all kinds of sound or repairable Scientific Appliances.—CAPLATZI, Science Depot, Chenies-street, near British Museum. Established 1862.

Wanted, set **Dynamo Castings**, about 150 c.-p., in exchange for Pint Bunsen Cells.—E. THORNTON, Hindpool-road, Barrow-in-Furness.

"**Flute Music**," in exchange for C. Nicholson's Pot-pourri and Weidner's Portuguese Air, flute and piano. One or both.—Particulars, J. DICKSON, Atlantic Avenue, Belfast.

Double **Dark Slides** (2), quarter-plate, nearly new Exchange turning tools, or offers.—J. T. SKINNER, Turner, Chase-road, Southgate, London, N.

Wanted, **52in. Club**, Humber, or Invincible BICYCLE in exchange for Lathe by Milnes.—F. UNDERWOOD, Beverley.

What offers in exchange for **Orguinette**, almost new, cost £2 15s.; and round Brass Clock, cost 10s. 6d.?—HARDING, 196, Holloway-road.

Good **Stereoscope**, cost about 30s., with slides. Will exchange for Opera Glasses, Microscope, &c.—HARDING, 196, Holloway.

Any offers for Dolly Varden **Sewing Machine**, a few parts missing; also set of 12 Bells on rod, best bell metal?—HARDING, 196, Holloway-road.

**Tricycle** wanted; can repair same. Exchange Singer's Sewing Machine, new, cost 80s.; "Cyclopædia Machinery," 50s.; 100 ENGLISH MECHANICS, 56 "Engineering Review."—T. PALMER, Keston, Kent.

"**English Mechanic**," Vols. XXXIV., XXXV., XXXVIII., XXXIX., XL., unbound, complete. Exchange.—H. COLLINS, Canterbury.

**Bichromate Batteries**, 20 cells, with filtering arrangements. Price £1.—S. COOPER, Brookfield, Heaton, Bolton.

Wanted, "**Knowledge**," unbound, to date, in exexchange for "Popular Educator," 6 vols., cloth, or 7 vols, Charles Dickens.—T. B. B., St. Chad's Parsonage, Derby.

**Bicycle**, 52in., strongly built, painted and bright; too large for owner. Offers.—12, Old Park-road, King's-hill, Wednesbury, Staffordshire.

**Medical Coil**, with primary and secondary currents; also vols. XXXIX. and XL, "E.M." What offers?—J., 56, New Kent-road, S.E.

**Rubber Stamp-Making Apparatus**, also four founts of Type, and all complete. Exchange for Silver Lever Watch, or a Concertina, chromatic scale.—F. HARRISON, 8A, Southwell-street, Liverpool.

A Sledge-Wyatt £2 10s. **Hand Dynamo**, quite new, in perfect order, with incandescent lamp and holder. What offers?—Apply, Rev. W. VEVERS, S. Oswald's, Worcester.

Wanted, **Bicycle**, 52 or 54in. Exchange DOUBLE GUN, Double Rifle, case, and fittings, Harmoniflute, or Thomas's Shoemaker's Machine.—Particulars, C. SPENCER, Richmond, Yorks.

**Pedometer**, hall-marked silver cases. Exchange for Knapsack, or value to 25s.—M. BYRNE, 152, Grove-street, Liverpool.

**Carriage Gates**, 2 pairs, wrought iron frames, with cast panels, size 4ft. 6in. by 4ft. 3in. each, with hangings. Exchange Galvanised Corrugated Roofing to value £3 10s.—G. BARKER, 1, Northwold-road, Clapton, E.

Fast sailing **Model Yacht**, 25 inches long, fore and aft rig. Exchange for Telescope.—J. H., 13, Mill-street, Whitehaven, Cumberland.

"**English Mechanic**," Vols. XXIV. to XXIX., and part XXX., with indexes, unbound and clean. What offers? Anything useful.—W., 62, Villa-street, Walworth, S.E.

**Lathe**, 6in. centres, back-geared, and compound slide-rest. Exchange Tricycle or offer.—16, Riley-street, Bermondsey.

**Circular Saws**, 12in. to 15in., grindstone in iron frame, with fast and loose pulleys. Exchange offers.—16, Riley-street, Bermondsey.

Booth's **Mitreing Machine** for making picture frames, &c., Photographic Lenses, Apparatus, Sundries. Exchange for Micro Objective, Lathe Head, Flywheel, and Crank, Electric Bell, Electro-Motor, Dynamo.—READ, 156, Wyndham-road, Camberwell, S.E.

I have an 8½ by 6½ bellows body **Camera**, with latest improvements, 3 double dark slides; also Dallmeyer's Rapid Rectilinear, 8½ by 6½; case of diaphragms, also just new. Exchange for 1-horse Steam Engine and Boiler combined, or offers.—C. H. HATCH, Alderley Edge, near Manchester.

Horizontal **Engine**, 1½ by 2, link motion, locomotive boiler, steam gauge, &c.; for 6in. slide-rest, launch hull, or offers.—SARGENT, 25, Holywell-street, Strand.

Wanted, 5 c.-p. Lamps (Swan's), for half-horse **Engine** Castings, cylinder, piston, piston rod, chest cover, eccentric and rod, cross head. all finished base, cylinder covers unfinished; cost rough, 24s.—Below.

What cash offers for Cylindrical **Electric Machine**, 8 by 5, with multiplying wheel, or will exchange for Lamps.—H. Howell, 61, High-street, Peckham, London.

Wanted, good 6in. **Slide-Rest**. Exchange Dynamo Electric Machine, with 10in. armature, superior finish.—J. Bamber, 12, Bessborough-street, London, S.W.

"**English Mechanic**," 170 numbers, from February, 1882, to present date. Exchange for anything useful.—A. Wells, 80, Western-road, St. Ann's, Lewes.

Cornish **Boiler**, half-horse, internally fired, grand fittings, equal to new, bargain. Exchange Bicycle, English Concertina, or offers.—Charles Walter, Springfield, Wellington, Somerset.

**Photographic Dark Tent**, cost £6. Chemical Apparatus and Copper Still, cost £9. Wanted, Magic Lantern, photographic, or any useful offers.—Bebb, Belbroughton, Stourbridge.

Wanted, Leg or Parallel **Vice**, latter preferred, 2½ to 3½ inch jaws. Offers.—Thos. Fawcus, Swalwell R. S. O., Co. Durham.

Small Gramme **Hand Dynamo** and two Lamps, cost £3, used once. Exchange for finished Motor Castings, or anything useful to value 25s.—S. Hunt, 11, Augusta Terrace, Franchise-street, Weymouth.

"**Life in London Streets**," illustrated; "Proctor's Flowers of the Sky," illustrated; "Life of Garibaldi," coloured plates; all new. Offers.—Nuttall, 109, Linaker-street, Southport.

Half-plate folding **Camera**, two double slides, new; for a good Bicycle, or offers.—W. Saunders, Dickleburgh, Norfolk.

## THE SIXPENNY SALE COLUMN.

*Advertisements are inserted in this column at the rate of 6d. for the first 16 words, and 6d. for every succeeding 8 words.*

**Motor Castings**, materials for Electric Bells, Batteries, Galvanometers, Intensity Coils, Microphones.—King, Mendham, and Co., Bristol.

**Insulated Wire Table**, showing size, weight, resistance per foot, feet per ohm, &c., price 3d.—King, Mendham, and Co., Bristol.

**Standard Ohm**, in box, copper poles, guaranteed correct to ten thousandth of ohm, 21s.—King, Mendham, and Co., Bristol.

**Wimshurst Influence Machine.**—Sole Manufacturers of Improved Pattern. Numerous testimonials as to thorough efficiency.—King, Mendham, and Co., Bristol.

**Galvanometer Cards**, improved for tangent and ordinary combined, 2½in., 8d.; 4in., 10d.; 6in., 1s.; post free—As above.

Write for **King, Mendham, and Co.'s** large new and reduced Price List, post free 4 stamps.

**Plating.**—Every description of Gilding, Silver Plating, Oxidising, and Bronzing, executed with very best finish. Speciality in nickel-plating. Special quotations on application. Send one stamp for price list. Small jobs attended to per return post.—Morris Cohen, 132, Kirkgate, Leeds.

**Fretwork.**—Illustrated Catalogue of every requisite and 400 miniature designs, 4 stamps.—Harger Bros., Settle, Yorks.

**Trouser Lengths**, 5s. each. Cheap Cloth for Ladies' Dresses, Mantles, Boys' Suits.—Hewitt, 27, Winfield Mount, Leeds. Patterns free.

**Electric Depot**, 10, Deansgate, Manchester.—Electric Breast Pins, 25s. Electric Bells, 4s. Induction Coils, 8s.—Millar, Proprietor.

**Billiards.**—Great success of Thorpe's Patent Automatic Cue Tips. Cannot fly off. Cues retipped instantly.

**Billiards.**—Excellent testimonials from Roberts, jun. champion, and other professionals. £5 per week easily earned.

**Billiards.**—District Agents wanted. Send 9 stamps for particulars and sample cue end fitted with patent.

**Billiards.**—Five Shillings for sample cue, also fitted, and 3 extra tips. Thousands already in use.

**Billiards.**—Apply to sole representative for United Kingdom.—A. W. Morgan, Lancaster Avenue, Fennel-street, Manchester.

Hard **Vulcanised Fibre** for Magnet Heads.—Mosses and Mitchell, 68a, Chiswell-street, London, E.C.

Hard **Vulcanised Fibre** for all kinds of insulation.—Mosses and Mitchell, 68a, Chiswell-street, London, E.C.

**International Inventions Exhibition**, East Avenue, Group 21, Stand 1683.—Mosses and Mitchell, 68a, Chiswell-street, London, E.C.

Tudsbury and Sons' "High Tension" **Wimshurst** Machines, with Compound Ebonite Plates. List, one stamp.—Edwinstowe, Newark.

**Cat Gut.**—Gut Hooks and Eyes for lathes and machinery.—James Bellamy, Regent-street, Leicester.

**Bellamys' Gas Stoves**, 1s. 3d., 2s. 8d., 3s. 3d., for oiling. Breakfast Stoves, 8s., 11s., 14s. 6d. Send for lists.

24 **Microscopic Slides**, in box, very cheap. List sent for stamp.—Well, Dalmain-road, Forest Hill.

**Mica**, otherwise Talc.—Richard Baker & Co., 9, Mincing-lane, London.

**Violin** for sale, magnificent solo instrument, suitable for lady or gentleman, labelled "Antonius Stradvarus, Cremona, 1690," with good case and mounted bow, only 25s. Sent on approval with pleasure.—Mrs. Jones, 50, Myddelton-street, Clerkenwell.

**To Capitalists.**—An Inventor seeks a Partner to assist him in manufacturing a small article of general use by all machinery users. Very little plant required.—Apply in first instance to J. C., 3, Gladding-road, Manor Park, E.

**Patents, Designs, and Trade Marks.**—For particulars of lowest charges, apply, G. L., Technical Bureau, 46, Queen Victoria-street, E.C.

**Tricycle Wheels**, Bicycle Wheels, and Fittings Wonderfully cheap. Also for Safety Bicycles.—W. Gwinnett and Co., Wolverhampton.

**Lathes**, Lathes. Cheapest and best. List, 2 stamps Nothing equal at price.—Robinson, Somerset-road, Sheffield.

100 **Foreign Stamps**, including Brunswick, Ceylon Tasmania, Egypt, Greece, Luxemburg, free 7d.—Hely, Foley street, London.

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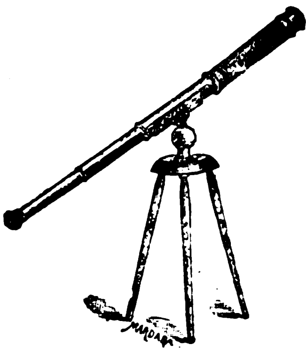

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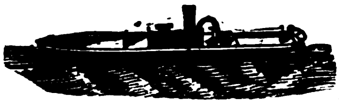

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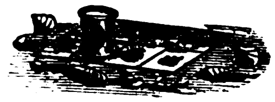

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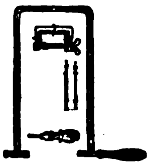

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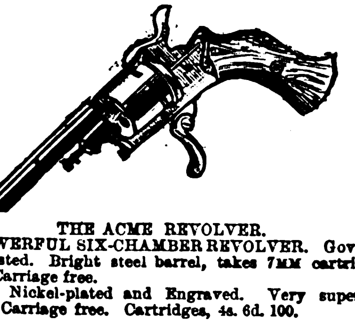

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The English Mechanic
AND WORLD OF SCIENCE AND ART.
*FRIDAY, MAY* 22, 1885.

# THE TERRESTRIAL TELESCOPE.

By Edward M. Nelson.

HARDLY a week passes without a reference in these columns to celestial telescopes; but somehow or other the terrestrial telescope has been left out in the cold. Perhaps it will be urged that they are identical, excepting only the inversion of the image, and that if they will stand the tests for the higher work it will be unnecessary to test them for terrestrial purposes. Another reason for the want of attention given to this subject may arise from the greater popularity of binocular Galilean field glasses.

It is true that in the navy one still sees a 2ft. telescope of 1¼ aperture freely used; but from the merchant service the telescope has quite disappeared. It is not easy to account for the decided partiality the public have for the binocular Galilean glass to the monocular four-lens eyepiece telescope. The cost can have nothing to do with it, for in this respect they are on a par. As far as weight and bulk go, the telescope has the advantage. Can it be that the binocular glass is more useful than the telescope? It is true that a telescope would be out of place in a theatre, neither is it of much use on a racecourse. On a steamer the vibration from the engine renders the use of a telescope impracticable; and for making land on a dark night the telescope must give way to its double rival; but for every other purpose the monocular telescope, with the four-lens eyepiece, is undoubtedly the better instrument of the two. One very often hears of a pair of binoculars being given as a present, or a prize, quite regardless of the fact that a pair of binoculars is like a pair of boots—to be of use they must fit. So important is it that the centres of binoculars should exactly correspond with the centres of the eyes of the person using them, that a slight divergence of even $\frac{1}{16}$in. is, in my own experience, quite sufficient to detract from the pleasure of using them. The field of binoculars is unsatisfactory. There is a central disc, scarcely as bright as the rest of the field, where the image is at its best (such as that is), the picture in the remaining annulus being chromatic and woolly. If my memory is correct, "A Fellow of the Royal Astronomical Society" has stated that the nearest approach to optical perfection must be sought for in a lens whose focus = 15 times its aperture. What shall we say, then, of the binocular field glass, the focus of whose objectives does not exceed 3 times their apertures.

The popularity of field glasses may be accounted for, I think, by the ease with which they are held and adjusted, the general public being better pleased with powers of 4 to 8 without trouble, than with higher powers and more critical pictures with trouble. It is a sad fact that at the present day the terrestrial telescope is only to be found in the hands of scorers for rifle shooting, and of a few infatuated individuals who still persist in carrying about these antiquated instruments. To pass on to the legitimate part of our subject, we shall have to consider what are the different classes of terrestrial telescopes, and what the most useful apertures and powers, and then how to test them.

1st. The different classes of terrestrial telescopes. It will be said that if we want to find out what are the different classes of terrestrial telescopes, we ought to consult the makers' catalogues. If we did that we should find every kind of monstrosity, from a 1in. equatorially mounted to a 3in. with ten draws, shutting up to 6in. for the pocket!

There are in reality four classes of terrestrial telescopes, viz.—1, Pocket hand-glasses; 2, Look-out hand-glasses; 3, Portable telescopes on a stand; 4, Non-portable telescopes on a stand.

1. Pocket hand-glasses should have an aperture of 1in. to 1¼in., and four to six draws, so that they may be shut up into a small compass. For my own part, I dispense with the slings and straps, preferring to carry it in my pocket. I have carried one of these telescopes for some years, and should now, if I went without it, miss it as much as my watch.

2. Look-out hand glasses are those such as are used by coastguards, or what you would keep on a rack in the house ready for any emergency. Aperture from 1½in. to 2in.; they should only have one draw. They should be fitted with a long sunshade, at least 1½ times the aperture, as it is an excellent protection from rain and dust. A look-out glass, for use in all weathers, and in every direction with regard to the sun's rays, should have a brilliant image, and be consequently of low power.

3. Portable telescopes on a stand. The aperture for these should be 2in., and this is, I think, the largest aperture that ought to be made portable, and the smallest that is worth putting on a stand. A telescope of this calibre should not have more than three draws, for fear that the optic axis of the eyepiece may not coincide with the centre of the object-glass. The stand should be a small tripod pillar and claw, with a compass joint movement in altitude, and with a movement in azimuth as well. The compass joint should have a clamping screw.

4. Non-portable telescopes on a stand.—The apertures for these may range from 2in. to? We will leave the consideration of the limiting aperture of these instruments until we have discussed the size of emergent pencils. The object-glass should be mounted like a celestial telescope in a single tube, with a rack and pinion tail-piece. The stand may be either a pillar and claw or tall wooden tripod. If the former is used the telescope should be fixed to one side of the pillar by a cone bearing, and not by a compass joint to the top of the pillar. There ought to be a screw and washer for tightening up the cone bearing. The telescope should be fixed at its centre of gravity (the cap being taken off); steadying rods may be dispensed with.

If the tall wooden tripod is chosen, it may have a metal top similar to the pillar-and-claw stand; or if with the common top, the telescope should be mounted on trunnions, at its centre of gravity, and have draw-tube steadying rods. A very good telescope stand (non-portable) may be made as follows: A stout board, about as long as the telescope, forms a kind of table; the board should be 6in. wide at the object-glass end, and 2ft. wide at the eyepiece end. The board should slope down from the object-glass end to the eyepiece end about 1 in 4. At the object-glass end there is a leg, with no caster on it, and on the board a boat's row-lock to take the telescope; at the other end there should be two legs, both with casters, and on the board a movable block of wood, with a V cut in it, to put under the telescope, on the object-glass side of the rack-and-pinion tailpiece.

## The Power of Terrestrial Telescopes.

It must be remembered that in observing terrestrial objects one is looking along the densest part of the atmosphere, which is usually very unsteady in the heat of the day. With celestial objects the case is different, because in looking upwards the atmosphere is always getting clearer and less dense. If one considers how clear the air is, even at the top of a mountain only 5,000ft. above sea-level, the enormous difference between looking in a horizontal direction through five miles of dense atmosphere, and looking vertically up through it, will be easily understood.

Another point is this: that the scientific method of arranging powers, both for celestial and terrestrial telescopes, is, and has been, according to their emergent pencils; in other words, so much per inch of aperture. Example: An emergent pencil of ·033 means a power of 30 per inch of aperture. This, I think, as far as terrestrial telescopes are concerned, is an erroneous method altogether. About terrestrial telescopes I can speak definitely, as I have made the necessary experiments; but not so with celestial telescopes. The conclusion I have come to is, that there is imposed by our atmosphere a limit to power, no matter how large the aperture of the telescope may be.

In determining what this power was, I had recourse to actual experiment on objects distant from 3 to 5 miles, and in these experiments I disallowed all pictures that resembled the appearance of a white stone when seen beneath a clear rippling stream. In former days the method employed was to put up a logarithm table about 60 yards off, and then increase the power until it could be read. By this it was found that an emergent pencil of ·025, on a power of 40 per inch, could be used with advantage on a bright day. This may be very true; but it eliminates the interference of the atmosphere altogether.

The conclusion I came to was that on average fine days a power of 30 was as bright as you could go to with advantage. On extraordinarily fine days this might be increased to 40. I have never used a power of 50 on any aperture which does not make the presence of the atmosphere unpleasantly conspicuous. It must be remembered that it is not the telescope we are testing, but the atmosphere. A few hints may be useful as to the object which should be chosen for these experiments. Do not choose an object such as the vane on a church steeple, standing out black against a bright sky. Neither a bright white house, which, as you stand with your back to the sun, you see in front of you lighted up as a conspicuous object. Choose rather a railway semaphore under the shade of a hill as you look in the teeth of the sun's rays. The power that will best show you the colour of the arm is the most suitable for the telescope. My remarks are, of course, not addressed to those who have an eyepiece for every emergency; such as one power for looking into the sun's rays, another for looking away from the sun's rays, &c., but to those whose telescope has only one eyepiece—my aim being to give them a few hints as to the power that eyepiece should have.

## Emergent Pencils.

In a properly constructed telescope the diameter of the emergent pencil is equal to $\frac{a}{p}$, aperture divided by power. Now it will be easily understood that if you have a very small emergent pencil, say ·02, the pupil of the eye will not be filled with light, and in consequence the image will be darkened. Again, if you have a very large emergent pencil, say ·4, it will be larger than the pupil, and therefore the eye will not be able to take it all in. Hence, it appears that light is increased with the increasing size of the emergent pencil, but only up to a certain point, when any further increase is useless. The question now to be decided is, what is that point. By experiment I have found on an ordinary bright sunny day, when not looking into the sun's rays, that if an emergent pencil of ·1 be increased to ·11 the increase of light will be perceptible, but if it be further increased to ·12 there will be no increase in the amount of light—*e.g.*, while, with a power of 25, there will be a perceptible increase of light in a 2¾in. over a 2½in., the difference between a 2¾in. and 3in. will be imperceptible.

We are now in a position to answer the question about the limit of aperture for terrestrial telescopes. We have found the maximum power to be 40, and if with that power the emergent pencil is to equal ·11, it follows that the limit of aperture will be 4·4in.

### Tests for Telescopes.

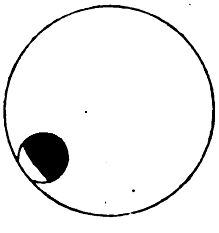
This subject is a difficult one, as it is not possible to state definitely what object ought to be seen by a certain telescope. It is not difficult to find which is the better of two telescopes of the same aperture and power, by trying them on the same object at the same time. But it is difficult to say if a certain telescope is a good one, as it necessitates the knowledge of the picture a similar telescope of known excellence would give under similar circumstances. Some will say: Why not treat them like celestial telescopes, and test them on celestial objects? To which I reply, that the method is a very good one, especially for the larger instruments, but it requires a whole battery of eyepieces. Tests for telescopes, as well as microscopes, are comparative, and require, therefore, much knowledge and experience.

A very good test for the uninitiated is to ascertain how far a logarithm table can be read by the naked eye; then measure the power of the telescope; then see if you can read the figures at a distance equal to the product of the distance they were read by the naked eye and the magnifying power. By carefully attending to the following directions a few unsuspected and important defects may be detected and rectified. Unscrew the cap from the eyepiece of the telescope and focus at some distant object; turn the telescope round, and look through the object-glass end at the disc of light seen at the eyepiece, keeping the eye some distance from the object-glass. Move the telescope so that this disc of light comes to the margin of the object-glass. If the margin of the object glass (*i.e.*, the edge of the cell) eclipses this disc of light, all is well; but if this disc of light goes out before it gets to the edge of the cell, or a blue-black, dark patch comes on it before it is eclipsed, then it shows that either the hole in the diaphragm of the erector of the eypiece is too small, or that the diaphragm is not in its right place (Fig. 1). The first thing to be done is to put the diaphragm in its right place, and that is in focus of the lens which is nearest to the object-glass of the telescope. Having done that, place the eyepiece back in the telescope, and go through the test again. If that blue-black patch still comes on before the disc is eclipsed by the cell of the object-glass, it shows that the hole in the diaphragm is too small. The remedy is to broach the hole out little by little until you get it right. The test should be constantly resorted to during the operation, so that the hole may not be made larger than necessary. This fault is one which can only be met with in terrestrial telescopes, as celestial telescopes have no erector in the eyepiece. The action of the too-small hole in the diaphragm of the erector is curious. It merely darkens the picture. It does not act in the same way as a diaphragm between the object-glass and eyepiece which cut off aperture would. That diaphragm is put into a telescope to sharpen up the image from an object-glass, which is defective from spherical aberration, and it also darkens the image by the contraction of the aperture. Not so, however, the diaphragm in the erector, that merely darkens the image without sharpening it at all. The rays from the object-glass have come to a focus, and the image, good, bad, or indifferent, has been formed. Any diaphragm in the microscope, which magnifies and inverts that image, can have no effect in improving its quality.

Reverting to our test, if the disc of light is eclipsed by a diaphragm concentric to the cell of the object-glass, before it comes to the margin of object-glass it shows that there is a diaphragm, cutting off aperture, between the object-glass and the eyepiece (Fig. 2).

Another test to discover if any aperture is cut off is to focus the telescope on a distant object, then point it to the clear sky. Put a small piece of paper over the top of the cell of the object-glass, in such a way that a small piece of it projects 1-16in. on to the object-glass over the margin of the cell. Now examine the spot of light at the eyepiece end (the emergent pencil) with a lens, and see if you can perceive the piece of paper projecting on the disc. If you cannot see the paper, it shows that the aperture is cut down by a stop. Having put the telescope through these tests, the magnifying power may be measured in the usual way, by dividing the diameter of the object-glass by the diameter of the emergent pencil. Great accuracy is required in the measurement of the emergent pencil; an error of ·004 would make a difference of one diameter in a power of 27 on a 3in. object-glass—e.g., a power of 27 would have an emergent pencil on a 3in. of ·111, and a power of 28 one of ·107.

F I G. 1.



F I G 2

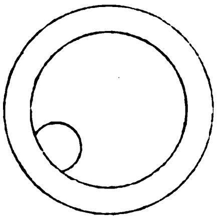


Fig. 1 shows the blue-black patch coming over the disc of light before it is eclipsed by the margin of the object-glass.

Fig. 2 illustrates how the disc of light is eclipsed by a diaphragm between the object-glass and the eyepiece.

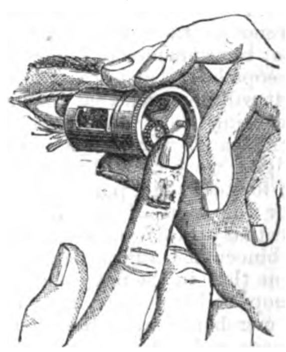
It is of no use attempting to measure the magnifying power of a telescope until you have applied the tests mentioned above to it, for this very good reason: that the disc of light at the eyepiece end may not be the image of the whole of the object-glass; but it may be either the image of a stop between the object-glass and eyepiece, or the stop in the erector of the eyepiece. In either case it would make the diameter of the emergent pencil less than it really was, and so falsify the magnifying power by making it too high.

I broached out the hole in diaphragm in the erector of a telescope by a very eminent maker, who had engraved the power of 50 in the eyepiece; I measured the power after the operation, and found it to be 40. This is only one instance among many.

I was surprised to find, on trial the other day, that my binocular glasses, aperture 2¼, power 8, and my 1½ telescope, power 15, had the same extent of field. In conclusion, a small piece of advice: Prefer a small, bright image, to a large and darker one. Practise yourself in the interpretation of small images. It will soon become a habit, and then you will easily walk to windward of your high-power critics.

## THE LABBEZ TELEMETER.

THE Labbez telemeter is a portable range-finder and surveying instrument, by means of which distances can be found with great rapidity and approximate accuracy, as a single observer can make an estimate in about 30 seconds, or, with the assistance of some one to "dress" the observer with the object, in from 15 to 20 seconds. The instrument consists of a cylinder 1¾in. long by 1in. in diameter, containing two reflecting planes set at an angle of 45° and giving by reflection 90°. These planes can be moved through a certain arc by revolving the cam-piece at the end, which acts upon a pin fixed to one of the mirrors. An adjustment for the other mirror is provided in a cogged-head screw. This cogged wheel and the scale being set at zero, the observer who wishes to find the distance of an object looks about for something which will serve as a "mark," and be as nearly as possible at right angles to the object. Holding the instrument as shown in the figure the observer looks through the small hole and turns the cogged wheel until the image of the object is superimposed on that of the mark. The observer now walks in a straight line 30 yards towards the mark, and having been "dressed" into line with that, again looks through the instrument and rotates the end of the cylinder until the object is reflected over the mark. The line opposite the fixed zero on the scale will then indicate the reading of the distance of the object in yards without any calculation. The advantages claimed for this instrument are no necessity for pickets; an exact right angle triangle need not be plotted; and any base can be used proportionate to 30, providing the result, as shown by the scale, is corrected in same ratio. When employed for small objects or long distances an opera-glass or telescope attachment is fitted. Specimens of this telemeter are shown by the sole agent for this country, Mr. J. H. Steward, 406, Strand, in Group 25 at the International Inventions Exhibition. The instrument can be used for finding the breadths of rivers, lakes, channels, &c., and, as instances of the approximate accuracy with which it works, it may be mentioned that at the School of Musketry, Hythe, estimated distances of 1,890, 790, and 300 yards were found on measurement to be 1,900, 800, and 300 yards respectively; while in some experiments made by Col. Edgcombe, R.E., on Runnymead, estimated distances of 1,950, 1,200, and 500 yards were found by actual measurements to be 1,930, 1,200, and 500 respectively. Obviously, much depends on the observer; but a little practice will enable any one to estimate distances with all the accuracy needed in practical work.

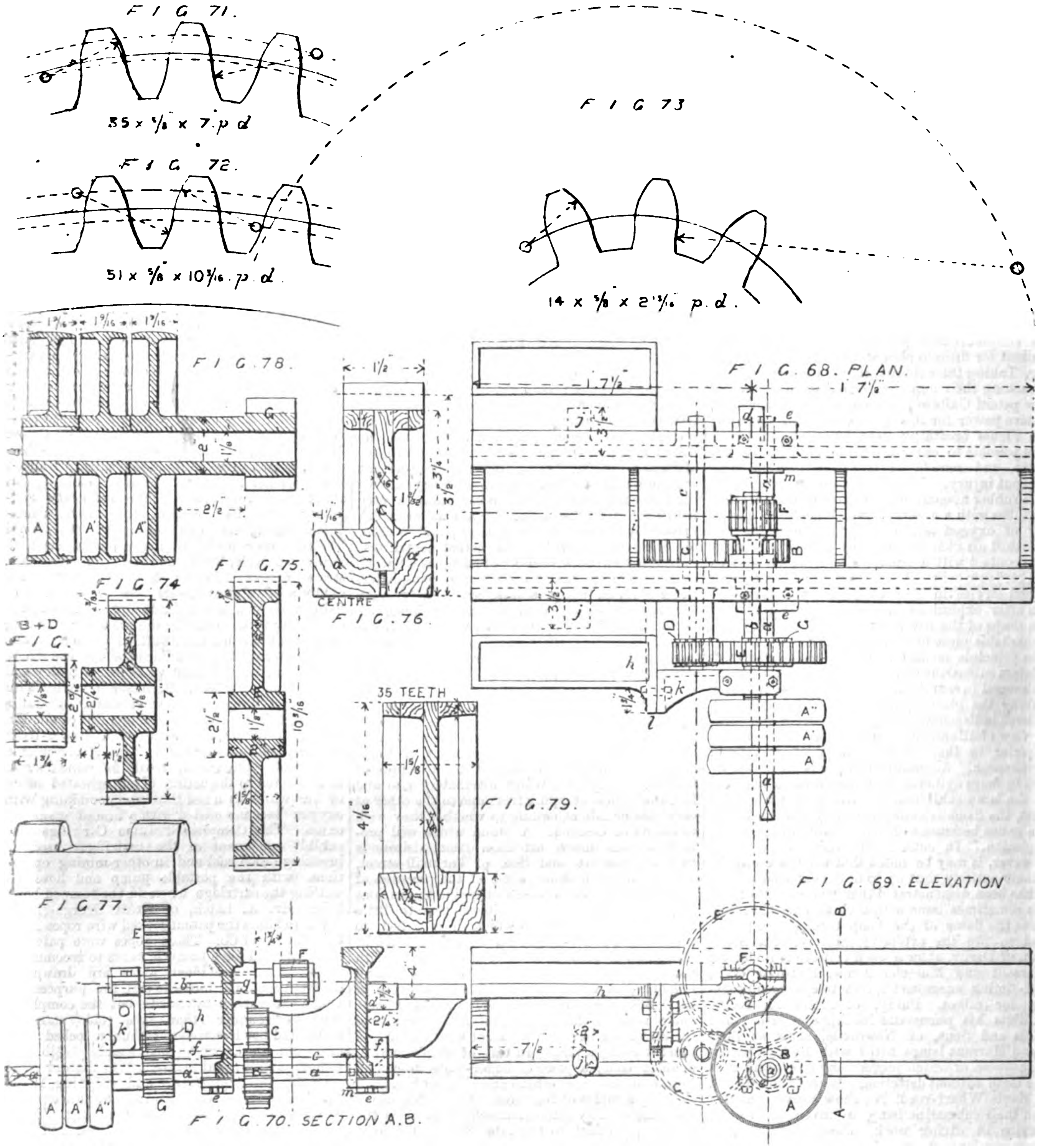


## THE INTERNATIONAL INVENTIONS EXHIBITION.—III.

### Mining and Metallurgy.

THE division of the exhibits into groups is not quite so satisfactory as it might have been, for some of the groups contain objects which do not properly belong to the class, while exhibits which do have been relegated in some cases to other groups. For instance, one of the most attractive exhibits in Group II., Mining and Metallurgy, North Court, South Gallery, is found at Stand 150, where Messrs. J. Rhodes and Sons, of Wakefield, show several of their ingenious machines for working sheet metals. So far as the general body of visitors are concerned this is probably the most interesting exhibit in the group, but it has very little connection with mining and metallurgy. Here the visitor can see with what ease and simplicity tin-plate boxes and pans are stamped out of the sheet metal and embossed with inscriptions; for at one machine the body of the box is stamped out perfect at a blow, and at another the lid, ornamented with a device and lettered, is also produced with a single stroke. Pans, pie-dishes, &c., require a little more work; but in this case one machine is employed to cut the metal from the sheet and shape it roughly into form, and another of rather more complicated design is used to finish the article. A small pan or pie-dish, for instance, stamped into shape is put upon a form in a machine which has some resemblance to a lathe; the back support is run up to hold it in position, and a tool then trims the edge, doubles it, and rubs or burnishes the article into a finished condition. It is fitting that an exhibit of this kind should be placed where the greatest number can witness the operations performed, and we presume that accounts for its position; but it should properly have been in the group devoted to metal-working machinery. On the other hand, mine surveying apparatus has been placed in the group devoted to philosophical instruments, especially when exhibited in company with other apparatus, for the simple reason probably that it is not convenient for firms to have stands all over the building. Taking the exhibits, then, in something approaching their numerical order, we find near the new patent Galloway engine, which provides the motive power for this group, some specimens of the Fleuss breathing dress, by means of which it is possible to enter a mine filled with choke-damp, and remain in it a considerable time without injury. The dress consists principally of a rubber nose-and-mouth piece communicating by tubes with a reservoir which contains a supply of oxygen and a receptacle in which the breathed air can be revivified by being brought into contact with a caustic alkali, which absorbs the carbonic acid. The Fleuss dress has been of signal service in connection with the saving of life after explosions in coal-mines, and also, in the shape of the diver's helmet, in performing a remarkable piece of work at the Severn tunnel. The principle is also utilised in making an oxy-calcium submarine lamp. Safety-lamps are shown by several inventors and exhibitors, the majority having the glass cylinder which is now considered indispensable, and which, from the point of view of illuminating power, is immeasurably superior to the old gauze type of Davy and Stephenson. Access to the flame is prevented by two or more cylinders of gauze, and in the case of the lamp exhibited by Evan Evans, of Llanrwst, the flame is extinguished by the gas before the gauze becomes sufficiently heated to cause an explosion. In connection with safety-lamps, however, it may be noted that what is wanted is a lamp entirely shut up from the external air, for it has been demonstrated that "blowers" of foul gas sometimes issue with such velocity that they force the flame of the lamp through the gauze, and so fire the explosive mixture. Davis and Son, of Derby, show a good collection, including Marsaut and Mueseler lamps, improved dials, self-timing anemometer, and telephonic apparatus for mines. Purdy, of Eastwood, Notts, exhibits his pneumatic locking apparatus; and Mills and Sons, of Newcastle, show at their stand Marsaut lamps fitted with Ryder's patent lock—both of which prevent any tampering with the lamp without detection. Barnett and Foster, of Eagle Wharf-road, N., show a diver's helmet and their submarine lamp, an invention of great service in diving work. Justice and Co., of Chancery-lane, show a large-size model, partly in section, of the Casson-Bicheroux direct-acting gas furnace and producers for heating and smelting metals; and Henry Simon, of Manchester, exhibits in diagrams and model the Simon-Corvés coke ovens, which formed the subject of an interesting discussion at the recent meeting of the Iron and Steel Institute. The object of these ovens is, while producing coke suitable for all the purposes of the metallurgist, to secure the products of distillation. From the experiments of Mr. I. Lowthian Bell, as detailed in his paper, it would appear that coke so made is inferior to that produced in the ordinary ovens; but on this point there is much diversity of opinion, Prof. Armstrong, for instance, holding that, from a chemist's point of view, the method of coking at a high temperature is irrational. It is certain, however, that coke produced in the Simon-Carvés ovens is in demand for many purposes.

Head, Wrightson, and Co., of Stockton-on-Tees, exhibit a large-size model of a centre crane for Bessemer plant, as used at the works of the North-Eastern Steel Company, Middlesbrough. The object of this crane is to obtain automatic balancing with a variable weight in the ladle. It is of the hydraulic type and carries 15 tons at a rake of 25ft., and the maximum horizontal strain at top of post does not exceed 4½ tons. Rock drills of all patterns, worked by steam, air, water, or hand power, are shown in great variety, many of them at work; and in Group III., Engineering Construction, the Beaumont boring-machine is shown by the South-Eastern Railway Company, with large models of the Channel in the course of the proposed tunnel. The Aqueous Works and Diamond Rock-boring Company exhibit their improvements in rock-boring apparatus in the shape of a portable prospecting diamond boring tool, with a number of cores extracted from different bore-holes. This arrangement differs from rock drills, which merely make holes for blasting purposes, as the cores are extracted in the solid, being cut out by an annular bit set with diamond tools. Hayward, Tyler, and Co., of Whitecross-street, have a good exhibit of their steam pumps specially adapted for mining purposes; and Rebey and Co., of Lincoln, have in this group a 12 h.p. winding engine with locomotive boiler mounted on patent wrought-iron tank foundations, into which the parts can be packed for transport. Crushing machines are shown by several firms, among which may be noted the patent knapping-motion ore and stone crusher of Baxter and Co., Leeds, and the dead-weight crushing mill of Chas. Sheppard, Bridgend. In the latter the material is carried under a very heavy roller by the action of a smaller roller driven by power. Askham, Bros., and Wilson, of Sheffield, show Lucop's patent centrifugal pulverisers, with a number of samples of work done by them in the shape of ores, phosphates, fuller's earth, sugar, spices, &c. Safety gear for mining cages, with automatic detaching hooks, is exhibited by several firms, and Lewis and Massey, of Aberdare and Twyford, show the application of their apparatus for preventing over-winding to the steam valve and reversing lever of an ordinary winding engine. Mr. Pichler, of Great Portland-street, exhibits a working model of a balance double-acting man-engine, for use in mines instead of cages or ladders. For the benefit of those who do not know what a man-engine is, it may be likened to a couple of ladders, side by side, which alternately rise and fall, the miners stepping from one to the other at each rise or fall, according to whether they wish to ascend or descend. A stand which will probably attract much attention from visitors is that of Bennett and Son, of Turnmill-street, E.C., at which is shown some of the processes of gold-beating. In a case at the side the various stages of the process are exhibited, from the little ingot and the ribbon into which it is rolled, to the finished leaf 1-300,000th of an inch thick. The stand of greatest interest in connection with metallurgy is, however, that of Thomas and Gilchrist, at which a number of specimens of basic Bessemer iron from different works at home and abroad are shown. To exhibit the ductility of the metal, we have specimens of wire beaten and twisted cold; a ramshorn test of ship's angles, doubled cold; a piece of boiler-plate folded in four, and numerous other examples, with a case showing samples of fractures. An exhibit which has a melancholy interest attaching to it is the casket presented to the late Sidney Gilchrist Thomas by the ironmasters of the Prague Society. The repoussé work is of basic ingot iron, while the figures are cast from pig iron as used in the Bessemer converter. Sir H. Bessemer exhibits in an unnumbered case an historical collection of original test pieces of Bessemer iron and steel, some of which date as far back as 1856. Mr. Snelus, of Workington, exhibits in model form illustrations of improvements in the processes of manufacture of steel, including apparatus for carrying hot steel ingots, and improved steel linings for Giers's soaking pits—a model of a pit being shown, with the appliances for handling the ingots. The deputy-master of the Mint exhibits the method of refining gold by the chlorine process devised by F. B. Miller, of the Melbourne Mint, and Prof. Chandler Roberts also shows a full-sized model of the battery for reducing chloride of silver, in which plates of zinc and cast slabs of the chloride of silver are placed in a weak solution of chloride of zinc, the silver being reduced in about 24 hours. He also shows a Stas pipette, modified by Mr. P. du Bois, of the U.S. Mint, Philadelphia. The continuous mercurial rain amalgamator of Dr. Atcherley is exhibited in working order. In this apparatus troughs are supported above the washing water and drop a continuous rain of mercury in order to seize upon the float and flour gold—light particles which would otherwise escape with the water. Cassel's process of extracting gold from refractory ores by chlorination is shown at the adjoining stand. Instead of using the gas in the free state it is evolved in the apparatus itself in the nascent state in contact with the ores, and oxygen being also generated at the same time, which oxidises the sulphides, arsenides, &c., the gold is seized upon by the nascent chlorine and converted into terchloride. The addition of lime prevents the iron in the pyrites from passing into solution. The Electro-Amalgamator Co. exhibit in working order their apparatus for extracting gold and silver from ores by the combined action of electricity and mercury, the current being employed to keep the mercury bright and lively. The Phosphor Bronze Co. show a variety of castings, &c., and their special silicium bronze wire, which has been found so useful for telephone and telegraph over-head-lines; and at the adjoining stand the Manganese Bronze Co. exhibit articles in their special metals, with a bent propeller-blade from the *Mosel*. The use of a peculiar-shaped two-bladed propeller for ventilating purposes is shown in the shape of the patent Crossley Air-Propeller, which gives a rapid movement of air at low pressure. It is shown running at about 800 revolutions, and from the simplicity of its construction, and consequent cheapness and economy, it should be found very useful in many places, such as mines and mills, hotels and theatres, hospitals, steam vessels, tunnels, &c. Amongst other exhibits of interest Messrs. Bailey and Co., of Salford, show a hydraulic hauling engine of the oscillating type, specially designed for working at a pressure equal to 1,200ft. in column; a one horse water motor of similar type for use where town water has sufficient pressure; a Bailey and Reid's cement tester; Professor Thurston's oil tester, and Stapfer's somewhat similar apparatus for ascertaining the lubricating value of oil. Mr. G. Bower exhibits drawings of a Bower-Barff furnace, and specimens of iron and steel rendered rust proof. The metal, it will be remembered, is subjected to the action of superheated steam or air while at a red heat, and combining with oxygen becomes coated with a film of magnetic oxide. The Compressed Lime Cartridge Co. exhibit specimens of the cartridges used in breaking down coal and in other mining operations, with the portable pump and hose for wetting the cartridge when in the tamped bore-hole. Mr. A. Latch, of Great George-street, S.W., exhibits the patent locked wire ropes made by Elliot and Co. These ropes were patented last year, and have many features to recommend them. The individual wires are drawn to different sectional forms to suit the purpose for which the rope is intended; but the completed rope is rounder than the old standard make, and has less weight; thus, a locked coil-rope 3in. in circumference weighs 13¼lb. per fathom, and is equal in strength to the old style rope 4in. in circumference and weighing 18½lb. The lock of the individual wires one into another is well shown by the sections exhibited. There are several stands of miners' tools, and Mr. Warsop, of Coniston, shows a hold-fast eyepiece with screw cone, for rendering picks and other tools interchangeable by expanding the shaft in the eye, and firmly holding it until the cone is unscrewed with a spanner. Miners' safety fuses and igniters are exhibited at two stands, that of Bickford, Smith, and Co. having a model showing the method of placing the igniters and fuses for firing several charges simultaneously. J. Buckton and Co., of Leeds, show a 50-ton testing machine, with their patent autographic indicator. At the time of our visit to this group several of the exhibits were still missing, or could not be found; but there is one which is sure to be seen by the visitor—viz., the patented machine of Scott and Hilder for separating iron filings. It consists of a rotating horizontal disc, fitted with electro-magnets, which are alternately magnetised and demagnetised by means of a commutator. Two endless belts run beneath, and the filings, being fed into a hopper, pass along the belts, the magnets picking up the iron filings when over one belt, and dropping them as they pass over the other. The two belts then throw them off into two bins for "iron," and "brass and refuse."



## THE AMATEUR WORKSHOP.—VII.

### Planing Machines.—Power Gear.

FROM the consideration of the hand-driven table we now pass to that of the multiple power gear. The Figs. 68, 69, 70 show a train of gearing adapted for the accomplishment of light work, strong, but not unwieldy. The wheels are of about the same size and pitch as those which are used for the back gear of lathes of 5in. or 6in. centres, and if such could be purchased of the makers, in sizes approximate to those figured, the labour of pattern-making could be saved. For the sizes of the wheels are not necessarily fast dimensions, but will permit of variation. Thus the return and cutting strokes are in the ratio of 2½ to 1, but the wheel C could be replaced by one having fewer teeth to give a ratio of 2 to 1, or by one having a greater number, to give 3 or 3½ to 1. The size of the wheel E could likewise be altered, either relatively to wheel G, or to the driving pulleys, and the rate of travel of the belt may be modified by altering the diameter of these, or the number of revolutions of the driving countershaft, or the diameter of its pulley. The pinions are not capable of much variation, since, if made larger, power is lost, while small pinions are driven with difficulty by their wheels, notwithstanding that they themselves will drive their wheels easily. The pulleys are made for 1¼in. belting, which is powerful enough for the work the machine has to do.

I have started with the assumption that the travel of the table is to take place at the rate of 15ft. per minute while cutting. The rate of cutting could be varied, however, if one class of work chiefly is intended to be done in it. For brass work the table could be driven faster, while for wrought iron its speed might be reduced, say, to 12 or 13, and these modifications can be made by the methods alluded to in the preceding paragraph—by altering the diameters of the driving or the driven pulleys, or the number of revolutions of the countershaft. Again, when the relative diameters of the pulleys are fixed finally, it is sometimes desirable to be able to drive at variable rates, and then, though the sizes of the direct driving pulleys remain unaltered, we can, by introducing speed pulleys overhead, upon the line shafting and the countershaft, get as many rates of travel as there are steps to the pulleys.

Returning to the figures, let us now see definitely what our train of gearing will effect.

A is the driving-pulley, 8in. diam., for forward or cutting stroke, B, first pinion for ditto, both of which are keyed on shaft *a*; C, first wheel for ditto; D, second pinion for ditto, both keyed on shaft *c*; E, second wheel for ditto, keyed on shaft *b*, which carries the rack pinion F.

Again, A″ being driving pulley for backward stroke, G is the pinion for ditto, working into the wheel E, and driving rack pinion F.

The list of wheels is therefore as follows:—

A, A′, A″ pulleys 8in. diam.
B, pinion containing 14 teeth of ⅝in. pitch
C, wheel " 35 " "
D, pinion " 14 " "
E, wheel " 51 " "
F, pinion " 11 " "
G, pinion " 14 " "

Having fixed on 15ft. per minute for cutting speed, we want to know the rate per minute at which the first shaft, *a*, must revolve to produce that effect. The two pairs of wheels, B and C, and D and E, will furnish us with the data for obtaining that ratio, and it will be—

$$\frac{C \times E}{B \times D} = \frac{35 \times 51}{14 \times 14} = 9{\cdot}1$$

That is, shaft *a* will make 9·1 revs. to one rev. of *b*.

The rack pinion F, measures 8¼in. in circumference at the pitch line. The number of revolutions, therefore, which the shaft *a* will make in one minute, the velocity of the table being 15ft., will equal—

$$9{\cdot}1 \times \frac{15' \times 12''}{8{\cdot}25} = 198{\cdot}4 \text{ revs. per minute.}$$

We have 8in. pulleys then, on the shaft *a*, to make 198·4 revs. per minute. If we assume that the countershaft makes 100 revs. per minute, the driving pulley upon that will have to be—

$$\frac{198{\cdot}4 \times 8}{100} = 15{\cdot}87\text{in. diam.}$$

These are our velocity ratios. The gain in cutting power simply, from the pulley A to the rack-pinion F would be

$$\frac{A \times C \times E}{B \times D \times F} = \frac{(8 \times 3{\cdot}14159) \times 35 \times 51}{14 \times 14 \times 11} = 20\ 80.$$

The gain in power in the return stroke would be

$$\frac{A'' \times E}{G \times F} = \frac{(8 \times 3{\cdot}14159) \times 51}{14 \times 11} = 8{\cdot}32,$$

and the ratio of the forward and backward speeds

$$\frac{20{\cdot}80}{8\ 32} = 2{\cdot}5.$$

I have struck the teeth of these wheels by means of Prof. Willis's odontograph scale, and in the case of each have also drawn three teeth to full size (Figs. 71, 72, 73). The directions given in the last article relative to the making of the rack pinion will also apply to the pattern of the pinions figured here, one pattern sufficing for the three castings. The two larger wheels, however, must be made in a different fashion. Figs. 74 and 75 show these in section. They are purposely drawn as light as possible consistently with strength, and the plated form is chosen as being simpler of construction than wheels with arms, and equally good for our purpose. If we describe the making of one of these patterns, therefore, those remarks will apply also to the other. The Fig. 76 shows the *pattern* wheel in section with the joints in detail. It is made as follows:—Get three strips of dry mahogany, each planed to 5/16in. thick, and large enough, when laid edge to edge to make a circle of 6¾in. in diam. It will really have to finish to 6½in. Screw them upon a true face chuck, not glueing the joints, but leaving them 1/16in. open. Glue a course of sweeped segments ⅝in. wide in the rough upon this plate, their outer edges being flush with the 6¾in. line. When the glue is dry, face over to a full ¼in. thick, and glue another similar course above this; the end joints in this last course to come midway between those of the previous one. Face this course to a distance of ½in. and 1-32in. measured from the plate. Turn the inner edges of the segments to the templet made from drawing, bore an inch hole through the centre of the plate, and by means of this hole rechuck against the side already turned. Build up two courses of segments upon the opposite side, turn their inner edges with the templet just used, then turn the whole width of the rim at once to 6½in. diameter, giving a very trifle of taper, indicated only by a tight and an easy fit of the calipers.

The outer diameter will then be pricked out by spring dividers into 35 divisions, and lines drawn across to these divisions with scriber and square. Each dimension will indicate the centre of a tooth; but it is immaterial whether the centre or the edge of the tooth be set to these lines.

The teeth are made in mahogany, and are worked in a templet box shaped like Fig. 77. The tooth stuff is first planed on one edge, and squared off to 1⅜in. lengths. These lengths are fitted and worked in succession in the space cut out in the block, a common round and rebate plane being used. Uniformity of shape and facility of production are thus secured.

When glueing the teeth on the rim, it is not safe to trust entirely for accurate results to the lines marked by the dividers and square; but calipers must be employed as a check while the glue is yet moist, and the teeth therefore being capable of minute adjustment sideways. A little cleaning up will be needed after the glue has dried, particles of worked out glue being removed with a chisel. Fine glasspaper will be applied to the tooth-flanks through the medium of a rubber, and the only taper needed in so shallow a pattern may be given by imparting slightly harder pressure on the lower than on the upper parts of the teeth. Two or three applications of shellac varnish will be beneficial in preserving the glue from the action of the moisture in the sand, and in imparting a smooth surface skin.

The bosses, *a a*, are turned separately, and held in place only with studs fitting easily into the central hole in the plate. An inch print will be attached to one of the bosses, and with this the pattern is complete. The wheel (Fig. 75) will be made in the same way.

The driving pulley (Fig. 78) is very light, as all pulleys ought to be, and that is a reason why especial care should be taken in making the pattern. Fig. 79 shows it in section as prepared for pulley A′. The bosses are studded on, as in the wheel just described, and there is another reason for this in this case, and it is that the bosses on the outer pulleys are different from those upon the inner pulley, A having a keyway boss, A′ having none, A″ having a special boss for the attachment of the pinion G. The very thin segments of which this pattern is composed must be made of mahogany, well jointed, and the best glue must be used, else the pieces will come apart very quickly. The rounding of the outside is better not done in the pattern, but a shade of taper should be given from the top to the bottom edges. Note also that ·1 in. of taper should be put upon the inner edges of the rim. By all means have the metal soft for facility of turning, for even soft metal cast so thin will become hardened slightly in casting.

We have to get our castings thus:—One off wheel C (Fig. 74), one off E (Fig. 75), two off pinions B and D (Fig. 80), one off pulley A′ (Figs. 78 and 79), perfectly plain; then one off same pattern for A (Fig. 78), with key boss ¼in. thick and 1¼in. long. Then one off same pattern with bosses altered to suit A″, in which pinion G, same pattern as B and D, is cast along with the pulley. Then one off rack pinion F (Fig. 70), described in the last article, having a boss cast on one side to bear against the boss on the bed.

The reference letters upon Figs. 68, 69, 70, to which no allusion has yet been made, have relation to details of the parts indicated, sketches of which will appear in the following article.

These castings are very light, wheel E weighing 11lb., wheel C 5½lb., and pulley A 6lb. About 15s. per cwt. will be paid for these.

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# NEW AND LITTLE-KNOWN APPLICATIONS OF THE NITROMETER.*

By ALFRED H. ALLEN.

AS long ago as 1847 the late Walter Crum described a method of estimating the nitrates and analysing gun-cotton, which consisted in passing up the nitrated substance, together with some water and sulphuric acid, into a graduated tube filled with mercury. The nitric oxide liberated in the reaction was subsequently absorbed by a strong solution of ferrous sulphate. The method of manipulation was greatly improved by Frankland and Armstrong in 1868, and recommended by them for the estimation of nitrates in water. Their use of a tube open at one end and closed at the other by a tap surmounted by a cup greatly facilitated the introduction of the nitrate and acid. This apparatus, which may be called the Frankland-Armstrong tube, would have come into more general use had the agitation of the lighter liquids with the mercury been more easy to effect; but the accuracy of the results yielded by it have been fully proved by Mr. R. Warington, who also found that the presence of chlorides did not interfere to any notable extent with the amount of gas obtained.

Mr. G. E. Davis states that the idea of applying the mercury process to the assay of nitrous vitriol was suggested to him by Dr. John Watts in 1872; and, in a paper read before the Faraday Club on January 22nd, 1878, Mr. Davis fully described the use of the Frankland tube for the assay of vitriol, which tube he used in connection with a mercurial trough. In February, 1878, Mr. Davis informs me that he connected Frankland's tube to a piece of combustion tube by means of indiarubber tubing, and used the two side by side in a burette-stand. This arrangement constituted the first form of the instrument we now call the nitrometer.

The name "nitrometer" is due to Dr. Lunge, who in 1878 published and illustrated a description of his instrument.

To Dr. Lunge, then, belongs the credit of the first published description of the nitrometer, but the same instrument appears to have been devised independently at a somewhat later date by Mr. Campbell.

Lunge's nitrometer possessed one decided improvement in the use of a three-way tap, which arrangement appears to have been adopted from Bunte's gas apparatus. When the nitrometer is employed for the estimation of nitrates, or the assay of nitrous vitriol, the three-way tap greatly facilitates the removal of the acid liquid at the end of an experiment, without necessitating the complete emptying of the nitrometer.

As ordinarily employed, the nitrometer-stand is so arranged that the open or reservoir-tube must be removed from its position and brought into close proximity to the graduated tube before the measure of gas in the latter can be read off, and it is therefore an advantage to have the stand so constructed that the closed and open tubes of the apparatus, which I propose hereafter to refer to as the "nitrometer" and "reservoir" tubes respectively, should be in close proximity.

Another inconvenience attending the use of the nitrometer is the persistent mercurial froth which remains after the completion of the reaction, and prevents the reading of the level of the mercury in the nitrometer tube from being taken without delay. When great accuracy is not required, this may be avoided by employing a tolerably wide tube; but, for ordinary purposes, it is preferable to adopt a plan suggested by me in a paper on the estimation of nitrates by the nitrometer published in 1880 (*Analyst*, v. p. 181). In that paper I proposed to make a mixture of sulphuric acid and water, in the same quantity and proportions as the acid and solution of nitrate are employed in the nitrometer-tube, and to pour this mixture on the top of the mercury in the reservoir-tube. It is then possible at once to bring the aqueous liquids in both tubes to the same level, and the incomplete separation of the mercury from the aqueous liquid becomes a matter of indifference. In the same paper I propose to make an experiment with a second nitrometer, in which a definite amount of nitre was used. By noting the volume of nitric oxide evolved in this apparatus, and comparing it with that obtained in the case of the liquid of unknown composition, it becomes unnecessary to make any correction for pressure or temperature; and the standard quantity of gas, when once obtained, can be kept in the tube without alteration for any length of time. If this course be pursued, it is desirable to keep a little strong sulphuric acid in the cup to prevent any possibility of leakage.

Before leaving the question of the estimation of nitrates in the nitrometer, I may point out a source

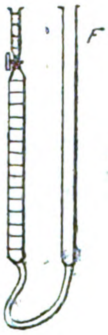

FIG. 1.

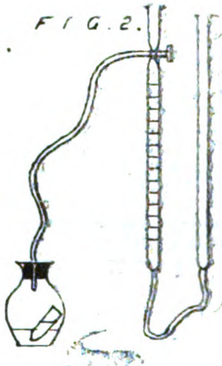

FIG. 2.

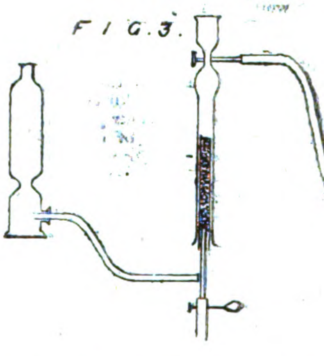

FIG. 3.

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* Abstract of a paper in the *Journal* of the Society of Chemical Industry, No. 3, Vol. IV.

of error which appears not unfrequently to have been ignored. This is, that strong sulphuric acid has a notable solvent power for nitric oxide, and hence the full amount of gas cannot be obtained unless the sulphuric acid be diluted below that point at which its solvent power for nitric oxide becomes appreciable. Warington and Thorpe both recommend that the strong sulphuric acid and aqueous liquid should bear the proportion of three measures to two, and my own experience is in favour of this condition.

For the examination of dynamite and guncotton, Lunge places about ·35 gramme of the sample in the cup of the nitrometer, and dissolves it in 5cc. of concentrated sulphuric acid. The liquid is then allowed to enter through the tap, and is agitated with the mercury in the usual way. Probably better results would be obtained if a few centimètres of water were added after the completion of the reaction.

Hitherto all employers of the nitrometer appear to have regarded mercury as the only liquid with which the instrument could be filled, and of course this is actually the case in the estimation of nitrates, since the mercury itself takes part in the reaction.

For many purposes, however, the mercury can be conveniently replaced by a dense aqueous liquid, saturated brine being most generally suitable, and the following are some of the applications to which I have put the nitrometer when filled with such a liquid.

The assay of spirit of nitrous ether and kindred preparations for the proportion of ethyl nitrite is a problem which has engaged the active attention of pharmaceutical chemists. Hitherto the processes for the purpose have not been very satisfactory, the one giving results nearest to the truth being that of Eykman, which consists in treating the sample with a solution of ferrous sulphate and dilute sulphuric acid, heating the mixture, and collecting the nitric oxide gas evolved. Though the process is theoretically perfect, there are certain sources of error in practice, and the apparatus is somewhat complicated, and requires skill in management. Mr. D. B. Dott has proposed to estimate ethyl nitrite by treating it with potassium iodide and dilute sulphuric acid, and estimating the amount of iodine set free by titration with a standard solution of sodium thiosulphate. The reaction which occurs in this process is expressed by the equation:—

$$(C_2H_5)NO_2 + KI + H_2SO_4 = KHSO_4 + (C_2H_5)OH + I + NO.$$

In making experiments on Dott's method it occurred to me to measure the nitric oxide gas evolved, instead of titrating the iodine liberated, and as the reaction occurs completely and promptly at the ordinary temperature the nitrometer is an apparatus well suited for the purpose. I have now had a large experience in the process, which is best performed in the following manner:—A nitrometer should be filled with strong brine, and 5cc. of the sample to be tested should then be placed in the cup of the nitrometer, and allowed to enter through the tap, taking care that no air gets in at the same time. About 5cc. measure of a strong solution of potassium iodide is next allowed to enter, and this is followed by about 5cc. of dilute sulphuric acid. Effervescence immediately ensues, and, if the tube be vigorously agitated at intervals, the reaction is complete in a few minutes, when the level of the liquid in the two limbs of the nitrometer is adjusted, and the volume of nitric oxide gas read off. There is no difficulty in confining the reaction to the liquid in the upper part of the closed limb of the nitrometer. The nitrometer method has been proved to give very good results with pure sodium nitrite, prepared from silver nitrite, and employed in known amount, and may be advantageously used for the assay of commercial nitrite of sodium. With some specimens of sweet spirit of nitre a considerable volume of nitric oxide is produced, and iodine liberated before adding the acid, the reaction probably depending on the presence of free acid in the sample. The results obtained in the nitrometer are remarkably constant, and the method furnishes a very easy means of assaying sweet spirit of nitre with considerable accuracy, which is further increased if a correction of 1·5cc. of NO be made for solubility of the gas. The process does not occupy ten minutes, including the calculation, and actually measures the nitrous compounds present in the sample, instead of leaving their proportions to be inferred from a more or less complex reaction, such as the reduction of permanganate, &c. When strictly accurate results are not required, as is rarely the case in assaying such a preparation, the volume of gas need not be corrected for variations of pressure, temperature, and tension of aqueous vapour, &c. 1cc. of NO at the ordinary conditions of pressure and temperature corresponds to ·003184 gramme of ethyl nitrite,[*] and hence 5cc. of samples of spirits of nitrous ether of reasonably good quality evolve from 25cc. to 40cc. of nitric oxide.

Another useful application of the nitrometer is for the estimation of *urea* in urine. For this purpose the tube is filled with brine as before, and 2cc. of the sample introduced through the tap. This is followed by 10cc. of the usual solution of bromine in caustic soda[*]. Before the bromised soda has time to sink through the brine it comes in contact with the urine, and the great bulk of the nitrogen gas is liberated. By now placing a clip on the indiarubber connecting-tube and agitating the contents of the nitrometer tube vigorously, the reaction is completed, and the volume of gas may be read off. Not unfrequently the reading is delayed by the existence of froth on the surface of the liquid in the closed tube, but this may be instantaneously got rid of by introducing a few drops of alcohol through the tap. In some respects it is preferable to bring the bromised soda and urine in contact with each other in a small bottle or flask fitted with a perforated cork, and connected by narrow indiarubber tubing with the nose of the three-way tap of a nitrometer filled with brine or water (Fig. 2). A nitrometer is much better for this purpose than the device of a burette or graduated tube immersed in a tall jar of water, as is employed by Dr. Squibb and others.

The last arrangement is well suited for the estimation of *carbonates*, the sample being placed in the flask, and the acid for its decomposition contained in a small tube in the usual way. This amounts to a suggestion to employ a nitrometer in place of the measuring tubes of Scheibler's carbonic-acid apparatus. Of course the usual corrections for solubility of the gas in the acid liquid, &c., apply as much in one case as in the other.

The nitrometer may also be very conveniently used for the assay of commercial *peroxide of hydrogen*, for which it was first employed by Mr. G. E. Davis, who filled the nitrometer with mercury and operated on 1cc. of the sample, which he agitated with 5cc. of a saturated solution of potassium bichromate. Under these circumstances Mr. Davis found the peroxide of hydrogen to be split up into water and oxygen, the bichromate remaining unchanged, and this observation has been subsequently confirmed by Mr. W. H. Symons. It is usual to express the strength of peroxide of hydrogen in terms of volumes of oxygen obtainable therefrom, and hence the nitrometer is well suited for its assay.

According to my experience, the reaction of bichromate of potassium on peroxide of hydrogen does not occur so promptly or completely as could be wished, and I have therefore substituted for it an acidulated solution of permanganate of potassium. I prefer to operate as follows:—

The nitrometer is filled with a saturated solution of sodium or magnesium sulphate[†]. 1cc. of the sample is then introduced through the tap, and this is followed by a strong solution of potassium permanganate, which has been previously acidulated with sulphuric acid. The reaction occurs very promptly, and the permanent coloration of the contents of the tube suffices to show that an excess of the permanganate has been employed. When acidulated permanganate is used, the reaction is as follows:—

$$2KMnO_4 + 5H_2O_2 3H_2SO_4 = K_2SO_4 + 2MnSO_4 + 8H_2O + 5O_2.$$

Mr. Kingzett and other chemists have independently proved the truth of the equation by adding standard permanganate to hydrogen peroxide (in presence of free acid) contained in a Woulffe's bottle arranged so that the evolved oxygen could be collected and measured. The accuracy of the results obtained by permanganate was checked by estimating the iodine liberated by the hydroxyl from potassium iodide. Hence, when acidulated permanganate is employed for decomposing hydroxyl, only one-half of the oxygen gas liberated comes from the sample, the other half being derived from the reagent. Therefore, 1cc. of a sample of peroxide of hydrogen, described as of "10 volumes strength," ought to give 20cc. of oxygen in the nitrometer. If an acidulated solution of potassium bichromate be substituted for the permanganate, the reaction occurs very promptly, a double volume of oxygen being evolved; but for some unexplained reason the results are sensibly lower than those obtained with permanganate.

While the nitrometer is frequently used as an instrument in which to evolve and measure gas, it has not met with such a wide application as it deserves for the purpose of *absorbing* gases.[*] But, as a matter of fact, by the aid of two of Lunge's nitrometers, having their three-way taps joined by a short piece of indiarubber tubing, we can extemporise an apparatus for gas analysis capable of a variety of applications.

Having not unfrequently to make analyses of blast-furnace and Siemens gases for technical purposes, the importance of having a rapid and moderately accurate method of gas analysis has forced itself on my attention, with the result that I have devised a very simple apparatus for the purpose.[*]

Perhaps there is no chemical operation more difficult to describe than that of the manipulation with an instrument for the analysis of gases, but in practice the mode of using the apparatus in question will be found exceedingly simple, and to anyone in the habit of working with gases, means will readily suggest themselves for increasing the accuracy of the results.

In conclusion, I may call your attention to some qualitative applications of the nitrometer with a three-way tap, which instrument furnishes an extremely ready means of obtaining certain gases in a state of purity. For instance, if the lower end of a Lunge's nitrometer tube be cut off and the opening closed with a perforated cork fitted with a T-piece, one branch of which is closed by a clip and the other communicates with the reservoir, we have a convenient apparatus for generating at will small quantities of such gases as can be readily evolved without application of heat (Fig. 3). Thus, for example, if some granulated zinc be placed in the nitrometer and the instrument filled with water, on allowing acid to enter through the cup, hydrogen perfectly free from air will be evolved, and can be utilised in any manner desired by opening the three-way tap, to which a piece of indiarubber tubing has previously been attached. The T-piece at the bottom enables the dense solution of zinc to be tapped off when desired, and so the apparatus can always be kept full of hydrogen and in order for use. For small quantities of sulphuretted hydrogen the apparatus is also well adapted, and by means of the T-piece any choking up by ferrous sulphate can be wholly avoided. Carbon-dioxide also can readily be generated in the nitrometer tube, and if a small quantity of oxygen be required, as, for instance, in a gas-analysis, it can be obtained instantaneously and in a state of purity by the reaction between acidulated permanganate and peroxide of hydrogen. It is the three-way tap which renders the nitrometer suitable for a large number of the purposes suggested.

## HINTS FOR CLEANING BOILERS.

FOLLOWING the application of any boiler purger, or other substance for loosening scale or deposit upon the shell, heads, or flues of a steam boiler, special care and attention should be given to cleaning out the boiler, with a prompt removal of such loose fragments as may have become detached and fallen down. These particles, if not removed, are often swept about by the various currents within the boiler, and, collecting in a conglomerate mass upon some part of the fire surface, prevent access of water to that particular part, and thereby it is overheated and bulged—or bagged, as it is sometimes called—often inflicting a dangerous injury to the boiler and requiring a considerable outlay for new sheets, a patch, or perhaps other expensive repairs.

In the use of soda and other preparations used for the removal of boiler incrustations that are soluble in water, a separate vessel may be provided, suitably connected to the feed-pipe, so that the preparation, in its proper proportions as recommended, may be first dissolved, and, when properly prepared, fed into the boiler. When there is a heater the solvent may be prepared and emptied into that. Logwood or oak chips, leather clippings, and many other waste products of a manufacturing establishment that contain some useful ingredient, as tannin, soda, or starch, may often be used advantageously when they are recommended and their use directed by an inspector; otherwise serious difficulties may result, perhaps endangering the safety of the boiler. We have known silk fabrics and other delicately-fine articles to be ruined in the dyeing process by the too free use of boiler compounds, of which the users were ignorant in two essential particulars—namely, as to their composition and the safe quantity to be used.

The importance of knowing these particulars will be evident when we remember the great tendency of the boiler to foaming when purges are used, and the increased danger at such times of carrying over some of this water mingled with steam to the dye kettles, or wherever it may be used. We should not have a great deal of sympathy for the man who, declining to avail himself of the services and advice of a physician, ruined himself by dosing with all sorts of nostrums of which he was ignorant; but such a man, at the worst, can but ruin himself, while another who persists in dosing his boiler may not only lose his own life, but he may sacrifice many other lives in the same foolish way. We know of an instance in which a party who had some condemned bacon in his storehouse which he thought to use advantageously in cleaning and lubricating his boiler, he having somewhere read that grease was an excellent thing for the purpose. As he described it afterwards, the boiler turned nearly inside out, and he fondly hopes that he may live long enough to get even with the man who recommended it to him. Another case was that of a fireman, whose duty it was, under the direction of the engineer, to fire and keep clean a battery of boilers, who, happening to hear some of his mates say that oil was an excellent thing for softening scale, thought to make a trial of it on his own account. So one Sunday, when cleaning out his boiler, he went through the shops connected with the establishment and gathered up the refuse oil and grease from various drip-pans, securing in this way two or three gallons, which he poured into one of the boilers and afterwards filled it with water. Soon after the steam was got up the fire sheets became bagged and beautifully corrugated, and leaked like a sieve.

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[*] I have had a special nitrometer (Fig. 1) constructed for me for the assay of nitrous ether preparations. The graduated tube holds 50cc. and the cup is narrow and cylindrical, and has marks at 5cc. and 10cc. above the tap. This arrangement renders the use of a pipette or other separate measuring arrangement unnecessary, as the cup can be filled to the 5cc. mark with the sample, and thus a definite amount taken for the analysis. In this case a three-way tap is of no advantage. Messrs. Cubley and Preston, of High-street, Sheffield, are now prepared to supply these nitrometers to those desirous of employing the process mentioned in the text.

[*] 100 grammes of caustic soda are dissolved in 250cc. of water and 25cc. of bromide cautiously added to the well cooled liquid. In some respects it is preferable to dilute the 10cc. of this solution with an equal measure of water before introducing it into the nitrometer.

[†] If brine be used there is a tendency to error from the evolution of chlorine.

[*] Messrs. Cubley and Preston are prepared to supply the apparatus for gas analysis described in the text.

In boilers under our supervision we have used crude petroleum many times for the purpose of loosening line scale, and with the most satisfactory results. We do not approve of the use of grease, and we deem the application of animal oils or fat to the interior of a boiler for that purpose as very hazardous. As a rule, when a boiler is in service, a systematie daily charge of a proper solvent, graduated to the capacity of the boiler, will be found more efficacious than a larger charge at longer intervals, and is less likely to cause foaming and kindred difficulties. An important matter sometimes overlooked is the need of regular times for it. When about to put a boiler out of service for a thorough cleaning, it will be found an excellent plan to let the boiler cool off gradually and the pressure fall slowly until it has reached about 5lb., when the safety valve may be raised and the remainder blown off. Run off the water and remove the hand-hole plates, when the scale will be found much softened and easily detached, while the deposit can readily be washed off with a hose. We have found this an excellent plan to pursue even in marine boilers using sea water and depositing a very refractory scale, as the North Atlantic or Gulf of Mexico. Blowing down a boiler between the limits of high and low water, or, in other words, between the upper and lower gauge cocks, is often very beneficial and assists materially in freeing it from the ill effects of scum and other impurities. If, however, this blowing down is not intelligently done there is a probability of great waste and serious loss; for in blowing out good water at the temperature of the steam pressure and replacing it by other water, perhaps of no better quality, at the much lower temperature of the feed, there is a great loss of heat and consequent waste of fuel. Blowing down a boiler can, however, under no circumstances be depended upon to thoroughly clean it and remove loose fragments of scale and much of the deposit commonly found. This can only be done by systematic periodical washing out at intervals to be determined by the circumstances of the case.—*Locomotive.*

## OLD AGE AND THE CHANGES INCIDENTAL TO IT.[*]

By G. M. HUMPHRY, M.D., F.R.S., Professor of Surgery at the University of Cambridge.

OLD AGE acquires a gradually increasing interest as advancing civilisation enables a larger number of persons to attain to it, and affords them additional means of enjoying it and profiting by it. We are, I think, too much accustomed in our ideas to limit the work of development to the periods of adolescence and maturity; and, indeed, the surpassing wonders of that work—I say surpassing wonders, for unquestionably the processes of development of an animal body are the most marvellous, the most mysterious, and the most interesting in the whole range of the physical world—are most fully demonstrated in the early periods of life. But they do not end in them, or even when the body has been brought to its fully matured condition. They continue in a definite and orderly manner, though with lessened and lessening activity, to the termination of life, at whatever period that termination may occur. The march of changing events in the human body, from the age of forty or fifty to one hundred, is as regular, as orderly, as developmental, though less quick, and therefore less apparent, as it is from birth to adolescence, or from conception to birth. It is one of the resultants of that inscrutable *vis*, call it what you will, and refer it to what you will, which makes all nature one, which determines the course and end of each animate and inanimate object, and by which, in the well-known words of Keble,

> "To its funeral pile this aged world is borne."

A main feature of the "ascending," if we may so call it, development, the development from birth to maturity, is an increase of material, an increase of activity, and an increase of strength—of passive or resisting, as well as of active, strength; and the main feature of the "descending" development, the development from maturity onwards, is a lessening of material, and lessening of activity, and a lessening of strength. In the normal "ascending" development, material and strength are added to the several parts of the body in due relation to their respective requirements, so that they may all grow on *pari passu*, and the proper harmony of proportion may be maintained between them; and in the normal "descending" development, the relative proportions of the several structures and organs are preserved, while weight, force, and activity are being lowered by gradual and well-adjusted diminution of material and of nutritive activity. During the time that the bones are becoming lighter and less capable of offering resistance, the muscles become, in like proportion, lighter and weaker, and with a narrowing range of action; and the associated volitional and other nerve-apparatus exhibits a corresponding lowering of energy and force. A time comes at length when, in the course of the descending developmental processes, the several components of the machine, slowly and much, though equally, weakened, fail to answer to one another's call, which is also weakened, when the nervous, the circulatory, and the respiratory organs have not force enough to keep one another going; then the wheels stop rather than are stopped, and a developmental or physiological death terminates the developmental or physiological decay. How much may those who pass gently into this natural or physiological death be envied by the many sufferers under the protracted and painful pathological processes which too often induce a premature extinction of life! The most distressing part of medical duty is the being called upon to witness, with the inability to arrest, the onward course of disease, such, for instance, as that of a slowly but surely growing cancer, boring its way into the strong and sturdily resisting frame; and the great hope and aim of medical study is to prevent such fatal interferences with the developmental processes, and to enable these processes to work out, in their own uninterrupted way, the quiet, easy, gradual method of dissolution. Yet, strange and paradoxical as it may seem, this gradual natural decay and death, with the physiological processes which bring them about, do not appear to present themselves in the ordinary economy of Nature, but to be dependent upon the sheltering influences of civilisation for the opportunity to manifest themselves and to continue their work. For the needs of the first, or infantile, period of helplessness Nature has made a sufficient provision in the parental instinct which protects and nurtures the young. But this lasts only so long as the requirement for it exists. It ceases as soon as the young has the ability to help itself; and it does not return and is not supplemented by anything of its kind. It gives way before that struggle for existence which is the engenderer of selfishness, dominating over all other impulses and shutting out all heed for the worn and weary, for the feeble and the decaying. These, being unable to help themselves, are crushed out by the various provisions which Nature makes for their destruction. The good result of this great seeming evil being that all in the natural, or primitive, animal world is in the ascendant to, or in the enjoyment of, bodily perfection. All teems with budding life or full health and strength. To falter is to fall; forasmuch as the first evidences of weakness and the beginning of decay arrest themselves by preventing the power of self-maintenance in the weak and the decaying. The same with disease. It, in like manner, stops itself. Indeed, it can scarcely be said to be allowed to enter into the pure realm of Nature. Sick animals are not there provided for, have no abiding-place there, and soon perish; so that there is no wasting and pining, no lingering fevers, no destroying cancers, no decrepit frames. Neither the bird that fails to elude the hawk nor the hawk that fails to seize the bird can long continue in existence. Thus, in the economy of Nature, death is swift, and comes early, as soon, at least, as failure of strength renders the animal unable to protect, or provide for, itself; and man, it would seem probable, had no exemption from this sharp, though, on the whole, beneficent law of animal life. In early times, when the race was to the physically strongest, when health, and strength, and activity were necessary to provide the hand-to-mouth means of sustenance, and to give defence, when men and animals were much on a par in this and many other respects, early death must have been the common fate, being brought about by climacteric agencies or by the tooth of the hungry beast, or by the hand of man himself. This, indeed, we still find to be the case among some of the rude race of mankind. But in man was the germ of a better order of things, the germ of sympathy with, of feeling and love for, others which was besides and above the mere parental instinct, and which was calculated to counteract and over-ride the selfish bent, and to raise man in this, as in some other respects, above the mere animal. It was not to be expected that this good seed should be without a blending with tares, and the scope thus given for the fuller development of the physiological processes, gave scope also for the development of the pathological processes, and enabled the various diseases to spring up and take their course, afflicting not man only, but those animals also which come under his fostering or protecting influence. It may therefore be said that the prolongation of life into and through the periods of decay and into and through the processes of disease—indeed, almost, if not quite, the very existence of decay and disease—is the result of human forethought and sympathy. In other words, decay and disease are, by civilisation, substituted for quick and early death. Without attempting to balance the *pros* and *cons* of this, we know it to be a position from which there is not, and ought not to be, any disposition to recede; and if there were the wish, there is not the possibility. The onward march of civilisation is a necessity, and the onward progress of disease will tend to go with it. But it does remain for forethought and sympathy to narrow the range of the evils they have themselves engendered, or which have sprung up with them; and it is pre-eminently the noble work of our profession to contribute to this—to weed out and check the growth of the morbid tares, and to help the good seed to grow on to its full harvest—to prevent, that is, the origin, and to arrest the advance, of disease, and to give to the body the best opportunities for health and longevity. The first requisite for longevity must clearly be an inherent or inborn quality of endurance, of steady persistent nutritive force, which includes reparative force and resistance to disturbing agencies, and a good proportion or balance between the several organs. Each organ must be sound in itself, and its strength must have a due relation to the strength of the other organs. If the heart and the digestive system be disproportionately strong, they will overload and oppress the other organs, one of which will soon give way; and as the strength of the human body, like that of a chain, is to be measured by its weakest link, one disproportionately feeble organ endangers or destroys the whole. The second requisite is freedom from exposure to the various casualties, indiscretions, and other causes of disease to which illness and early death are so much due. Now, in both these—notably, in the second—woman has the advantage over man, and she consequently attains to greater age. That this superiority is not entirely due to the comparative freedom from exposures and to the greater temperance in the woman, but is partly a result of a stronger or more enduring inherent vitality is shown by the fact that, even in the first year of life, when the conditions and exposures of male and female infants are the same, the mortality of girls is less than that of boys. A somewhat large number of boys are born, but they are more difficult to rear; so that the females soon gain the numerical lead, and maintain it, with almost steadily increasing ratio, to the end. This superiority may be to some extent associated with the less wear and tear in the smaller machinery of the woman's frame as compared with that of man; and one might expect that the small persons in both sexes would live longer than those of greater stature. This, however, scarcely seems to be the case. We find from our returns that the average height of the woman above eighty is about 5ft. 3in., which, allowing an inch for the shortening incidental to age, makes it to fall little, if at all, short of the average middle-age stature. The men also we find to be 5ft. 6in., which, making a corresponding allowance, gives them a good average height. It may also be observed, which we should not have expected, that the rate both of the pulse and respiration is quicker in the longer-lived sex; the average pulse in the woman over eighty being 78 to 79, while that in the men is 73; and the respiration in the women is 22, while that in the men is 18 to 19. It is a point of interest, in connection with the inborn or hereditary quality, that phthisis is reported to have appeared in some of the immediate relatives—father, mother, brothers, or sisters—of 82 of the 500 aged persons; in 51 of the relations of the 250 females, and in 31 of those of the 250 males. In the reports of some of these, it is stated to have occurred in several members of the family; and, in a few instances, the disease was manifested in both father and mother. It is evident, therefore, that the delicacy, or peculiarity, whatever it be, of constitution, which is associated with the tendency to the development of tubercle, is not only not incompatible with longevity, but is not unfrequently associated with it. No other special peculiarities have been shown in sufficient numbers to deserve notice here. The greater portion are reported to be of long-lived families, to have enjoyed good health throughout their lives, to have had good appetite and good digestion, requiring little or no medicine, to have been moderate or small eaters, to have taken little alcohol, and, commonly, not much meat; they have been good sleepers; and they show no traces of gouty or rheumatic affection in the joints of the hands. I have said that the main features in the downward, or senile, developmental process are a diminution of material and a diminution of force; and I apprehend that in the normal state it should be simply this—such a diminution, with, perhaps, a slight addition to the amount of oily matter naturally existing in the tissues; and that the other changes and degenerations that are incidental to age are no part of, but are rather to be regarded as deviations from, or morbid departures from, the natural phenomena. Let us consider the changes which take place in the skeleton, forasmuch as they are most appreciable, and, in many respects, the most interesting. The bones which, up to maturity, had been gaining in weight and size, now gradually loose weight, but do not ordinarily diminish in size, as they do in atrophy from paralysis; indeed, they not unfrequently rather increase in size from the continuance of a slow process of subperiosteal ossification. To this, in part, may be attributed the sharp outlines which the figure of old persons commonly acquires, except in the case of those who become corpulent. The absorption takes place first and chiefly in the more vascular and cancellous parts, the bony plates becoming thinned and removed, and the cancelli and the canals being enlarged and filled with marrow, while the bony tissue itself becomes often, though not always, more impregnated with oily matter. Hence, although the walls of the shaft are being gradually thinned from within, the ends of the bones are first and most affected, which explains the greater liability to fractures near the joints in old persons than in the middle-aged. This change, with the proportionate liability to fracture, is especially remarkable in the trochanteric and cervical parts of the thigh-bones, the strength of which is so much dependent upon the strength and disposition of the cancellous plates. This change takes place earlier in women than in men. The vascular and cancellous character of the alveolary processes of the maxillary bones renders these parts peculiarly liable to undergo wasting or absorption, causing the loosening and falling out of the teeth. This absorption of the alveolary processes and consequent removal of a part of the bodily machine which is in full and daily use is remarkable, though it has something of a parallel in the removal of another cuticular appendage—namely, the hair of the head. For the reasons I have given, it can scarcely take place in the condition of struggle for existence of the natural animal world, or in man in his primitive state; and it is accordingly commonly observed that the unearthed skulls of our early ancestors are well provided with teeth. The loss of teeth would imply a decay which the early man could scarcely have survived. What effect in more modern life this loss has upon the general health and the duration of the body is not easy to determine. It is often survived for many years; and it may be noted that, as before stated, it takes place more in women than in men, though they are the longer lived. Civilisation is doing something to supply the deficiency which it thus brings in its train by providing artificial substitutes; and they are at any rate free from some of the disadvantages, such as disease and decay, associated with the natural organs. It is remarkable how completely the alveolary processes become cleared away, so that scarcely a trace or them remains above or below; and the whole framework of the face, which ministered with them to mastication, is attenuated, and the body of the lower jaw is reduced to the narrow bar of its hard lower margin. At the same time, the resistance of the teeth being removed, the direction of the pull of the muscles upon the jaw is altered so as to open out the angle of the bone and bring the ramus and the body almost into a horizontal line. Thus the form of the lower jaw returns nearly to that of the infant. But there is this great difference, that whereas in the infant the bone consists mainly of the tooth-bearing or alveolary part, and the sub-alveolary portion scarcely exists, in the senile condition the latter only remains, the former having been cleared away. The changes which take place in the skull during old age are interesting. Commonly they correspond with those in the facial part, and the whole cranium becomes lighter and thinner, and therefore smaller. In some cases, however, it acquires an increase of thickness, by deposit of bone on the interior of the brain-case, and chiefly of the calvarial part, which seems to depend upon the lessened pressure there, and the consequent greater afflux of blood caused by the shrinking of the brain. The increase is usually most marked in the frontal region, which accords with the fact that the shrinking is most pronounced in the frontal lobes of the brain. The cartilaginous parts of the skeleton become somewhat thinner, which accounts for the loss of height in the aged; but I do not think that they usually undergo any other perceptible change in ordinary healthy old age. I have invariably found the costal cartilages soft in old people in whom I have had an opportunity of making an examination after death: the body of Old Parr, as described by Harvey, therefore presenting in this respect, as I believe, no exception to the general rule. And I regard the calcification of them to be a morbid rather than a senile change—a degenerative change to which the body is liable, as it is to cataract, bronchitis, and some other conditions, when it has passed maturity; and not one of the natural senile developmental processes. It may, I think, in like manner, be said, with regard to the calcification of the arteries, that it is the result of a morbid process intruding itself upon, interfering with, and arresting the normal progress of senile development. The rate of the heart's beats, according to our returns, does not vary much as age advances. From eighty to ninety it averages 73 to 74 in men and 78 to 79 in women. It is stated to be regular in 322 and irregular or intermitting in 85. The respiration in 110 returns of men between eighty and eignty-five averages 17 per minute. In 47 returns of men between eighty-five and ninety it averages 19 to 20; and in 16 returns of men at and over ninety it averages 23; in women it is a little quicker. Thus, in 86 returns of women between eighty and eighty-five it averages 22; in 54 between eighty-five and ninety it is also 22; and in 37 at and over ninety it is 23. It has to be borne in mind, however, that the not unfrequent occurrence of bronchitis in the aged raises somewhat the average rate of respiration in them. The failure of nutritive force in the brain manifests itself in the lessening of that power of concentration and quickness of attention upon which the sharp stamping of impressions and the ready recall of them depend; hence the memory for recent events is commonly impaired. The old man meanders on in his conversation unconscious that he is repeating himself; he remembers the tales of long past times, but forgets that he has just told them. This may go on to the condition of senile dementia. Happily, it does not often do so; and it is satisfactory to note how many of the very aged are in good possession of their mental faculties, taking a keen interest in passing events, forming a clear judgment upon them, and full of thought for the present and future welfare of others. It is no less satisfactory to find that the active, even severe and long-continued, functional activity of the matured brain seems in no way to impair its enduring qualities, and that good earnest useful employment of body and mind are not only compatible with, but even conducive to, longevity. After all, length of life is to be really estimated not by number of years so much as by good work done, not by the amount of time spent in the tame, fruitless manner indicated by the pithy words of Cowper—

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[*] Extracted from the Annual Oration, before the Medical Society of London, as reported in the *Lancet.*

> "For fourscore years this life Cleora led:
> At morn she rose, at night she went to bed"—

nor by endeavours solely to advance our own fortunes, or reputation, or comfort, but by persevering efforts to promote the welfare of our fellow-men.

# SCIENTIFIC SOCIETIES.

## LIVERPOOL ASTRONOMICAL SOCIETY.

THE fourth session was closed on Monday evening by a meeting at the Association Hall, the Rev. T. E. Espin, B.A., president, occupying the chair. In a paper on "The Possible Origin of Comets," Mr. J. P. Sutton said the recent return of Encke's and Tempel's comets to our evening skies afforded an opportunity of considering what might have been their origin. The periodic time of Encke's comet had been observed to decrease by an average of about two hours in each revolution, and there could be no doubt that this would eventually land it on the sun's surface. The most natural explanation of this peculiarity was that some retarding influence gave the sun's attraction greater power than would otherwise be the case. The theory that comets had been erupted from the interior of planets was very ably argued by Mr. Proctor, but the only factors that could support such an hypothesis seemed to be that the aphelia of periodical comets crowd upon the orbit of Jupiter, and that the ascending node of Tempel's comet was very near to the orbit of Uranus. But the connection which we now know to exist in so many instances between comets and meteor systems was fatal to Mr. Proctor's view, because, if Tempel's comet was erupted from Uranus, so also must have been the meteor system to which it belonged. But he contended that no planet could by eruption generate a quantity of matter which would revolve in a continuous ring around the sun; in fact, he would point out that the enormous length of these meteor systems which form rings, unbroken perhaps throughout their entire length, quite precluded the idea that they could have originated anywhere within the bounds of the solar system. Whether they came to us from the stars might reasonably form a matter for dispute, though spectroscopic analysis certainly seemed to point to their formation by stellar processes. But certain it was that a sufficient retardation had been proved to render either the planetary capture or eruptive theories unnecessary for the argument.

Mr. W. F. Denning, F.R.A.S., would remind Mr. Sutton that the number of certainly known cases of identity between cometary and meteoric orbits was remarkably small, amounting, in fact, to only four instances. The connection between comets and meteors was proved rather by the precise agreement of their orbital character than by the mere number of such agreements. He thought, also, it was quite possible that comets might have a derivative source in planetary eruptions. A planet might, for example, have evolved a certain quantity of matter, in the form of an immense cloud of meteoric pellets (or, say, a volcanic outburst similar to the great Java eruption of August 1883), and this cloud would, if ejected with sufficient force to leave its parent planet, certainly tend towards the sun, and in process of time assume the form of a meteor ring. The foremost particles of the original mass would primarily gain ground on the central portion, and this would cause an extension of the stream. Then, as the mass passed perihelion, there would naturally be a slight difference in perihelion distance, and this meant a difference in periodic time. The mass would thus be resolved into a train of particles, and ultimately into one complete ring. Therefore, granting that comets and meteors had heen erupted from planets, their subsequent resolution into rings could only be a question of time.

Mr. Joseph Baxendell, F.R.S., &c., said Captain W. Noble had lately drawn the attention of the Royal Astronomical Society to an apparent discrepancy between the proportion of Saturn and his rings as seen in a telescope and those derived from data given in the *Nautical Almanack*. Since the publication of Captain Noble's communication it had struck him that a phenomenon he had witnessed in Oct., 1882, strongly supported the position Captain Noble had taken. At the date mentioned the outer minor axis of the outer ring had, according to the *Nautical Almanack* elements, become relatively less than the polar diameter of the ball; but he had observed the S. polar limb of the planet to extend sensibly beyond the southern edge of the outer ring, though no trace of the N. polar limb could be perceived on the northern edge of the ring. This appearance became well marked on the 28th October, when it was readily seen with a power of 180. As the elevation of the sun above the plane of the ring was at this time about 11½ minutes less than that of the earth, the invisibility of the northern limb of the planet could not have arisen from the shadow of the ring being thrown upon it. Assuming the elements in the *Nautical Almanack* to be correct, the only explanation appeared to be that the centre of the ball was not coincident with the centre of the ring system, but was at a sensible distance on the S. side, and, therefore, was not the centre of gravity of the planet.

Mr. R. C. Johnson read a paper by Mr. Geo. Knott, LL.B., &c., on the variable star U Geminorum. It was seldom the case that circumstances favoured the obtaining a complete observation of a maximum of Mr. Hind's remarkable variable star. In addition to cloudy skies, a further disturbing cause was to be found in the moon, whose path was comparatively near the star's place, and whose presence sometimes seriously interfered with, if it did not entirely prevent, all effective observations. The brightness of the star had been observed to vary from 14·5m. on the 1st of April, 1885, to 9·5m. on the 6th, when it slightly decreased in brightness; it reached its principal maximum of 9·2m. on the 8th. It would, therefore, appear that on this occasion the maximum was a double one, with a subsidiary minimum intervening—a phenomenon which had already been observed in maxima of this star. Professor Schönfeld had pointed out in his *Zweiter Catalog* that not only were the intervals between successive maxima of this star subject to great irregularity, but that the duration of the maximum phase (or length of time taken in rising to maximum and falling to minimum again) had a varying range of from 10 to 20 days. It would seem indeed that the maximum might be broadly divided into two types—one well marked with a duration time of 10 ± days, the other (not perhaps presenting quite such distinct characteristics, but still well marked) with a range of from 15 to 20 days. The longer maximum was sometimes marked by a slight subsidiary minimum. Whether the maximum was of longer or shorter duration the rise appeared to be rapid. He had not found any regularity of sequence as to long or short maxima, nor did there appear to be any decided relation between successive maxima and the lengths of the duration. Neither, on the other hand, did it appear that the point of magnitude touched was in either case higher or lower than in the other. But at the same time it must be admitted that the observations were hardly sufficiently complete to enable one to speak decidedly on points of this nicety.

The president read a paper on "The Probable Period of the Variable Star LL 14551." This star had been observed to be variable by him in 1883, and photometric observations of it were published in the *Monthly Notices* of the R. A. S., Vol. XLIII., page 432. During 1884 it had been observed with a photometer of his own contrivance, but only very casually, as the star was badly situated in our English sky. Mr. W. E. Jackson, of Constantinople, had, however, kindly taken up the observations, and, as an example of the magnificent opportunities enjoyed by astronomers in that part of the world, no less than sixteen complete observations were obtained last month, eight of them being on consecutive nights. From data that had thus been established, a period of 14·09 days was calculated. The photometric observations of 1883 also gave a similar period. The variation in light was very irregular. After a maximum the star decreased for 1½ day, the light then increased for about the same period, and, after remaining stationary for about 2 days, showed again a tendency to increase for 1½ day, after which it diminished, and then remained stationary, rising steadily for 2½ days before the maximum. As this was the first variable star known in this constellation, he purposed to call it R Puppis.

The Secretary read a paper, by Mr. J. Baxendell, jun., on "Transits of Jupiter's IV. Satellite." Attention had lately been drawn to the appearance of IV. as a dark spot when transiting the disc of the planet, and it might be worth while to submit a series of his observations of this phenomenon made with a 6in. refractor. On May 18, 1884, at 9.14 p.m., IV., and also the shadows of I. and II., were on the disc; IV. appeared as a dark spot, almost like a shadow, and nearly, if not quite, as dark as the shadow of I. The shadow of II. was not so dark, but more like Indian ink, and not more than one-third of the diameter of I. On Feb. 27 last, at 10.15 p.m., IV. appeared as a *very black spot*, much darker and better defined than the shadow of I. On April 18, at 7.50 p.m., IV. was observed not far from the *f.* limb, but not nearly so black as on previous occasions, though two hours later it was seen to be much darker; whilst at 11.15, when it was very near the *p.* limb, it was scarcely to be distinguished from the planet. Altogether, the observation seemed to confirm the statement lately made by Mr. Knobel, that IV. appeared much darker in the middle of its transit than when near either limb of the planet.

In a paper on "The Formation of Lunar Bays," Mr. S. E. Peal called attention to the shapes of Le Monnier and Fracastorius, which, he thought, seemed to show that they were the remains of circles once complete, and now probably de-formed by some influence of the adjoining mare which had bodily removed the plain from that side. Those who held that the bays were ruins of complete circles were, however, met by two insoluble difficulties: 1st, as to how such a huge circle could have been formed; 2nd, how so large a segment could have been so completely removed as to leave not a trace behind, and which, on the volcanic hypothesis, appeared to be impossible.

In submitting a voluminous report of the planetary section, Mr. W. S. Franks, F.R.A.S., said it contained a summary of the work done by members of the section during the recent opposition of Jupiter. No fewer than 185 sketches of the planet, many of them coloured, had been received, and some of them were exceedingly well done. The remains of the great red spot had received considerable attention, and dark transits of the 3rd and 4th satellites had been repeatedly noted. Other papers were read, and a motion to enable members residing at a distance to vote for the election of the Council was unanimously agreed to. Seven gentlemen were elected members, and Mr. W. S. Franks and Mr. J. E. Gore were elected associates of the Society.

## WESTERN MICROSCOPICAL SOCIETY.

THE monthly meeting of this society was held at the house of E. Bartlett, Esq., M.R.C.S., L.D.S., on the 4th inst. The subject was "The Human Lungs in Disease and Health"; on the table was an interesting series of illustrative preparations. Among them the host drew attention to a section of stonemason's lungs, and lungs showing carbon deposit from London smoke. Dr. Clippingdale exhibited a fœtal lung at seven months, with no air vesicles, and to all appearances perfectly structureless, with only a small supply of vessels. Under the microscope of Mr. E. Swain was a section of Sheffield saw-grinder's lung, the irritation from the steel gradually obliterating the lung structure and rendering it perfectly useless for breathing. Magnetic masks to arrest the filings are provided for the workmen, but very seldom worn. Mr. B. B. Woodward, F.G.S., showed Bacillus tuberculosis; Mr. Stokes, F.C.S., catarrhal pneumonia with thickened pleura and commencing cavity. Mr. S. P. Moore, B.Sc., a beautiful specimen of toad's lung injected. The next meeting of the club will be held on June 1st at the house of Dr. Foulerton (Pembridge Villas), who will demonstrate to the members a method of photographing microscopical objects.

## SCIENTIFIC NEWS.

THE death is announced of Mr. Robert D. Napier, the senior partner in the firm of Napier Brothers, the famous engineers, of Glasgow. David Napier, the father, was a pioneer in steam navigation, and the sons inherited his mechanical ingenuity. Robert has contributed many papers to the transactions of various societies, but will, perhaps, be best remembered as the inventor of the self-holding brake, and in New South Wales as the engineer who had charge of the dredging operations at Sydney harbour. Mr. Robert D. Napier, who died suddenly on the 8th instant, in his 65th year, devoted nearly all his spare time to mechanical and physical problems, and was an occasional contributor to our columns. Modest and unassuming, he was highly esteemed by all who knew him.

The death is also announced, at Göttingen, of Dr. Henle, the distinguished anatomist and founder of the so-called school of rationalistic pathology.

The Council of the Royal Geographical Society are making arrangements for holding in the Albert Hall an exhibition of articles used in the teaching of geography. The exhibition will probably be opened soon after the annual meeting, which will be held on June 8.

Lecturing last Friday at the Royal Institution, Prof. Burdon Sanderson gave a short history of cholera, and stated that those who resided in the west and north of London had little occasion for fear, even if the epidemic did appear in the East-end, and he ventured to predict that if cholera were about to attack London this year, it would long ago have been on the march.

Dr. Koch, who is one of the representatives of Germany at the International Sanitary Conference, recently attended a meeting of specialists on the cholera question, and reiterated, as the general results of his researches, that the comma bacillus manifests itself nowhere but in cholera cases, and is never absent from them.

At the meeting of the Physical Society, held on the invitation of the local Naturalists' Society at Bristol, a note by Prof. Ramsay and Dr. S. Young was read on Evaporation and Dissociation, in which they refer to the relation existing between pressure and temperature of certain dissociating substances. They hope shortly to publish full details of their experiments. Prof. S. P. Thompson exhibited and described a model illustrating the propagation of the electro-magnetic wave. The model consists of two sets of differently-coloured beads fixed to the extremities of wires, the beads being made by a mechanical movement to execute an approximately harmonic motion at right angles to the wires and the mean plane of the set. Prof. H. S. Hele-Shaw exhibited a self-recording stress and strain indicator, designed for one of Wicksteed's 50-ton single-lever machines erected in the laboratory of University College, Bristol. The stress is applied by moving a mass of a ton along a lever, which mass is connected by a cord with a vertical cylinder on the indicator. Horizontal distances are measures of stress, and vertical motions of the pencil indicate strains. The dimensions of the indications can be multiplied at pleasure by using a larger wheel for the wire connected to the pencil.

The annual reports of the Aëronautical Society of Great Britain for 1883 and 1884 have been issued in one volume, which contains several papers of interest. It can be obtained of Hamilton and Co., Paternosterrow. Mr. Brearey, the hon. sec. of the Society, will be glad to receive communications from those who are desirous of making a balloon voyage during the Aëronautical Exhibition at the Alexandra Palace.

The Rede Lecture will be delivered at Cambridge on June 2 by Mr. G. J. Romanes. The subject is "Mind and Motion."

At the April meetings of the San Francisco Microscopical Society, amongst the objects exhibited was a section of a malignant tumour by the president, Dr. S. M. Mouser. The section had been stained with carmine, and showed the unmistakable characteristics of the round-celled Sarcoma. Mr. Payzant, who is making a study of the life-history of Pulex irritans, exhibited specimens of the eggs and larvæ of the annoying insect. Mr. A. H. Breckenfeld exhibited Vol. I. of Cole's "Popular Microscopical Studies," consisting of twelve slides, each accompanied by a chromo-lithograph plate, and a pamphlet giving an elaborate description of the object. Samples of rich diatomaceous mud were received from Cuxhaven, Germany, and various parts of America. A paper on "Sarcoma" was read by Dr. Selfridge, and Mr. Banks exhibited a new class microscope by Messrs. J. W. Queen and Co. As a hand microscope, and for purposes of class demonstration, this instrument leaves but little to be desired. The method of illuminating opaque objects is very ingenious. The object slide is clamped by a novel spring arrangement to the base of the instrument, and as this base is hollowed out in the shape of a parabola, with a highly polished reflecting surface, all that is necessary is to direct the microscope towards a sufficiently strong light, the rays of which are then converged to a focus upon the object by reflection from the parabolic surface.

"Polarised Light as Applied to the Microscope" is the title of an interesting paper read before the Hackney Microscopical Society by Mr. E. A. Holmes. The author states that the idea some entertain, that the colours seen with polarised light are pure and unmixed, is a mistake. The colours, however vivid and brilliant, are always a mixture.

At the fortnightly meeting of the Edinburgh Medico-Chirurgical Society, Dr. Foulis gave a demonstration of the circulation in the web of a frog's foot and of some botanical test objects by means of the oxyhydrogen light. The light, transmitted through a powerful condenser, passed through an ordinary microscope lens, and was thrown upon a large plate of ground glass at a distance of about 25ft. The image of the object demonstrated could be focused on this plate with great exactitude, the definition even with high powers being excellent, and the general effect strikingly satisfactory.

The conversazione of the President of the Institution of Civil Engineers will be held in the International Inventions Exhibition, South Kensington, on Friday, June 5.

Experiments with the Phelps method of telegraphing to and from trains in motion, which we described on p. 25, continue to be made with satisfactory success; but we learn now that Mr. Edison has a method which dispenses with the insulated line between the rails. According to the report, Mr. Edison says: "By putting up this tinfoil-covered board lengthwise on the top of each car I can catch a message from the wire strung on poles 35ft. off, and can fling an answer back to the wire. It requires no change in the wires of any sort. The secret of it is in the machine for transmitting. When I was investigating what I called the 'etheric force' a few years ago, I accidentally discovered certain curious properties of static electricity. These I have now applied. The process is very inexpensive, as three men could equip a road 300 miles long for 1,000 dols. in three or four days. It seems certain that its adoption will be general, so that every train will be run from headquarters and every passenger will be accessible to his friends."

Thirty-four electric-light towers are, it is stated, to be erected in New Orleans.

Reichemberg's system of telegraphing and telephoning on the same wire simultaneously has, it is said, been tried with success between Madrid and Toledo.

The French Association for the Advancement of Science will this year meet at Grenoble on August 13, Prof. Verneuil being the president.

A translation has been issued of a lecture delivered at Coblentz by Capt. Callenberg, of the Rhenish Field Artillery, on the wire system (Longridge's) of manufacturing guns, in concluding which the lecturer said: "Let us not, therefore, like the English Ordnance Committee, rudely repulse the hand which is held out to lead us a step forward on our way, but rather let us make a trial." Experiment is the foundation of progress.

Messrs. Chittenden and Cummins, in the *American Chemical Journal*, describe their experiments to determine the relative digestibility of various food substances. They used artificial gastric juice, prepared with hydrochloric acid and pepsin, and putting the digestibility of beef at 100, they give the following figures for the other substances named:—Veal, 95; mutton, 92; chicken (light meat), 87; ditto (dark meat), 84;

salmon, 92; mackerel, 86; haddock, 82; trout, 78; lobster (young), 88; ditto (large female), 79; ditto (large male), 69; fresh cod, 72. Generally the white flesh is more digestible than the dark, and raw meat than cooked.

With reference to our notice of Miss Ormerod's report on injurious insects, p. 228, it may interest readers to know that "Notes" in a condensed form, with illustrations, are available for all who are anxious to spread a knowledge of these common and yet little understood facts of natural history. No. 3 is a brief account of the Ox warble fly, and we venture to think that if it were widely distributed amongst cattle rearers and daity farmers, it would help materially to stamp out the pest. Copies can be obtained free by addressing Miss E. A. Ormerod, Dunster Lodge, Isleworth.

# LETTERS TO THE EDITOR.

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*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

*All Cheques and Post-office Orders to be made payable to* J. PASSMORE EDWARDS.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

**"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original."**
***—Montaigne's Essays.***

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## ZETA HERCULIS—DARK TRANSITS OF JUPITER'S SATELLITES—THE SEPARATION OF DOUBLE STARS — EVOLUTION — THE STORY ABOUT THE STORES — MATHEMATICAL ASTRONOMY—TELESCOPE FOR OBSERVING JOVIAN PHENOMENA — LEGAL — POCKET TELESCOPE — POWERS OF OPERA-GLASSES—THE RESULT OF THE RECENT MEETING OF THE ROYAL ASTRONOMICAL SOCIETY—MERCURY IN THE SOLAR DAY-GLOW—THE NEW TIME—APPARENT ENLARGEMENT OF CELESTIAL OBJECTS NEAR THE HORIZON—TRESPASS—THE HELIOGRAPH.

[24249.]—I SHOULD like to add to what I said (in letter 24196) on page 211, that since replying to "Beta" there, I have examined ζ Herculis, with the result that with a power of 400 on the 4½in. Dallmeyer object-glass of which I spoke, and which is of the highest excellence, I wholly failed to divide the star. Hence I can only come to the conclusion that your correspondent must be labouring under some curious mistake as to having recently seen it double with a smaller aperture than mine. I hardly like to suggest the possibility of "Beta" having got hold of the wrong star. I should, by the way, like to ask Mr. Sadler whether the distance he gives in letter 24226, p. 233, is from calculation or from actual observation?

Mr. Bone (letter 24197, page 211), should read page 167, et. seq., of the last edition of Webb's admirable "Celestial Objects for Common Telescopes."

Some of the difficulties whose solution is sought by Mr. Nelson, in letter 24201 (page 212), have their origin in the fact that, as I endeavoured to explain some four years ago in these columns, separating power is a function of aperture (letter 18314, Vol. XXXII. page 494), and that the larger the object-glass the smaller the discs of stars become, and consequently the wider apart they seem. Bear in mind, then, that if the object-glass does not split a close pair of stars, no amount of magnification subsequently by the eye-piece will divide them; though, of course, if they are so far separated by the objective as to be just in contact, they may appear like a single object with a low eye-piece, while a higher one will sufficiently enlarge the image to enable its duplicity to be observed. I must repeat, though, that press deep eye-piercing as we may, we shall always have our stars in contact. To show how the aperture of the object-glass acts, we will take Mr. Knott's measures of the discs of three stars with a power of 368, and with various apertures of the objective:—

| Star Observed. | Diameter of discs as measured with the various apertures. | | | | |
|---|---|---|---|---|---|
| | 6·00in. | 4·95in. | 4·00in. | 3·00in. | 2·00in. |
| α Tauri.... | 0·846″ | 1·047″ | 1·398″ | 1·772″ | 2·608″ |
| Polaris..... | 0·929 | 1·130 | 1·395 | 1·729 | 2·378 |
| α Orionis .. | 0·852 | 1·214 | 1·683 | 2·162 | 2·932 |

The ordinary formula for separating power $\frac{4{\cdot}56''}{\text{aperture in in.}}$ presupposes that the compound stars are both of the 6th magnitude. Other considerations come in, in the case of stars like Polaris, in which the glare of light of the primary, with a low power, prevents the eye from readily catching so minute a point as the *comes*, when involved in it. Many minute stars are only visible with the highest powers that can be employed. This possibly has its origin (or part of it) in the fact that high magnifiers darken the sky without making a corresponding reduction in the light of these all but invisible objects. I do not see my way to any trustworthy formulæ such as Mr. Nelson asks for. To give a single illustration why: Blue stars remain visible when red ones of the same magnitude can by no artifice be seen.

Does not "Pre-Adamite" (letter 24202, page 212) see how naively he begs the entire question by his allegation that the seal and whale are distinct creations. Who told him so?

In connection with Mr. Dickson's letter (24217, page 218), I will now say that, as a shareholder in the Army and Navy Co-Operative Society, I was extremely surprised to read the letter (24163) of your excellent correspondent, "Montmartre," and the advertisement which appeared on the front page of No. 1048 of the ENGLISH MECHANIC. I candidly confess that I looked forward to a "row" at the next meeting of the society.

"Another Amateur" (query 56511, page 222) must be a little more precise in his definition than merely to employ the phrase "the higher parts of astronomical science." Assuming him to possess a competent acquaintance, though, with algebra and plane trigonometry, he may go on to read Todhunter's "Spherical Trigonometry," and the same writer's "Differential" and "Integral Calculus"; Puckle's "Conic Sections," Newton's "Principia," Godfray's "Lunar Theory," and Chauvenet's "Spherical and Practical Astronomy." This will suffice for some time to come.

"E. B. F." (query 56521, page 222) may observe the transits of Jupiter's Satellites capitally with a 2½in. object-glass and a power of 100. It seems an extraordinary thing that he has never attempted to make the experiment for himself.

The best books for "T. G. T." to get (query 56529, page 223) are "Stone's Justices' Manual," published by Shaw and Sons; "The Justices' Note Book," by Mr. Knox Wigram, published by Stevens and Sons; and "A Digest of the Law of Evidence," by Mr. Justice Stephen.

"Devoniensis" (query 56534, page 223) can only increase the amount of light in his telescope by lessening the power; and that at a cost wholly disproportionate to the total value of the instrument.

And in answer to his succeeding query (same page), let him point his opera-glass to a brick wall at such a distance that the rays from it are approximately parallel, and look through the glass at the wall with one eye, and at the wall directly with the other one. Then if one brick, as seen in the opera-glass, covers four as seen by the naked eye, the power is four, and so on. A divided scale affords a more refined mode of measurement.

I do not think that the Fellows of the Royal Astronomical Society, upon whose requisition the special meeting was held on the night of the 8th instant, have much reason to complain of its result, inasmuch as they succeeded in carrying, by an overwhelming majority, a motion which will practically enfranchise every one entitled to be addressed as "F.R.A.S.," be he resident where he may. In view of the frank way in which the memorialists were met by such of the Council as were present at the meeting, it may possibly have struck some of those present that the boon—or, rather, right—which they obtained for themselves might easily have been granted a little sooner, without having the necessity for it forced upon our rulers at all; but we will charitably suppose that the Council wished to ascertain most thoroughly the feeling of the Fellows generally in this matter before themselves stirring in it. On the question of voting by proxy at annual and special general meetings, the Fellows present were much more equally divided, and the motion for it was lost by a very small majority. Perhaps, after all, this is not an unmixed evil, inasmuch as there will always be people in every society who like to be thought for, and who would have posted their proxies to the Council to do as they liked with. The meeting was, on the whole, very good-tempered.

One thing came out pretty plainly in the discussion, and that is that our antiquated by-laws sorely needed revision throughout. For example, by-law 3 requires remodelling entirely, inasmuch as its spirit is annually systematically evaded. So, again, with by-law 12, which makes an "insufficient" balloting-list invalid—in other words, refuses to suffer a Fellow of the Society to give fewer than 21 votes! That a *redundant* list should be null and void is only common sense; that one allotting votes to such men only as the voter approves of should be rejected, is downright indefensible nonsense. So, again, with by-law 53, which recites, with reference to special general meetings, that "a week's notice shall be sent to every Fellow residing in or near London." Well, this dates from April 6, 1831, and the first railway out of the metropolis, that to Greenwich, was not opened until December 14, 1836; so that our fathers and grandfathers had to come into the metropolis by what were called "stages," or stage-coaches. Now that a man can run up from Brighton in about the time that it then took to get from a northern London suburb, this "near London" restriction is simply ridiculous, and as gross an anachronism as a doublet and trunk hose would be. I have selected three instances only; but these will amply suffice to support my contention that the time has arrived when a revision of our bye-laws is called for. Will our Council themselves summon the next special general meeting for this purpose?

I have to thank "Garrison Gunner" (letter 24225, p. 233) for the courteous and friendly little paragraph with which he concludes. It is satisfactory to find that we have the *intellect* of the Society with us, at all events.

I was very much interested in learning from letter 24223, p. 233, that Mr. Clapham had succeeded in observing Mercury during his recent eastern elongation, because I tried in vain myself to do so.

Let me thank "Civicus Olim" (letter 24247, p. 238) for kindly doing the work of the printer's "reader," and correcting the typographical error of "of" for "from," which appeared in the communication on which he comments. And, having done so, I may perhaps be allowed to add that I have never said one word about a *striking* clock; and am quite with your correspondent as to the grave difficulty which would arise from an attempt to discriminate between 22 and 23 strokes on a bell by anyone who had nothing but his ear to guide him. If, however, we are always to listen for the time, instead of looking for it, surely two bells would meet this difficulty; one upon which all hours up to 10 should be struck, and which should thenceforth give one stroke for ten, a bell tuned a third or a fifth higher, being employed for (so to speak) the units place of the hours. The endless confusion of which "Civicus" speaks would possibly exist for a week or ten days at the outset; after which, I must repeat, every one would wonder how he had been content to go on all his life in the present cumbrous and unscientific fashion. If "Civicus Olim" can devote a day to hunting up eighteenth-century literature at the British Museum, on the change of style in 1752, he will find that considerably stronger arguments than he employs were then used to show why such change might, could, would, and should, never be made. "Stare super vias antiquas" is an excellent motto; but it is one which is not of universal applicability. There is something very naïve in the *Civici quæstio* anent "Bradshaw," "Would it be used and sold, as it and other railway guides are, if so misleading?" Simply remarking that my accusation was that it was difficult to understand, and not that it was "misleading," I would reply Yes! of course it would—if it was the best and most intelligible one procurable.

Mr. J. W. Frazer (query 56613, p. 244) will find the paper by M. Stroobant, from which I quoted, in the number of *Ciel et Terre* for the 15th of February in the present year. The price is only half a franc in Brussels, where it is published. It ought to be procurable of one of the French booksellers in London for 6d. or so.

The only trespass committed by "Ento" (query 56614, p. 244), in rambling over private land in search of natural-history specimens is a civil one, for which the owner's remedy (if any) is an action at law. I am, of course, assuming that your correspondent breaks or damages no hedge or fence in getting on to his happy hunting ground. If he does such mischief, even in the smallest degree, he renders himself liable to a penalty of £5 (over and above the amount of the injury) under 24 and 25 Vic. c. 97, s. 25. Of course he may find his way into some strictly preserved cover, or among a congeries of rabbit burrows, and if a hard-swearing keeper can get the magistrates to believe him, may be fined £2 for trespassing in the daytime in pursuit of game. The legend so often seen on a board, "Trespassers will be prosecuted," is the merest *brutum fulmen*.

"Magister Artibus" (query 56628, p. 244) should invest threepence in the "Manual of Instruction in Army Signalling," published by Clowes and Sons, and obtainable at any of the military booksellers. He will find a description both of the heliograph and of the signals (which are dots and dashes) both in it.

**A Fellow of the Royal Astronomical Society.**

### DOUBLE STARS—γ LEONIS, &c.

[24250.]—Although Mr. Sadler will no doubt supply Mr. Holmes (letter 24199) with the information he requires, I inclose a few measures of the stars he mentions, in the hope they may prove useful. They are the mean of a series of measures made during the present season with my own instrument and an 8¾in. equatoreal belonging to a friend; and give for γ Leonis P.A. 112·5° and 54 Leonis P.A. 104·3°. I think any slight discrepancy in position angles may be reasonably referred to the atmosphere, which has been unusually unsteady of late. In fact, to obtain reliable measures has been a task of extreme difficulty, and I have little doubt the above are open to correction, but they are the best I have been able to obtain.

I do not know the date of the measure of 54 Leonis given in Webb, but it very probably is taken from the "Cycle." With regard to Cor Caroli, I am not aware that any very decided orbital motion has been detected either in distance or angle.

**Kenneth J. Tarrant.**

Letchford House, Pinner.

### A CHEAP TELESCOPE STAND.

[24251.]—I think H. Ritchie (letter 24228) will readily perceive that any deviation from the perpendicular in the axis of the telescope stand will necessitate an inclined floor, as the mirror end of the telescope will move in a plane parallel to that on which the axis turns; so that if the floor were horizontal and the axis inclined, the movement of the telescope in azimuth would be interfered with.

The equatorial mounting of the Newtonian telescope has the inconvenience of turning the eyepiece in inconvenient positions. This is remedied in the cylindrical metal bodies by causing the top of the telescope with the eyepiece and flat to revolve, so that the eyepiece may be conveniently placed in all positions of the telescope. The great convenience of following a star with one motion of the telescope is only to be obtained by an equatoreal mounting. But I hope, in the stand I am now making to carry my 15in. Calver mirror, to give to the telescope the two motions requisite to follow a star by the bladder clock, each to be carried by the telescope—the one for altitude to be fixed to the lever by which that motion is given to the telescope, and close to the front of the post; the other for azimuth to be fixed to the fast-and-loose lever, and carried by an extension of that lever behind the post, both motions being regulated by tubes from the two bladders fixed conveniently near the eyepiece. Thus I hope to make my new stand perfectly convenient.

**Philip Vallance.**

### CHEAP SET OF RESISTANCE COILS, WHEATSTONE'S BRIDGE, &c.

[24252.]—Seeing that I laid no claim to the particular form of Wheatstone's bridge, described by me in the issue for May 8 (which, by the bye, is illustrated and described in that well-known work "Magnetism and Electricity," by F. Guthrie, at p. 222 of the 1875 edition), I am rather puzzled to account for the *raison d'être* of Mr. J. Edgington's remarks (letter 24233).

I may, however, mention that having often, as a young student been precluded from obtaining necessary apparatus by the fancy prices put upon such articles, I have felt it almost a duty and always a pleasure to point out the way to the beginner how to procure or how to make any piece of apparatus which lay really within the powers of an amateur. It is for this reason I wrote the articles on "Resistance Coils," on the "Construction of Spectroscopes," and on the "Dynamo."

I would also mention that on examining the lists to which I am referred by Mr. J. Edgington, I find that even in this "cheap" set, the bridge is priced over 20s. If my friend will turn to my advertisement in the Sixpenny Sale Column he will find I furnish these bridges, with contact spring and ten binding screws complete for 5s. **S. Bottone.**

The Limes, Stanley-road, Carshalton.

### SHRINKAGE OF PAPER.

[24253.]—The difficulties referred to on p. 245 can, I think, be entirely overcome by a system we have adopted for many years past—i.e., all drawing paper is ruled with very faint lines to either ¼th or ⅛th inch scale, and the drawings are made to correspond with these lines. Whatever the alteration in size or form of the paper the variation in any square of ¼in. or ⅛in. is a matter of no importance, and the drawing and scale both being on the same base, a ready and certain means of correction always exists. **T. F.**

### COMPARISON OF TIDES.

[24254.]—A review of atmospheric conditions which have operated in producing the various changes of sea-level throughout the month of April shows a prevalence of anticyclonic pressure during the early part of the month, followed by stationary weather afterwards. Subsequently, a succession of anticyclonic disturbances until the 20th caused the intense cold which has characterised the spring season, and not until the end of the month have south-westerly winds prevailed. The tides, it will be noticed, have coincided more accurately with the predicted height than has been the case for some months past.

**James Pearson, M.A., F.R.A.S.**

Comparison of Tides at Liverpool and Fleetwood for the Month of April, 1885.

| Date. | Calculation. | | Observation. | | Error. | Barometer | Wind. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | ft. | in. | ft. | in. | | | | |
| April 1 | — | | — | | — | — | — | — — |
| | 28 | 2 | 28 | 5 | +3 | 29·9 | S.W. | Strong. |
| 2 | 27 | 6 | 27 | 0 | −6 | 29·8 | N.W. | Strong; anticyclone. |
| | 27 | 4 | 26 | 6 | −10 | 29·9 | N. | Strong breezes. |
| 3 | 26 | 4 | 25 | 10 | −6 | 30·2 | S.S.E. | Slight; anticyclone. |
| | 25 | 9 | 25 | 5 | −4 | 30·2 | S.S.E. | Slight; anticyclone. |
| 4 | 25 | 4 | 24 | 8 | −8 | 30·2 | S.S.E. and W. | Slight; anticyclone. |
| | 24 | 3 | 24 | 5 | +2 | 29·9 | S.S.W. | Slight. |
| 5 | 23 | 10 | 23 | 11 | +1 | 29·8 | S.S.W. | Strong. |
| | 22 | 8 | 22 | 9 | +1 | 29·8 | — | Calm. |
| 6 | 22 | 5 | 22 | 5 | 0 | 29·7 | — | Calm. |
| | 21 | 0 | 24 | 0 | 0 | 29·6 | — | Calm. |
| 7 | 21 | 1 | 20 | 11 | −2 | 29·2 | E. | Strong. |
| | 19 | 8 | 19 | 7 | −1 | 29·4 | — | Slight winds. |
| 8 | 19 | 10 | 19 | 11 | +1 | 29·5 | N.E. | Increasing. |
| | 18 | 11 | 19 | 0 | +1 | 29·6 | — | Slight winds. |
| 9 | 19 | 10 | 19 | 8 | −2 | 29·7 | N. | — — |
| | 19 | 4 | 19 | 4 | 0 | 29·7 | — | Calm. |
| 10 | 20 | 6 | 20 | 6 | 0 | 29·6 | N. to N.E. | Fresh. |
| | 20 | 6 | 20 | 7 | +1 | 29·7 | N.E. | Slight. |
| 11 | 22 | 3 | 21 | 10 | −5 | 29·7 | N.E. | Fresh. |
| | 22 | 1 | 21 | 11 | −2 | 29·7 | N.E. | Slight { Dominant system |
| 12 | 24 | 1 | 23 | 3 | −10 | 29·8 | N.E. | Fresh { anticyclonic. |
| | 24 | 0 | 23 | 6 | −6 | 29·8 | N.E. | Strong. |
| 13 | 25 | 7 | 24 | 11 | −8 | 29·9 | E. | Moderate to fresh. |
| | 25 | 5 | 25 | 1 | −4 | 29·9 | E. | Fresh. |
| 14 | 27 | 0 | 26 | 7 | −5 | 29·9 | E. | Fresh. |
| | 26 | 10 | 26 | 5 | −5 | 29·9 | E. | Fresh. |
| 15 | 28 | 0 | 27 | 5 | −7 | 29·9 | E. | Moderate to fresh. |
| | 27 | 7 | 27 | 1 | −6 | 29·9 | E. | Strong. |
| 16 | 28 | 7 | 27 | 11 | −8 | 29·8 | E. | — — |
| | — | | — | | — | — | — | — — |
| 17 | 28 | 0 | 27 | 5 | −7 | 29·9 | N.E. to E. | Fresh; anticyclone. |
| | 28 | 6 | 28 | 0 | −6 | 30·0 | N.E. | Fresh; anticyclone. |
| 18 | 27 | 8 | 27 | 4 | −2 | 30·1 | — | Variable airs; anticyclonic system. |
| | 27 | 6 | 27 | 5 | −1 | — | — | moved southward. |
| 19 | 26 | 9 | 26 | 5 | −4 | 30·2 | S.W. to S. | — — |
| | 26 | 1 | 26 | 4 | +3 | 30·2 | S.W. | Slight. |
| 20 | 25 | 7 | 25 | 8 | +1 | 30·2 | S.W. to S. | Freshening. |
| | 24 | 9 | 24 | 9 | 0 | 30·1 | — | Calm. |
| 21 | 24 | 5 | 24 | 7 | +2 | 30·1 | S.W. | Fresh to strong. |
| | 23 | 2 | 23 | 8 | +6 | 30·0 | S.W. | Fresh. |
| 22 | 22 | 11 | 23 | 3 | +4 | 29·9 | S.S.W. | Fresh to strong. |
| | 21 | 10 | 22 | 11 | +13 | 29·6 | S.W. | Bar. falling; strong breeze. |
| 23 | 21 | 9 | 22 | 5 | +8 | 29·5 | N.W. to S.W. | Strong. |
| | 21 | 10 | 22 | 1 | +3 | 29·5 | S.S.W. | Slight. |
| 24 | 22 | 7 | 22 | 11 | +4 | 29·6 | S.W. | Strong. |
| | 22 | 8 | 23 | 1 | +5 | 29·5 | S.W. | Fresh to strong. |
| 25 | 23 | 8 | 24 | 3 | +7 | 29·3 | S.W. | Strong to gale; steep gradients. |
| | 24 | 0 | 24 | 10 | +10 | 29·1 | S.W. | Barometer falling; gale. |
| 26 | 24 | 10 | 25 | 7 | +9 | 29·2 | S.S.E. | Fresh to strong. |
| | 25 | 5 | 25 | 10 | +5 | 29·4 | S. | Slight. |
| 27 | 26 | 2 | 26 | 2 | 0 | 29·5 | — | Slight. |
| | 26 | 3 | 26 | 3 | 0 | 29·7 | — | Calm. |
| 28 | 26 | 6 | 27 | 3 | +9 | 29·8 | S. | Strong. |
| | 26 | 8 | 27 | 1 | +5 | 29·7 | S. | — — |
| 29 | 26 | 11 | 27 | 2 | +3 | 29·6 | N.E. to W.S.W. | Slight. |
| | 26 | 11 | 27 | 0 | +1 | 29·7 | N.N.E. | — — |
| 30 | 26 | 10 | 26 | 7 | −3 | 29·8 | N.W. | Slight. |

### MYSTERY GOLD.

[24255.]—"Nun. Dor." (letter 24232, p. 234), asks if this alloy has ever been used for imitation sovereigns. It is not at all likely to be successfully used for this purpose, owing to its extreme lightness as compared with standard gold; the detection would be easy. An alloy of platinum with a small quantity of copper, and also platinum alone, heavily gilt, are both used for making imitation sovereigns; and I have seen imitations of most of the gold coins of England, France, America, and India made in this way. They are correct in weight, ring fairly well, and are practically impossible to detect until the gilding is worn off. The profit on the difference in value of the metals used as compared with gold is large, and there is no risk whatever in passing them, as they could not be detected so long as the gilding remained perfect.

**T. F.**

### EVOLUTION.

[24256.]—In letter 24202, "Pre-Adamite" seems to be perplexed when he asks, "What reason is there to suppose that a fossil creature, half-bird and half-lizard, or other recognised intermediate link, is so in reality? Why should it not have been purposely created in that form?" He fails to recognise that the supposed intermediate form may have been a connecting link, even though it may have been purposely created.

The subject of evolution recurs at intervals in your correspondence columns, and since in the form in which it is usually presented and discussed, the controversy leads to no definite conclusion, but brings the disputants back to where they respectively started from, I would like, with your permission, to present it to "ours" on what I consider is its true basis, though to some it may appear a novel one. To begin with, it is necessary to define clearly the rival theories. *Evolution* means the gradual evolving or unfolding of latent qualities, either physical or mental.

*Creation* means the coming or bringing into existence of such qualities previously non-existent even in the latent state.

It cannot be conceived that the simplest organic form could possibly have held latent within it the diversified organic characteristics, physical and mental, which are now existent between the amœba and man; and so it is held creation must have intervened. But admitting creation, it is not necessary to believe that it operated spasmodically by fits and starts. More likely its operation was slow and gradual, and the links which perplex "Pre-Adamite" may have been "so in reality."

Darwin has shown how, by the struggle for existence and survival of the fittest, the chain may have been indefinitely linked together. His theory is built on the principle of heredity—that the offspring retains the characteristics of the parents, subject to reversion to ancestral types, which latter point may be here dismissed. But he stipulates also for a condition which cannot be reduced to any law, inasmuch as it is capricious in its operation, and can neither be foreseen nor foretold—a condition, nevertheless, of such importance that he over and over again asserts in his works that without it his theory of natural selection is impossible. This condition, which is quite independent of natural selection, is that the offspring may differ from the parents not only as a reversion, but also in some new direction previously non-existent, and that this new character may be propagated. The appearance of such new and previously non-existent character comes within our definition of "creation," and can be explained in no other way. Regarded in this light, all organic nature bears the stamp of creation at every step, and Darwin has done good work in showing that these creations have not proceeded, as was at one time supposed, by violent leaps and bounds from one form to another very different from it, but that they have been brought into existence by slow and insensible processes less repugnant to our ideas of nature as we are able to judge of it. Evolution alone, without creation of new forms, could not account for progressive development.

The loss of members from disuse, and their appearance finally as rudimentary organs, is outside the main issue here dealt with, since they are traceable to pre-existent forms, and do not explain the appearance of what did not before exist.

**H. B. F.**

### EVOLUTION.

[24257.]—I have to thank two correspondents for information supplied in answer to my query, which query was an honest, not a captious one—as I am not opposed to the theory of evolution, nor is it my purpose to support that of independent creation. I am far more disposed to the idea that the truth lies in a combination of the two—that the Creator made a few typical forms of fish, bird, and mammal, and, compared with what we now have, only a few, which, owing to climatic and other geological changes, may very likely have ramified and branched out into the countless variety of the present race of creatures. My query meant to ask in reference to this: "Was the half-lizard, half-fish one of the few original creatures, or is it evidently and unquestionably an intermediate link?" If all creation—I must use the word for want of a better—sprang from protoplasm, then to my own uninstructed mind the puzzle of animal life is far greater than if I suppose a Creator's hand making a few typical creatures called beast, fish, and fowl to fly above the earth—called thus because the writer at that date was surrounded by creatures known by such names. It is the development of one of these three typical forms from the other that I always stick at, as, *e.g.*, the mammal from the fish as stated in "Crumby's" letter. True, there is the spine, and its processes, rays, or ribs ready made; but although a fin *might* become a leg and a spiny tail drops its fan-shaped extremity, I can get no further. The bony structure may possibly develop, but the *mammæ* whence and how? Surely, if a fish's surroundings were changed, the fish would die instead of accommodating itself to them? However gradually we dry up the pond, at last the time comes when the fish's surroundings become unbearable, and Nature yields up the struggle. I certainly can grasp such a development as that of a seal to a walking mammal, because it is already fairly at home on land, and its flappers might in the course of ages further develop if the water of its home so far diminished as to compel it to attempt, to a still further degree, progression on dry land. But here we have the mammæ, and the change is not so stupendous; but go back a step to fish with gills, and no such mammæ—fish whose youngsters never needed such motherly appendages, and there necessity compels me to draw the line. Again, in reply to "Rex," is it not possible that we are advancing backwards—that the rudimentary pelvis is not a remnant, but an embryo—that the seal and whale are becoming terrestrial mammals as I have suggested in the case of the seal? Does not the tadpole teach, in its development, extending over a few days and weeks, what is going on, on a larger scale—that the whale, if developing at all, is to become a dry-land animal, and not as "Rex" supposes? I do not hesitate to acknowledge the difficulty even of a theory of a primal creation of the three typical forms of mammal, bird, and fish; but it appears to me a simpler one than others. As to the insect world, it is not even named or intimated by the writer of Genesis, which is at least strange, as is also his statement that fishes and birds both originated in the water. Is anything suggested here in reference to the development theory? I do not hold on to the skirts of that writer, who evidently wrote unscientifically of what he knew as bird, beast, and fish; but if there was an ark and a flood, that ark could have contained perhaps the *then* birds and beasts, few in number, which answered to those simple types. I can imagine, for example, one ancestor in common of leopard, tiger, cheetah, puma, and, maybe, lion of our own times—one ancestor of the whole tribe of Felis, or Canis, or Equus, and for these there would have been room; but I care little to prove it—only I thus get back to the ancestral created type of bird, beast, and fish, and the question still presents itself whether a development of one into the other is possible or probable. It seems to me at least probable that a Creator made the type, *e.g.*, Felis, and subsequent causes tended to give it the form of Leo or of the domestic cat.

**Pre-Adamite.**

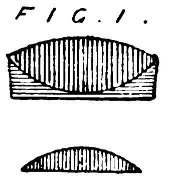
[24258.]—If it is not entering upon a forbidden subject, there is a statement in letter 24230 which seems to call for remark. It is, "On the whole, it seems more reasonable to believe that rudimentary structures are structures which were useful to the animal's ancestor." That this is true in some instances may be looked upon as certain; but is it not too much to infer, in the present state of science, that it always is so? May not a rudimentary structure be, not a remnant of a past structure which was once useful, but the germ of a structure which may become useful in time to come? That seals and whales, as mentioned in the above letter, are, like other animals, in a state of transition, may be granted; but in which direction are they moving? Do seals, for instance, tend to become entirely aquatic in their habits, so as to become something like porpoises, or do the latter tend first to partially and then to entirely terrestrial habits? To be able to answer this for certain, we ought to be able, to some extent, to trace the pedigree of the seal, in the same way that that of the horse has been done; it may in this case be traced distinctly to a four-toed animal about the size of a fox, the hipparion I believe it is called. The writer of the next letter (24231) tells us that "Evolution says that fish were the ancestors of mammals." If this be so, the change is from aquatic to terrestrial life, and not from terrestrial to aquatic, as the first letter supposes it to be—at least, in the cases of seals and whales.

**W. G. P.**

### THE MICRO-OBJECTIVE.—II.

[24259.]—Suppose a plano-convex lens to be used in connection with an over-corrected back, also plano-convex, we should have an arrangement like this (Fig. 1), in which there are six surfaces to prepare and three different curves, the optical result being no better—as regards the curve and colour errors—than may be obtained from a single pair, if properly constructed.

FIG. 1.



The difficulty about the proper construction of these lenses lies in the largeness of the angle required in micro-o.g.'s as compared with telescope o.g.'s. In these latter only about 9° of the circle or sphere is used, whilst in the former for a low power—say, 1in.—one would like at least 40°, for that would give only 20° of "aperture" in a plano.

If appropriate lenses be placed behind a plano-convex having, say, 40° of the sphere, its focus may be made to coincide with the centre of curvature, and thus its "aperture" would be equal to its angular dimensions, provided the back additions could transmit to the eye all the rays delivered by the front.

As objectives of 40° "angular aperture" and upwards need a combination of three lenses, our subject divides itself now into o.g.'s of two and o.g.'s of three lenses, or combinations of less or more than 40° "angular aperture." We will, however, call them high and low powers.

A good low power cannot be produced by the formula generally used for the high powers; a high power cannot be made at all as low powers are produced.

The lenses for an inch o.g. may be two plano's having foci as 1 : 2, both achromatic, and made of a plano-concave flint lens and double convex crown; curves of front to be of $\frac{3}{8}$in. radius, of back $\frac{5}{8}$in. radius; the distance between them is better decided by experiment, as it will not need to be equal to half the sum of their foci. This is our modification of Fig. 1 for a low power o.g., giving two extra surfaces, but only two curves instead of three; moreover, the combination is separable to form a 2in. single o.g. of passable quality.

Before saying anything further on the theoretical part of the subject, I will proceed with the practical—get a few lenses completed for o.g.'s and eyepieces, after which—if our Editor doesn't put on the extinguisher—I will describe the high powers, give curves and qualities of glass used in some of the best $\frac{1}{8}$ and 1-10in. powers that have been made by our experts, as well as those more simple data by which I have succeeded well with powers up to $\frac{1}{8}$in.

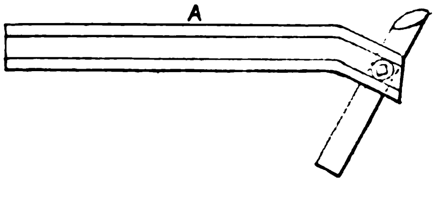
Whilst I am preparing the next paper, those who may be following me should prepare themselves with a bit of flint glass (see Sixpenny Sale Column), also a bit of the whitest patent plate (look through edge for colour); two or three ounces of emery powder like that on No. 1 cloth, a bit of flour emery, an ounce or two of rouge, some good clean hard pitch, and two or three of the best watchmaker's gravers (square) with which I turn up my concaves.

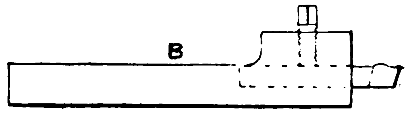
**Rob. Crus.**

### LATHE MATTERS.

[24260.]—There seems to be some doubt about the possibility of cutting a V-thread on a cylinder with a revolving cutter. To me it seems plain enough that it can be done, for given any V-thread it is certainly possible to turn a disc, the edge of which shall touch the thread in every part, and if that disc is of steel and teeth are cut in it, it will cut the same thread; but I think it will be a difficult tool to use. It must be set at exactly the line of centres, or it will make a lop-sided thread. This is easily seen by taking an extreme case and putting the cutter quite at the top or bottom of the work, when the distortion will be largest, and it must be also set at exactly the right angle or it will take too much out, a small error in the setting making much more difference than a similar one would in a point tool.

It may interest some readers to know of a very simple, easily made, and extremely useful tool holder. I have two in use, and find them handier and cheaper than ordinary forged tools, and they will stand any amount of hard use. That marked A is a piece of octagon steel, bent as shown and drilled to take $\frac{3}{8}$in. round tool steel, which is held in place by a set screw. This I use for plain work, and it is surprising what a heavy cut it will take with little expenditure of power, and power is a consideration when working a foot lathe. That marked B is a simple forging with $\frac{3}{8}$in. hole drilled horizontally, in which fit the $\frac{3}{8}$in. round tool. This I use for screw-cutting or parting tools or for ordinary tools for light cuts, but is most useful for the two former. If a tool breaks (and parting tools will do so at times), all there is to do is to file up to shape again, and that does not take long on $\frac{3}{8}$in. round. I suppose most of the readers of "Ours" can easily make these for themselves, and am sure will be pleased with them; but for any who have not convenience, and would like to try them, I will advertise in next week's "Sale" column.





**S. Beeching.**

[24261.]—I send a couple of sketches to indicate how a change of cutters becomes necessary for each different number of threads in a screw. Fig. 1 shows six threads of an 8-threaded screw of 1in. distance of threads, and also 1in. depth of threads, making the angle of thread 53° 6′ or thereabouts. The angle A B E is the angle of rise of top of thread which, with a diameter of 5·28in. and rise of 8in., is equal to 25° 45′ more or less. A C F is the angle about halfway down the thread, and is drawn about 31° 36′ A D G is the angle of rise of the bottom of the thread, which, with diameter of 3 28in. and 8in. rise, gives 37° 50′ A cutter is represented as placed in the groove at the mean angle of 31° 36′ with the line A D. The cutter fills the groove at top, and its thickness by measurement cannot be more than about ·85in. I find also by measurement on a wooden model, carefully lined out in the lathe, that a four-threaded screw would take a cutter about ·92in. thick, whilst, of course, a single-threaded screw would allow of one of very nearly 1in. thick being applied.

Fig. 2 shows a cutter ·90in. thick inclined to the path *a b* at the same angle as the difference between A C F and A D G, or 6° 14′, and it will be observed that it is making a groove 1in. wide at top, and that at $\frac{9}{10}$in. of its depth the groove which, if cut by a screw tool, would measure $\frac{1}{10}$in. wide, is here as nearly as possible $\frac{2}{10}$in. wide.

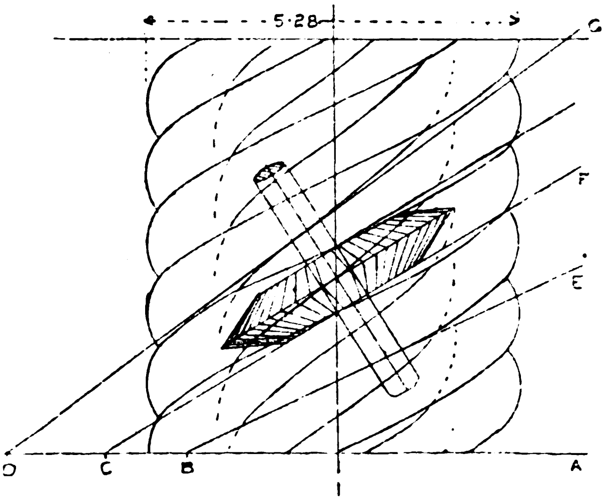


FIG. 1

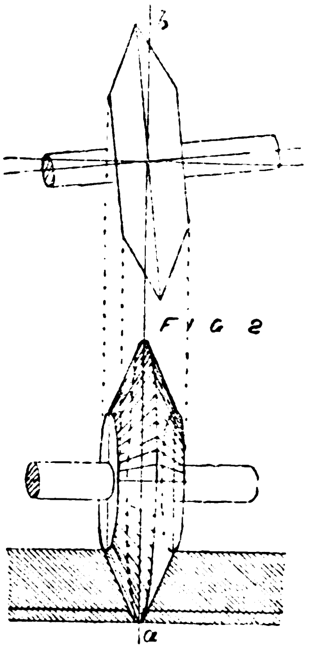


FIG 2

The plain answer to the plain question, "How is it?" &c., on p. 189 is, that metal headstocks taking the place of wooden ones, and the introduction of slide-rests, say 100 years ago, rendered imperative the adoption of a plain sliding fit in place of screws inaccurately cut, with insufficient length of bearing, and which, when somewhat worn, were always thrown further off the centre line by the very means used for steadying them.

As to letter 24239, calling my attention to the above question, I may remark that I do not answer questions to order, nor permit anyone to determine whether I may write, nor to choose or veto any subject for me; I can do all that for myself.

The paragraph one-third down, 3rd col., p. 214, appears to me a pure self-contradiction. The so-called cylinders are simply slides—one with a very short amount of traverse, and the other with a great deal more. As they are merely slides, they only require to be parallel; their cross section may be circular, and usually is so, until either a groove is cut or a flat filed on the one for the movable headstock, when it ceases to be a cylinder. It might very appropriately be of square or hexagon section, particularly if the lathe chucks screw on to or into it, as is sometimes done. I have one arranged so as to take the chucks.

As to the short one at rear end of mandrel, I should say economy, if nothing else, would indicate a plain fit as preferable to a screw. The hole has to be bored in either case, and fitting a plain plug with a pair of counter-nuts would certainly cost less than a screw, plus some means of setting it fast. I am quite ready to agree with "Vulcan" (see p. 236) that a cutter of, say, 55° can be used on any cylinder to cut any particular number of threads required; but that is a very different thing from saying that the resulting thread will be of the same angle, whether single, double, or of any other number of threads on some other diameter. No doubt a set of cutters might be made and used and a record kept if it were worth while; but in this respect they would be like toothed-wheel cutting tools—viz., a set for each gauge, and different tools for different numbers of threads, and, worst of all, very different cutters for such low numbers of threads as are ever used for screws.

An experiment recently made surprised me as regards the slightness of the distortion in cutting a moderately high-pitched screw with a cutter, and I may as well acknowledge the fact here as anywhere. It is quite impossible for me to pursue the subject for some time to come, and I write this hurriedly for the 22nd inst. **J. K. P.**

## CUTTING SCREW-THREADS WITH A REVOLVING CUTTER.

[24262.]—IT may be of interest to mention three cases in which the above plan is used. The first instance I found in an article on screw-cutting in the *Scientific American*, wherein the method was said to be the invention of Mr. Harton, and to be used by him in his well-known jaw chucks.

Joshua Rose also, in a book which, I believe, first appeared in the *Scientific American*, states that the Morse Company use it in making their taps. Lastly, there is Col. Dumbleton's screw-chaser, which has been described and favourably commented on in these columns.

Leaving the question of the trustworthiness of these instances to more practical men, I may refer to several advantages which the method appears to me to possess: Firstly, since the speed of the cut is wholly independent of that of the cutting-edge, the work will be better done—especially on soft material; it may proceed with the greatest deliberation and care, and may be stopped at a given point with the utmost exactitude. Secondly, the thread may be cut to its full depth at one trip; and thirdly, since the strain of the cut is not borne by the slide-rest, the possessor of a light or ornamental lathe is enabled to perform screw-cutting which he would not venture upon with a fixed tool.

"J. K. P.'s" sketches on p. 237 do not go far enough. The cutter in Fig. 2 may be compared to a vessel under sail, and "fetching where she points," while in Fig. 3 she is drifting bodily to leeward. There should have been a fourth Fig., showing that, when sail is made (or, in other words, when the change wheels are put into gear) on Fig. 3, the cutter (vessel or tool) will again travel in the line of her keel, and, as in Fig. 2, produce a symmetrical groove.

May 18. **Faber.**

## CUTTING SCREW-THREADS.

[24263.]—SEVERAL valuable letters have been given to us in our number for May 15. We are all anxious not to occupy valuable space in mere verbal disputation, yet some of us seem to be writing about one thing, and some about another.

Will "Vulcan" kindly reconsider his diagram and his terminology? Unless we start with clear and distinctive terms for the things about which we are writing, we are sure to get into confusion. "Vulcan's" diagram of a double-threaded screw (p. 236, col. 2) seems to me to show a cutter with its axis set at a horizontal angle to the lathe-axis. This is not what I have proposed. A revolving cutter, with its axis trimmed in the plane of the lathe-axis, becomes a bevel wheel; this is a frustum of a cone, and, at a certain angle, the side of this cone runs parallel to the lathe-axis. If the cutter-axis be trimmed additionally in a plane parallel to the plane of the lathe-axis, the cutter becomes a skew bevel wheel, and hyperboloidal surfaces come into the question. I will not now ask whether a rectangular helixoid—*i.e.*, a square-thread screw—surface could be ground up by a skew bevel wheel, as the object of this letter is merely to get accurate definition of the topics which crop up.

"Hadah" sends a clear letter and "Canmore's" diagram, Fig. 2 (p. 236, col. 2), perfectly shows what it is that I have proposed. I merely add that his line A B is my hypothenusal line, which, under the influence of the traverse, is transformed into *the helix*; and that his cutter-axis, C D, represents the line which, under the influence of the revolution, is transformed into *the normal helix*. In "Canmore's" text (par. 2) he gives a description of his diagram which, till we come to the bracket, I also adopt; but to his concluding sentence about the shape of the section I demur altogether. "Canmore's" conclusion does not seem to follow from his premises, and his Fig. 3 does not seem to represent the normal section which he refers to. I say that *there is no difference in the traverse cut of an angular point tool, whether fixed or revolving, so long as the tool clears itself*. In order that the tool clear itself, its plane of revolution must be tilted to the hypothenusal line which determines the rake of the thread. The thread surfaces also must be skew helixoids having a certain lateral angle, this angle being dependent upon conditions to which I have already referred (page 190, No. 1,049). If the revolving cutter be not accurately tilted to the hypothenusal line it cannot clear itself, and it cuts a groove more or less U-shaped, the sides of the thread being therefore left hollow. The square-thread screw-surfaces are rectangular helixoids; and the revolving square-tool, if used with these, would leave a U-shaped deformation of the groove. With other threads—those which are rounded or angular—the clearance is simply a question of more or less lateral curvature or lateral angle. Perhaps those readers to whom I have failed to make this clear will reperuse "Hadah's" letter at page 235.

The shapes assumed by the surface of a lady's fan as it is opened out or closed up will bring home to the eye the surface termed *a rectangular helixoid*. Upon a square screw-thread there are two such surfaces, one right-handed the other left-handed. If there must be, theoretically, deformation of the straight generating lines which determine the section of the angular thread, the sides of the groove would be rounded instead of hollowed, as in "Canmore's" figure. They would, in fact, be side arcs of an ellipse so flat as to be indistinguishable from straight lines.

Two of my old failures in the way of model screw-noses that I had at hand I have posted to "Vulcan," and have asked him to report upon their screw-threads. They were cut with a revolving point tool.

Perhaps "Canmore" will reconsider his Fig. 3, and the conclusion which I have ventured to demur to. Something more on the defects inherent in chasers would also be acceptable. There is no subject of greater interest or importance to the readers of the ENGLISH MECHANIC than that of "cutting screw-threads."

As to nomenclature—the following is what I understand by some of the terms. *Screw* is used in the ironmonger's sense. A *screw-thread* is not "a screw," but the thread or helicoidal projection upon the stem of the screw. A *screw-groove* is neither a screw-thread nor a screw. If, then, we use the terms screw or screw-bolt, screw-blank or cylinder, screw-stem, screw-thread or thread, and screw-groove or groove, when we respectively mean these things, we shall in future have no such corrections as recent letters have needed. By "stereotomy" of screw-threads I mean the sectioning of screw-threads and screw-grooves in various directions, and the describing of those sections. By "stereometry" of screw-threads I mean the measurement of the angles, sectional areas, and solid contents of the grooves and threads produced by tools ground to various forms and then tilted, rotated, or skewed at various angles to the traverse line.

*Reversible thread* means a thread of such shape that the nut or counterpart screw will go on equally well each way.

A *symmetrical* thread is the same thing as a "reversible" thread, but named from a different standpoint. "Vulcan" defines a "reversible" thread as having "its axial section bisected throughout by a radius cutting its apex on the centre of its summit." I should have defined it as "bisected throughout by the rectangular helixoid."

*Counter-screw* means sometimes the nut, and sometimes the bolt, according to which is the counterpart. There will also be *counter-thread* and *counter-groove*. The counter-screw may or may not have the same axial section as the screw. Screws for wood take a wooden counter-thread much larger than the iron thread to which it is opposed. But the thread surfaces should match, and counter-threads, though unlike each other, may be reversible. The propensity for word-coining must be restrained; but as the mind discriminates, so must the pen, if our notions are to be discussed without confusion.

*Abnormal* seems a confusing term when applied to screw-threads, as we must use the term *normal* in other senses.

The cut given by the cutting face of a tool when handled in various ways is a complicated and difficult subject by equation-mongering, but is simple enough when studied experimentally. If through an opening in a window shutter sunlight be let in, and a penny-piece be held so as to throw its shadow upon a screen placed at right angles to the path of the rays, we can realise all the changes of form in the cut by means of this simple projection apparatus. When the penny is held at right angles to the rays, it casts a circular shadow the size of the penny. If held parallel to the rays, it casts a straight line shadow as broad as the penny is thick, and as long as the diameter of the penny. If the penny be tilted, one diameter is shortened, and the shadow becomes an ellipse—*plus* the projection form of the thickness of the rim of the penny—the minor axis always being the cosine of the tilt.

But there is no manipulation by which both diameters of the shadow can be shortened or its thickness lessened. The penny cannot be made to cast the shadow of a farthing, nor can it be made to cast a shadow larger, or thicker, or longer in diameter than the penny. If, however, the screen be tilted, we can lengthen out either diameter of the shadow to any extent and without diminishing the other diameter.

In the first case the projection gives elliptic sections of the cylinder by diminution of one axis of the circle, and the short axis is the cosine of the tilt; in the other by the increase of one axis, and the lengthened axis is the secant of the tilt. The straight line shadow is, in one case, always the same length; in the other it may be lengthened out infinitely.

If, now, the penny be replaced by a revolving cutter attached to the tool carriage of a planer, and upon the planer bed beneath there be a slab of wood, we have only to lower the revolving cutter in order to make a cut into the slab. One way this cut will be a segment of the circle described by the revolving cutter, when projected along the line of its axis, and the other way a profile of the cutter when projected at right angles to its axis. The depth of the segmental cut will represent the depth to which the revolving cutter has been lowered. Now the shadow thrown by the revolving cutter is a cylinder whose section is the figure upon the screen—i.e., the projection-form of the tilted or untilted circle, *plus* the projection-form of the cutting-edge of the tool. By now putting the planer-bed in slow motion parallel to the line of projection, *the intercept* of the projection-form of the revolving cutter becomes the normal section of that segment of this cylinder-space which appears as the traverse-cut. If the cutter-axis be parallel to the traverse-line, the normal section of the traverse-cut will be a segment of a circular cylinder. If the cutter-axis be at an angle with the traverse-line, the normal section will be that of an elliptic cylinder whose short axis is on the line of tilt. The long axis of the elliptic section will always be the diameter of the revolving cutter, and the short axis will always be the cosine of the angle through which the plane of rotation has been tilted. It will be recollected that the thickness of the rim of the penny added its projection-outline to that of the tilted circle. Now, when the cutter-axis is parallel to the traverse-line, the profile of the cutter-face is of no account; but in all other cases the projection-form of its profile has to be interposed between two arcs of the elliptic curve derived from the projection-form of the circle. With small cuts, such as those used in shaping screw-threads and in most ornamental work, the projection-form of the cutting edge of the tool constitutes a very large factor in the resulting shape, and an endless variety of beautiful forms may be produced by varying the profile of the cutting edge and its relation to the traverse-line.

The second primary element to which I briefly referred at page 190 is exemplified by tilting *the screen* on which the projection-form of the object is received. Here, there comes into action a new set of variations, which, for the purpose of geometrical analysis, must be looked at apart from those due to the tilting of the revolving-cutter-plane. This tilting of the screen does not alter the form of the cylinder of shadow which is projected; it only varies the direction in which the shadow is cut, and in that way alters the form of the section. By appropriate chucking of the slab upon the planer bed these effects may all be superimposed upon those produced by rotating or tilting the cutter axis. If a cross motion of the cutter-frame along the tool slide be combined with the rectangular movement of the planer-bed—the cutter-plane being rotated to the hypothenusal line—all the phenomena of screw-cutting can be studied upon the flat, as I have already indicated (page 190). And one component after another can be put into the resultant. On rotating the cutter-plane at various angles athwart its traverse-line we see the external ellipse gradually substituted for the profile of the traverse-cut.

In cutting screw-grooves upon cylinders we bring in our third factor, i.e., *the helicoidal character*. Each particular screw-thread is an untransformable geometric entity, just as is the sphere of each particular radius. One screw-thread can no more be transformed into any other than a spherical surface of one radius can be transformed into a spherical surface of any other radius or into a plane. So long as this remains, so long will the screw-thread retain its helicoidity. The fact that the pitch of every screw-thread increases towards infinity at the axis makes it not possible for any one hypothenusal line to meet simultaneously the rake of concentric portions of screw-thread; but in equal step with the increase of curvature and the advance of helicoidity there comes an alteration in the outline of "the intercept" of the projection-form of the revolving cutter. In substituting the cylinder for the flat slab we have, in fact, *tilted our screen*. The flat slab intercepted a straight-line segment of the projection-form; the cylinder intercepts only a circular segment, and its intercept, therefore, does not rise so high up the shoulders of the cutter-circle. As the helicoidity and the curvature increase, so does the intercept shorten and fall away from the path of that portion of the cutter-circle which is shaping the groove. Therefore, the question is one of degree. To cut a screw-thread which approaches the last limits of theoretical accuracy is impracticable. With a fixed screw-tool the spiral base may be made a true counterpart of the thread; but it is only the edge of its cross-section which can cut. If the spiral base were to fit the screw as a true counterpart, there would be no relief, and the edges of the section would fail to cut. The question is, Which tool will true up a hardened steel screw most perfectly to the end of its thread?

Reverting to the projection-form given by the penny in parallel light as the guide for the stereometry of our cut, we must give further consideration to the influence of cutting-edge upon the projection-form. If the cutting sides meet at an angle of 50°, and we take the extreme case of a double-coned spindle-shaped revolving cutter-wheel, we settle the case out of which this discussion arose, and may also refer very briefly to the general proposition. Now, as the profile projection-form has an angle of 50°, it is obvious that this cutter can clear no cut whatever whose sides include an angle less than 50°. Here the cosine is 0, and, with every increment of cosine as the cutter-plane is rotated across the traverse-line, it is obvious that the edges of the projection circle will bulge out elliptically, and cut away the straight sides of the profile until they are obliterated by a U-shaped groove which, at the limit, becomes a segment of a circle. It is obvious that this obliteration will encroach more rapidly with the flat slab than with the revolving cylinder.

As I have before shown, *the normal helix* is the shortest line across a given number of thread-turns. Therefore, the section given by *the normal helixoid* is the section with the shortest base line. If also the radial altitude remain constant, it follows that the normal section will have the smallest angle, the shortest sides, and the least area, as well as the shortest base line. The narrowest part of the screw-groove must, therefore, be its *normal section*, and this is *the cut*. All other crossings must be wider, and if so, the tool will clear itself so long as the lateral angles of the sides are sufficient to allow clearance when the cutter-plane is tilted to the hypothenusal line which determines the rake of the thread. This tilt must be in a plane parallel to the lathe axis. **James Edmunds.**

Grafton-street, Bond-street, W.

## CRANK AXLES.

[24264.]—Your correspondent "Locomotive" (24238), page 235, is correct in stating that the crank axles break across the webs, through the fault of the fibre running in the wrong direction. If the present mode of forging crank axles is correct, why do they require hooping, which must enhance the price considerably, also the weight? There is a new mode of forging crank axles with the fibre running in the several directions as best suited to bear the various strains whilst in motion, patented by Messrs. Linney and Lawson, Rochdale-road, Manchester, in which they proposed to dispense with twisting to get the right angles; if so, it would certainly save the centre of the axle crystallising sooner than otherwise. **Wilfred.**

## THE MUSICAL SCALE.—WHAT IS A SEMITONE?

[24265.]—IN the scale of equal temperament a semitone is, of course, just the half of a whole-tone interval. In the harmonic scale it is greater than this, and in the natural or melodic scale it is less, the sharps in the former being below the flats, and in the latter above them. On the assumption that the harmonic scale is the only correct one, this relative position of the sharps and flats in the melodic scale has been pointed to as one of its errors. That it is by no means erroneous, however, may be shown by a simple musical test. There is a certain chromatic cadence, or phrase of four notes of frequent use in music, by means of which modulation is effected from any key into the key of the fourth of its scale. It is most generally used where a melody has modulated into the key of the fifth of that in which it began—to lead it back into the original key. Thus, a melody which began in the key of C, and has modulated into that of G, is restored to the key of C by the phrase consisting of the notes G, F sharp, F, and E. Of the intervals between these successive notes, only two (G—F sharp, and F—E) are true semitones; they belong respectively to the scales of G and C. The middle interval (F sharp—F) is not a semitone, and has no place in any scale. Whether it is more or less than a semitone may be determined by the following experiment:—Let a practised singer or violinist sing or play the cadence in question *without accompaniment*. It will be observed, and he will himself admit, that he makes the first and third intervals (the two semitones) narrower than the middle one. He does this naturally, and almost unavoidably, if he does his best to give the notes in tune. This arrangement of two semitones, separated by a perceptibly wider interval, of itself shows that the notes used by the performer are those of the melodic scale. If he had used those belonging to the harmonic scale the middle interval would have been the smallest of the three, and, moreover, the final note E would have sounded flat. But, indeed, unless aided by an accompaniment (necessarily harmonic), he would find it very difficult to give the phrase on these harmonic notes—impossible to do so *in tune*. It may here be noted that when the cadence in question is used for the purpose above described (in a harmonised piece), the first three notes are given *almost invariably* without accompaniment. The preceding chord having belonged to the key of G, the harmony is dropped until the E is reached, along with which it comes boldly in again with the "common chord" of C. The reason of this no doubt is that the cadence, being essentially melodic, cannot be given so effectively if harmonised. **W. Hardie.**

## PARAFFIN-OIL LAMPS.

[24266.]—I HAD no intention of troubling you again on this subject, but for J. Hughes's letter (24209, page 215). My greatest desire was to establish the fact that there was not the danger attached to paraffin lamps which might be inferred from what Sir F. Abel said, and what is generally considered to exist. I went through every letter that had been recently published in ours on this question up to my time of writing, and considered myself free to criticise any doubtful assertions, and to add, in return, what I could for the benefit of anyone, and cannot, therefore, consider J. Hughes's opening remarks in his last to be quite out of place and uncalled for.

Then, again, as to my championship of "paraffin oil," and that being the names of all hydrocarbons, is there no difference between the grass, the calf, the milk and the cow; or between ale, wine, or spirits?—is not paraffin oil considered the mildest of this class of hydrocarbons, and, as such, how was I wrong in recommending it in preference to those containing more serious qualities. Then, again, as to attempting to refute his argument, is not the "Silber" a domestic lamp?—and I touched upon this lamp because P. Ward says, in letter 24127, page 150, that his "Silber" had blown up several times. In reply to this, I gave my experience of the Silber lamp, all under most dangerous circumstances; as, for instance, some years since, before I fitted myself up with the lime-light, I worked three or four magic lanterns, with the Silber lamps. They were the best lanterns in the market, mahogany bodies tin lined. I have had the Silber lamp shut up in these, hours at a time, in full blaze, and the internal heat has been so great as to burn and dry up all the japan on the lantern tops, make the solder run, scorch the timber, and crack, at various times, three best 4½in. condensers. Yet with all this accumulated heat, and in such close quarters, my metal containers, too hot even to handle, never troubled me or gave way in the least. There is no English domestic lamp I should think ever burned under such severe conditions as these; where would a glass container have been under such conditions?

Then, again, J. Hughes says, "While combating his assertions, I go out of my way to prove him right, by admitting the advisability of using a cork washer," &c. Now, I deny this, and protest against his style of misconstruing my words to bolster up his own ideas. What I wrote was, "Even if there were positive danger in using metal containers, the interposition of a washer of cork between the burner and container would effectually prevent the heat from descending." How far this goes to prove his theory right, or to strengthen it in any way, I will leave others to judge. Then, again, he says, "All the replies (except Col. Shakespear's) have been particular and interesting, advocating, as they do, some special lamp or oil." How far Col. Shakespear has strengthened J. Hughes's theory respecting glass retainers I fail to see, nor has he answered a very simple question which that gentleman puts to him in his letter 24059, page 108; and, finally, is it right to say that all the other correspondents are advocating some special lamp or oil, and are interested? I am thinking there are many of "ours" who have read up J. Hughes's letters, who will think with me that his interests in glass, opal, or earthenware containers are very obvious, and, in fact, serious. Now, as to metal containers, I made reference to Martin's lamps in my last, and now quote a portion of their foot-notes, which is printed in something like italics at bottom of their circulars.

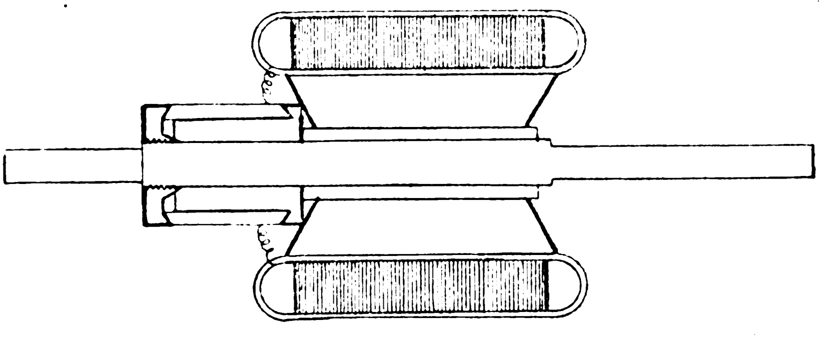
"The inventor is engaged in designing some new apparatus to be supplied with his burner, as well as new metallic lamps, &c." And lower down: "By the use of these lamps the public has the great advantage of security against fire, as they cannot be broken like those with glass or porcelain reservoirs."

And now as to my supposed interests in the lamp trade. I am not connected with it in any shape or form, nor with any other business particular; but I have well-to-do friends who live where gas does not reach them. Consequently, they rely entirely upon paraffin lamps for artificial light, and I may say they jump at every new thing in this line, in the hopes of reducing the annoyances and danger attending them. Having from time to time noticed these defects, I commenced two years back, to see if it was not possible to construct a lamp perfect in every degree. I have purchased every lamp I could get hold of with any pretensions to excellence, and have tested them in my laboratory in every conceivable way for light, heat, consumption, and attention required, and have spared no expense to establish the real facts of the merits and demerits of the various lamps, and have noted everything down most precisely; nor have I rested satisfied with one particular trial, but have made several under different conditions, and amongst my trials I have two or three lamps with metal containers, one more especially, that has never been out of use for 18 months, and it has been burning more than once from Monday morning until Saturday night, or continuously for 132 hours, giving an equal light all the time of about 22 c. p. This lamp I am willing to show to any one under certain conditions, or, what would be better, I will send a sketch, with many more important particulars, to "ours," if it is desirable, and the Editor is disposed to publish it. There is one important reason why metallic containers should gain the supremacy so long as they are safe in other respects; for we all know they are not so breakable as glass, &c., and that reason is that it would throw more work in our own factories for our own people, instead of importing such vast quantities of the glass and opal fittings as we do, and I was very pleased to see Mr. Martin's announcement as to metal lamps which are now to be seen, and there is not a doubt but they will be thoroughly appreciated.

**G. R. Postlethwaite.**

## 30-LIGHT DYNAMO.

[24267.]—Before commencing to describe the construction of this machine, I must mention that I address this letter to those who, having built small dynamos, are anxious to try their hands at a machine that will be something more than a mere toy. The first thing required is the shaft: this should be made of good mild steel, Bessemer steel answers admirably. The diameter of the shaft, when finished, must be 1½in., and its length 25in.; one end of shaft (commutator end) must now be turned down for 5in., to 1¼in. diameter; a thread 1¼in. long is now cut on shaft. On this thread is placed the disc which holds together the commutator bars (see sketch); 10in. from end of shaft a mark is placed, which shows the distance up to which the brass boss is driven; the other end of shaft is now turned down for a length 9in. to a diameter of 1¼in., leaving 11in. of shaft 1½in. diameter, on which is placed the boxwood drum which holds the commutator bars, and the brass centre-piece which supports the armature core.



We must now proceed to fix the sheet-iron rings which form the core of the armature. There are two methods which I know of: one is by means of a wooden boss, which is keyed on the shaft; the shaft is then put in the lathe, the wood turned slightly taper, and the armature driven gently on; a cement composed of pitch and guttapercha is poured between the armature and the wood, and so prevents the armature from slipping. The other method is to mount the armature on a star-shaped piece of brass, having four radial arms.

The first plan is simple, but it has several defects. 1st. Because it is a difficult matter to mount the ring true, as the slightest inequality in the winding will throw the ring out of truth, which is a serious fault in a high-speed dynamo. 2nd. The wires on the inside of the ring become hot, as the air cannot reach them to carry off the heat. 3rd. As the armature gets hot the cement gets soft, which, together with the expansion of the ring by the heat might cause an accident not pleasant to contemplate. There are some other objections to this method of mounting, but I think I have said enough to show that it is both unsatisfactory and unmechanical.

I shall, therefore, proceed to describe the second method. The arms of the brass boss must be made strong and substantial, and should taper from ½in. at their ends to 1¼in. where they join the boss, the length of the arms will be 8in. and the length of the boss 6in. I have endeavoured to make this plain in sketch, which shows a cross section of armature, commutator, and shaft. The next things we must consider are the sheet-iron rings, which form the core of the armature. These rings, which must be made of the best charcoal iron, are 7¾in. external diameter, 5in. internal diameter by $\frac{1}{20}$in. thick; thus the depth of the iron core will be 1⅜in. Before the rings are mounted they must be thoroughly annealed. I have experienced considerable difficulty in obtaining these rings, especially the larger sizes, and I am sure that anybody advertising them in the "E. M." at a reasonable price would meet with a ready sale.

The brass boss must now be keyed on shaft, care being taken to make a good job of it, as if ever the key shakes out or comes loose there will be a smash up. The shaft is now put in the lathe, and a few light cuts taken off the brass arms, till the rings slip on easily but not loosely.

The methods of fixing these rings on the brass arms are very varied, nearly every dynamo manufacturer having a different plan; so although I shall describe only one method, readers will understand that they are not tied down to any particular plan, but may use the one that seems to them the most practical and mechanical. The method I am about to describe is not very difficult, and I can answer for its practical value, as I have used it in the construction of machines of much larger dimensions than the one under consideration.

Two massive iron rings are to be forged, their dimensions being 8in. external diameter and 4⅜in. internal diameter by ¾in. thick. These rings are now put in the lathe and bored out, so that when heated they will just slip on the brass arms. On the outside face of one of the brass arms must be cut a slot 8in. long, ⅜in. broad, and ⅛in. deep, and in this slot is fitted a steel key, 8in. long by ⅜in. broad and ¼in. deep. The key will thus project ⅛in. above the brass. A slot is now cut in one of the heavy iron rings, which is then heated and slipped on the end of the brass arms. Before the ring has time to cool the shaft is put in the lathe, and a few taps given to the ring, so as to get it as near flat as possible, care being taken that the slot in ring is directly over the slot in the arm. When the ring is cold we may proceed to turn it up, a small key being put in to prevent any possibility of slip. The inside face of the ring is turned flat, and the outside face rounded, so as to prevent the wire when it is wound round being cut by the sharp edges. The small key may now be driven out, and the long 8in. key inserted. We must now proceed to mount and insulate the sheet-iron rings. I have tried several ways of insulating these rings, one of which was to give each ring two coats of thin Japan black; but although this method is easy, it does not give perfect insulation. A better plan, and the one I have generally used, is to insulate with rings of brown paper.

Before the iron rings are put on the arms, a notch is cut out on the inside of each ring, so as to allow the ring to slip over the long key. This key, it will be seen, prevents the possibility of the heavy rings or the sheet-iron rings from slipping, either while the armature is in motion or while the core is being trued up.

The rings are now slipped on the brass arms, a ring of brown paper being placed between each iron ring. We next slip on the second heavy ring, and clamp the whole together. This will be a somewhat difficult matter for an amateur who has not an engineer's shop at his disposal. The proper way to do it is to slot the heavy ring, and having heated it, slip it on the brass arms; then the core and shaft are placed in a specially constructed press, the whole of the rings forced firmly together and left to cool, when it is removed from the press; the heavy ring having shrunk on the brass arms holds the whole firmly together. Another method is to have the heavy iron ring bored out so that it slips on the brass arms cold; four or five U-shaped clamps are then used to draw the rings together. During this operation the armature is put in the lathe and occasionally turned round, when any unequal tightening of the clamps can be at once detected and remedied. When the rings are drawn together sufficiently tight, four small holes are drilled through the heavy ring into the brass arms; into these holes are driven tightly four small pins. The clamps may now be removed, and a light cut taken over the outside of the armature, so as to bring it up perfectly true; the outside of the second heavy ring is rounded off, and the armature is ready for the insulation and the wire. The core must now be insulated, which operation will require some care. I have found linen covered with Japan black very good for this purpose. The armature must be wound with the linen while the Japan black is wet. Four strips of linen, each 2in. by 5ft., will be sufficient. The wiring of the armature may now be proceeded with. The wire required will be 12lb. of No. 12 double c.c. so that the resistance of the armature will be ·07 ohm. on account of its stiffness. No. 12 will be difficult to wind, so it would be best to procure a stranded wire of equal proportions. The outside of armature must be entirely covered by a single layer of wire, while on the inside of the ring the wire must be wound two layers deep. We must now decide on the number of sections. Looking at the matter by the light of my own experience, I shall fix 24 as the proper number; but, of course, those who construct the dynamo may have as many more as they choose. After the armature is wound the layers should have several coats of good shellac varnish to keep out the damp; the armature must now be wound round with some fine steel wire to prevent the centrifugal force from disturbing the wire. Great care is necessary in winding on the steel wire that it does not cut through the insulation of the armature wires. The next to engage us will be the commutator, or, what is more correct, the collector, for there is no commutation of the induced current in the Gramme ring. The best metal for commutator bars is brass, which will be improved if it is well hammered. The best substance to insulate the commutator bars is vulcanised fibre, or, next to that, mica. The way the commutator bars are fixed is shown in sketch. The commutator should be 4in. in diameter and 4½in. long, the pulley may be 7in. in diameter by 5in. across face. I shall now conclude the description of armature. In my next letter I intend to describe F.M.'s, connections, winding, &c.

In letter 24107, Mr. Bottone describes a 30-lighter which has been put up by a friend of his, intimating at the same time that it might interest readers who were about to construct a dynamo of this size. Now, as some of "ours" might possibly start making a machine based on these particulars, I hope that Mr. Bottone and his friend will excuse me if I point out, among others, two serious defects in this machine. First, the resistance of the field-magnet is five times too large; second, that when the machine was running 30 lamps, the internal resistance was as large as the external, which means that of every horse-power transmitted to the pulley, half is wasted in the machine itself; so that the 2½ h.-p. engine which did not seem overtaxed, must have been indicating nearly 6 h.-p. I may add, that I doubt the ability of No. 14 wire to stand a continuous current of 30 ampères for four hours.

Coventry. **W. H. Eaves.**

## COMMUNICATION CORDS ON RAILWAYS.

[24268.]—Will any reader of your journal kindly give the law with regard to the use of communication cords on railways? On 24th April I was a passenger by the Midland from St. Pancras to Carlisle, and rode in a "bogie" carriage about the centre of train; near Luton I looked out of window on the right side and saw a quantity of brake-blocks, &c., lying on the step-board (doubtless left on by mistake). I should have pulled the cord and stopped the train, but feared I might be fined £5 if I did, as others have been; but it is a fearfully dangerous thing for platelayers on the road to have brake tackle left on the steps to fall off and strike men at a speed of 60 miles an hour. Can you, Sir, or will the Midland Company say, if under these dangerous circumstances, I should have been justified in pulling the cord?

**Carlisle Passenger.**

Carlisle, May 19.

## JERKS IN RAILWAY TRAINS.

[24269.]—In past numbers of the English Mechanic I have observed many letters on the action of brakes, and especially of those which leak off and cause jerks. Last week a Mr. Green was actually brought up before the magistrates for getting out of a train in motion, when in fact he had been thrown down by the leaking off and jerking of a brake. It seems, Sir, a very serious thing for passengers to be thrown down in this kind of fashion. Some years back I remember that an old and valued correspondent, "Meteor," used to give us details of jerks in trains. Would he kindly now explain the jerks which arise from running about twelve fish vans, not fitted with brakes, behind a train of carriages fitted with the Midland leak-off brake worked by vacuum?

I was on the platform, having got out before Mr. Green, witnessed the frightful jerk, saw the passenger thrown down and injured, and can swear that the train had just stopped and that it then moved again with a jerk; but don't just know in a scientific manner how to explain the cause of the jerk. So many passengers are being thrown down by this leaking-off jerking brake, that the matter is getting one of serious importance.

**One of the Passengers.**

New Humberstone, near Leicester, May 18.

# REPLIES TO QUERIES.

◆

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[54825.]—**Salt, &c.** — I certainly agree with "F. W. H." that Nature's law is uniform, and that is why I begin with a civilised man instead of a so-called low type man, such as the Palæolithic men and their chipped flints. If these so-called implements were really manufactured by some primeval race of men, they ought to be found under varying conditions and in all localities. But in Europe they are always found in the river valleys, or associated in some way with the great floods of the Post-Glacial epoch, also with beds of sand, generally beneath such a deposit. They are always of flint, and washed away from the beds of chalk, which are found in the Somme Valley, at Hoxne, Bury St. Edmunds, Brandon, Herne Bay, Beaulness, Fimber, and at Fisherton, &c. The specimens are always picked and selected. No other implement or utensil has ever been found with these flints; every other trace has perished. Now, Mr. Sydney Skertchley, F.G.S., writing upon the "Antiquity of Man," says of Palæoliths (see ENGLISH MECHANIC for March 28, 1879, p. 49), that they "were more degraded than any known savage tribe," which I can well believe, if such men ever lived; but it is only as yet a supposition. Besides, if man had lived upon the earth for a thousand centuries (and that is not so long as some scientists insist upon), and starting from only a single pair, with the normal rate of increase, we should not be able to find a rood of ground without a skeleton in it. And instead of the caves and ancient sepulchres presenting a few doubtful Neanderthal skulls, the crania of Palæolithic men would have supplied inexhaustible stores of material for our manufacturers of bone manure. But coming to the cave men, we get something sure and firm to walk upon. Man is now upon the earth along with the remains of the mammals, as also of the goat, pig, sheep, rabbit, ox, bat, &c., in fact, all the modern animals. We have bone needles, awls, and gouges, potsherds, harpoons, ironstone weapons, and a very fine drawing of a hog-maned horse. Now, when men can produce hog; manes, and also make drawings of the same upon bone—said bone being cut with a saw, and the surface well polished—it won't do to speak of these men as being primitive. The artist, then, that drew this horse, lived at a time when horses' manes were cut to fashion; but Palæolithic times were by no means fashionable times either for men or horses.—DENS.

[55393.]—**To "Inviota."**—I should much like to have further details as to lathe-heads, &c., having the bed and standards fixed up and ready.—M.

[55875.] — **Cupola Blast.** — To "INVICTA."— You will find I sent a promised sketch, and it will be found on page 218. As to the steam used, I will endeavour shortly to lay some data before the readers of the "E.M." relative to the same cupola worked with a fan blast, and subsequently altered to run with a steam jet blast. On the subject of the ejector I may say that it is a very simple one. The idea being taken from a modification of the ejector in use with a vacuum-brake; but proportioned to deal with a large volume of heated gas instead of a small volume of air only. In the absence of the precise data I propose to bring forward, I may, in passing, say that originally we had a four h.p. boiler and engine. The engine is now dispensed with for blowing purposes, and the four h.p. nominal boiler certainly makes sufficient steam for two such ejectors as we have on the cupola. And as we, of course, have but one ejector, the moral is obvious. So far, the economy is in favour of the jet; whilst later on, we hope to utilise the waste gases for the production, in part, of the steam needed. The casing mentioned is now made into a feed-heater, and with a satisfactory result. In my reply on p. 218, several typographical errors have crept in, the chief one being in line 3, p. 219, which should read "fused," instead of "fired." The others are unimportant.—INVICTA.

[56209.]—**Sunshine Recorder.**—Many thanks to "Cyrax" for his reference to back numbers; but, as I am a new subscriber, and have no opportunity of referring to them, I should be glad if any one could give particulars of and directions for making the instrument, somewhat vaguely described in my query. I do not want one of the type having a glass focussing ball, but one in which the rays of the sun shine through a hole in the lid of a box of semicircular section, and trace a line on a strip of photographic paper on its curved bottom. Perhaps Mr. Lancaster could help me.— MIKROS.

[56282.]—**N.E. Locos. (U.Q.)**—A driver informs me that, owing to a deficiency of heating surface, McDonnell's engines would not steam well, and that they were too light to exert their calculated tractive force. I have never heard anyone say a kind word about them.—WM. JOHN GREY, F.C.S., Analytical Chemist, Newcastle-upon-Tyne.

[56312.] — **Distempering.** — Ellis Davidson's book on "House Painting," Lockwood and Co., is about the best for the purposes of your correspondent; but if he has access to back volumes, he will find a number of practical details which he cannot discover in any book. For instance, in Vol. XXXIX, pp. 497, 593, there is something about distemper. An improved distemper is described in Vol. XXXII. p. 79; Vol. XXXI. p. 144, contains a useful general description of the process.—NUN. DOR.

[56318.]—**Owls.**—I do not think "Agricola" will find any number of owls will much reduce the army of rats. They will eat mice, particularly field-mice; but rats are rather too large. The owls will not need any food to be supplied. All you have to do is to get them to take up their quarters with you, and then the less notice you take of them the better.—NUN. DOR.

[56322.]—**Miranda Pianista.**—I remember reading something about this in Vol. XXXVI. (see pp. 334, 431, 501, 547, 595); but as I have never seen it, cannot describe it. I see, however, that "pianistas" are entered at the International Inventions Exhibition; but whether the particular "Miranda" is there, this deponent knoweth not. As he means to go, he will eventually find out; but then the querist can also do that much better. As the querist seems to be aware that a company is being formed, I might suggest that the secretary would no doubt give all information.—N. E. CHILD.

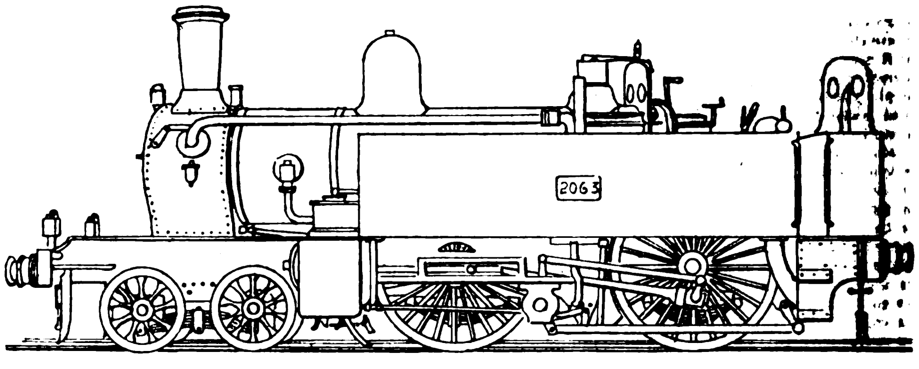
[56335.]—**Wheel Gearing.**—"J. H.'s" reply has greatly enlightened me, and I think I shall master my difficulty with a little more of his help and instructions on bevel-wheel work. I want to know if the inside lines should be the same distance as on the outside (pitch lines I mean), and what are the top and bottom lines for, and what distance should they be from the pitch line, and would "J. H." oblige me with the thickness of teeth from $\frac{1}{4}$in. to 4in. pitch? I know the length they should be—a third and a fourth; I think that is right.— MILLWRIGHT APPRENTICE.

[56351.]—**Worm in Mahogany.**—"G. S." should certainly not make up his wood without taking precautions to kill the worms. Fill every hole with oil; force it in, and finally stop up. No insect can live in a bath of oil.—N. E. CHILD.

[56354.]—**Turning Cannel Coal.**—I am afraid that not much can be done in the way of "turning" cannel coal; it may be filed into shape.—C. E. S. P.

[56354.]—**Turning Cannel Coal.**—"Ryhope" will find the method of turning Cannel coal described in Holtzapffel's "Turning and Mechanical Manipulation," Vol. I. page 162.—EN BON FOYE.

[56399.]—**L. and N.W. Compounds.** — The dimensions of the small or "Compound" class of these engines are: Two high-pressure cylinders, 13in. by 24in.; one low pressure cylinder 26in. by 24in. Boiler: length of barrel, 9ft. 10in.; mean diam., 4ft. 1$\frac{3}{16}$in. Firebox: length inside at top, 4ft. 9$\frac{5}{8}$in.; width, 3ft. 5$\frac{1}{4}$in.; length inside at bottom, 4ft. 10$\frac{1}{2}$in.; height 5ft. 5$\frac{3}{8}$in. Tubes: Number, 198; length between plates, 10ft. 1in.; diameter, 1$\frac{7}{8}$in. Heating surface: tubes, 980 sq. feet; firebox, 103·5 sq. feet—total, 1,083·5 sq. feet; grate area, 17ft. 1in. Wheels: leading, 3ft. 6in. diam.; front (radial) driving, 6ft. 6in. diam.; trail driving, 6ft. 6in. diam. Wheel base: leading to front driving wheel, 9ft. 4in.; Front driving to trailing driving wheel, 8ft. 3in.—Total base, 17ft. 7in. Weight: empty, 34tons 15cwt.; in working order, 37ft. 15ft. The large new ones of the "Dreadnought" class are of the following dimensions: Two high-pressure cylinders, 14in. by 24in.; one low-pressure cylinder 30in. by 24in. Boiler: length of barrel, 11ft.; diameter, 4ft. 3in. Firebox: length outside, 6ft. 10in.; depth below centre line of barrel, 6ft. 3$\frac{1}{2}$in. Tubes: number, 225; length between plates, 11ft. 3in.; diameter, 1$\frac{7}{8}$in. Heating surface: tubes, 1,242·4 sq. feet; firebox, 159·1—total, 1401·5. Grate area, 20ft. 5in. Wheels: leading (radial), 3ft. 9in. diam.; front driving, 6ft. 3in. diam.; trail driving, 6ft. 3in. diam. Wheel base: leading to front driving wheel, 8ft. 5in.; front driving to trailing driving wheel, 9ft. 8in—Total base, 18ft. 1in. Weight: empty, 39tons 10cwt.; in working order, 42tons 10cwt. In this new type the leading wheels are again in their usual position, and give the engine a neater appearance than when under the smoke-box, as in the previous type. Some time since there was a query about L. and N.W. bogies on the Metropolitan; one of these has now been compounded, and I send sketch of it herewith. The dimensions of these engines, which were bought from Beyer, Peacock, and Co., are—Non-compound: Cylinders, 17in. by 24in.; boiler, 10ft. 3in. by 4ft.; 164 tubes, 10ft. 6$\frac{3}{8}$in. long by 2in. diameter. Heating surface: tubes, 903 sq. ft.; firebox, 111 sq. ft.—total, 1,014 sq. ft. Grate area, 13ft. 1in. Diameter of coupled wheels, 5ft. 9in. Wheel base: c. of bogie to c. of driving, 9ft. 11in.; c. of driving to c. of trailing, 8ft. 10in.—total, 18ft. 9in. Weight, 45tons; pressure, 120lb. Dimensions of 2063, compounded: 2 high-pressure cylinders, 13in. by 24in.; one low-pressure cylinder, 26in. by 24in.; boiler barrel, 10ft. 6in. by 3ft. 10$\frac{1}{2}$in.; 177 tubes, 10ft. 9in. long by 1$\frac{3}{4}$in. diameter. Heating surface: tubes, 933·86 sq. ft.; firebox, 94·57 sq. ft. — total, 1,028 43 sq. ft. Grate area, 14ft. 6in. Wheel base: c. of bogie to c. of driving, 9ft. 4in.; c. of driving to c. of trailing driving, 8ft. 10in.—total, 18ft. 2in. Weight, 46tons 17cwt.; pressure, 150lb. Capacity of tanks, 1,250 gallons.—B.



[56355.]—**Legal.**—No. The "references were the property of the person to whom they are sent."— LIMB O' TH' LAW.

[56383.]—**The New Station at Birmingham.** —I cannot give you the information, as there are about six platforms whose combined length, that is, if each were placed end to end, would exceed a mile and a quarter. I wish to correct an error which occurred in my previous answer (page 177). I there said "there are seven through lines," which should have been "there are eleven through lines." —H. W. HUDSON.

[56427.]—**Gramme Armature.**—Would Mr. Bottone kindly add to the value of his sketch of small Gramme armature by giving us a sketch of F.M.'s best adapted to that shown in his drawing, with size and mode of winding, &c. Our warmest thanks are due to him for his lucid little sketch.— VIGILIA.

[56468.]—**Turning Cranks.**—"Young Smith" asks: "What kind of lathe is used for turning inide of crank up?"—the shafts being made of 1$\frac{1}{4}$in. round iron, 6in. throw, and 3ft 6in. long. Your correspondent says, rather confidently, that the method described in reply No. 56127 is not practicable in this case, as, owing to their length and small diameter, they would require some support in the middle. If "Young Smith" expects a job of this kind to be done without some amount of trouble, I fear he is greatly mistaken. There *are* machines for turning crank pins. In these machines the work is stationary, the *tool* being made to travel round the work. They are used only for turning the pins of large and, consequently, very heavy cranks, which, if turned in the lathe, would require an enormous weight on the chuck to counterbalance the weight of the shaft and quadrants. For reasons which I need not discuss, I do not think these machines could be adapted to turn such small cranks as those above referred to. There is no doubt that some contrivance to prevent the work springing away from the tool would be of immense service in turning cranks of small diameter. Perhaps the only appliance that could be used for this purpose would be something in the form of an eccentric and strap, which might be constructed in the manner indicated by the following figures:—Fig. 1 is a side view of a cast-iron sheave, and Fig. 2 an edge view of the same. The large slot Fig. 1 is for the reception of the block, Figs. 3 and 4. The two small slots, Figs. 1 and 2, are for the purpose of inserting bolts to secure the block to the sheave, after adjusting the block to the requisite degree of eccentricity in the sheave. The block is not unlike a gland. The principal difference is that it has two flats planed on it to fit the slot in the sheave, or it may be made square. It is bored to fit the shaft to be turned, and to which it may be secured by a key. The holes in the lugs of the block correspond, in distance apart, to the small slots in the sheave. The Figs. are not drawn to scale. The sheave may be run in a wood carrier, or in a brass or iron strap secured to the lathe frame. It will be seen that this contrivance can be used for cranks of different throw, and also by having blocks to suit, of different diameters. If intended to run in wood, it would be better not to continue the large slot right to the periphery of the sheave.—AN ENGLISH MECHANIC, Newcastle-on-Tyne.

FIG 1

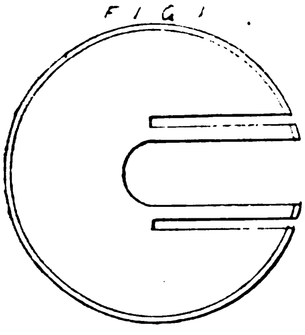


FIG 2

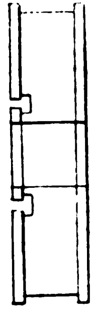


FIG 3.

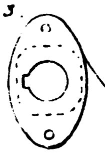
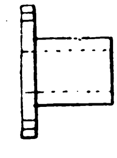


FIG 4



[56479.]—**Surface Condenser.**—Seeing that "C. E., jun.," in his reply to this question last week, has made one or two good-natured errors, I have worked out the subject from details to hand of one out of several well-proportioned compound marine engines with which I have had to deal, and with the Editor's permission I submit the following:—In the reckoning, after stating the total I.H.P. of the engines is 350, and in this case = 2·8 times the nominal power, we need deal only with the low-pressure cylinder: diameter = 55½in., stroke 32in., revols. per min. 65. The indicator diagram shows that at each revolution of the engines the low-pressure cylinder twice discharges its contents at an absolute pressure of 10lb. into the condenser; thus the condenser receives 5,785 cubic feet of steam per minute, equal to 153lb. weight, each unit having a total temperature of 1,172° F. The condensing water at 52° F., after circulating about the tubes, is discharged at 94° F., whilst the condensed steam, as feed water, is drawn off from the condenser at 130° F. Now, each unit of steam has to give up 1,172 – 130 = 1,042° F., and the available cold to do it with is 94 – 52 = 42° F. Then $\frac{1042 \times 153}{42}$ = 3,779lb. of condensing water required per minute, or 24·7lb. of water per minute to condense 1lb. of steam, having a temperature due to 10lb. absolute pressure per square inch. This gives some idea of the large quantity of condensing water required for a surface condenser, even when the steam is used very expansively in the cylinder. The modern practice is two to three square feet of tube surface per I.H.P., and never less than two square feet. In this condenser there was about 900 square feet, or 2·57 square feet of tube surface per I.H.P. I do not think there is any off-hand rule for finding the quantity of water required; but "Subscriber" will find no difficulty after fixing on the respective temperatures of the waters and steam to be condensed.—YAMA.

[56484.]—**Varnished Wallpaper.**—"C.D.R." is to be congratulated on his discovery of the detergent properties of soap-and-water; but it is regretable that he does not suggest the attainment of much honour as a critic. To endeavour to clean dirty, smoky wallpaper with a rag and paraffin oil is, it appears, "simply nonsense," and "Nun. Dor." is told (very properly, too) that he "should read queries before he attempts to reply." Now, I confess that when I read "Virago's" query, I thought that she had of course tried soap-and-water, probably also solution of soda or weak liquor of ammonia, and wanted something to remove greasy or sooty marks, stains left by flies, &c., and remembering how successful I was when trying paraffin oil and a rag, with, if I recollect, a little elbow grease, I just dotted down the reply which has produced a thoroughly courageous critic, who winds up with what I suppose is intended for a climax—"you might as well clean dirty windows with paraffin oil as dirty wallpaper." Well, if the windows are much begrimed with soot and grease, it is wonderful how very effective is a rag just moistened with paraffin oil. For cleaning paint or varnish I prefer to avoid soda or potash—even soap-and-water,—and if weak ammonia solution (I use the carbonate) does not remove the "dirt," a rub with a rag moistened with paraffin oil rarely fails.—NUN. DOR.

[56485.]—**Model Boat.**—To "VIRAGO."—I am glad my reply met the exigencies of your requirement. I do not at the moment recollect anything I can add to the information briefly given. But you will know where to apply if you want any further point elucidated.—INVICTA.

[56502.]—**Faulty Dynamo.**—To MR. BOTTONE.—The formula given for finding the proper resistance of the shunt-wound dynamo, if written in full, would stand: "The resistance of the field magnets' coils must be equal to the square of the resistance of the external circuit, divided by the resistance of the armature." That is S. P. Thompson's rule.—S. BOTTONE.

[56509.]—**Cheap Gas.**—To "INVICTA."—I much regret that the announcement named did not meet my eye, and hence the reason why I did not at once communicate. I therefore beg to publicly tender him my regrets for the oversight, and should any other brother reader be suffering from a similar neglect on my part, I would desire to tender him my sincere apologies in advance, and to assure both our friend Mr. Barry and any other gentleman that the oversight was entirely unintentional on my part. I also regret that, through absence from home, I did not see my copy of the "E. M." for the 8th until the date of the succeeding issue, and hence a further delay in dealing with the matter, which might otherwise appear as evidence of still further inattention on my part.—INVICTA.

[56519.]—**Chemical.**—When soap is placed in water it has an alkali thrown out, and an acid left free to combine with the fatty matter, &c., on the body or object being washed, and forms a soluble compound. When, however, the water is hard—that is, contains salts of calcium and magnesium—the metal combines with the fatty acid and forms an insoluble compound, producing what is known as curdling.—FABER FABRUM ADJUVET.

[56527.]—**Engine.**—To "INVICTA" OR "GLATTON."—I would with the greatest pleasure possible give you all the information you may need; but your dimensions are given in such a way that I think it best to ask you to put them in such a form that no mistake may creep in. I shall want to know (1) length and width of steam ports, (2) width of the bars between, (3) length and width of exhaust port. I assume that the steam port and bars are $\frac{3}{32}$in. wide respectively. Is this so? because, as will be seen, the dimensions may read otherwise. Now, as to some of the points you name, I may say that the engine in question would be rated by me as ¾ h.p. for each cylinder. With the speed and pressure you mention, it would indicate possibly 2 h.p. With only 60lb. steam you would need a screw of fine pitch to get 140 revolutions per minute. For such a pair of engines I should use a three-blade fan, 15in. diameter and 12in. pitch, width of blades would depend on many points; but if on a Griffiths model, I should make the middle of the blades 3in. wide. Then as to the boiler, that may be of the form illustrated at page 326 of last Vol.: Length, 3ft. 6in.; diameter of shell, 2ft. 6in.; furnace tube, 1ft. 3in. diameter and 3ft. 6in. long; return tubes thirty in number, 1½in. diameter and same length. A furnace tube, viz., 3ft. 6in. Such tubes will be sufficiently large in the bore to draw freely enough for the length, and will, with the fire-grate, which should be 1ft. 3in. long, give you ample steaming power; such a boiler for its size will give an exceedingly good account of a pair of engines run at the speed you name, always assuming the exhaust be sent into the funnel. Now had you consulted the contributors to the "E. M." earlier, I would have advised you on a different line altogether as far as your engine goes; and I would mention that my ideas of what a compact and really serviceable screw-launch should be may be seen at the Inventions Exhibition at South Kensington. I have above referred to the exhaust as being sent into the funnel to sharpen the draught. This is a necessary evil with the engines you have. The continued sharp "puff-puff" of the exhaust is to me always a sound that is unpleasant, and hence I always recommend a far superior system where the natural draught is sufficient and the noisy "puff" is abolished; therefore we get two advantages at once with extra power as well. If any of our mechanical friends are contemplating building the machinery for a steam launch I would recommend them earnestly to lay the matter before the contributors to this journal, and the appeal, I know, will not be in vain, and some ideas would be imparted which will be of value.—INVICTA.

[56533.]—**Pocket Telescope.**—You can increase the power, but at the expense of the light, which you say is at present not excessive. You cannot improve the definition, as that is a function of the o.g. Neither can you increase the magnifying power except at the expense of a loss of light. I may for myself say I do not know of any cheap expedient to effect your wishes other than the purchase of a larger o.g.—INVICTA.

[56539.]—**Electric Lighting.**—I was hoping that some abler correspondent would have replied in last week's "E. M." to your queries of a fortnight ago. No reply having appeared, I shall try in a humble way to give some of the desired information. 1. You say that in the sunk flat of your warehouse are large piles of paper which will interfere with the proper diffusion of the light. This settles the question as to the system of electric lighting. Incandescent lamps would be of greater advantage than arc lamps, for this reason, that you will obtain a better distribution of the light, by being able to place a lamp wherever it is wanted, instead of having an intense light at a given point, gradually fading into darkness. 2. Assuming the standard burner to yield an illumination equal to 16 candles, your 12 gas jets will give a light of 192 candles. To come to plainer figures, your warehouse would require a light of 200 candle-power, and to produce this 10 lamps of 20 candle-power each would be required. 3. On the incandescent system one horse-power is necessary to yield 200 c.p. effectively. 4. The cost of a 200 c.p. dynamo and wires may be put down roughly at £30. The lamps would cost about 5s. each, and as their usual life is not much more than 1,000 hours, the cost of 10 would be 3d. per hour. Taking the cost of dynamo as stated, let us allow 4d. per hour for interest and repairs both on the dynamo and the gas-engine, and 2d. per hour for oil, sundries, and attendance; the total cost would stand, roughly, thus:—

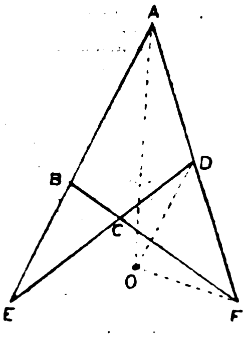
| | | |
|---|---|---|
| Gas for motive power...... | 4d. | per hour |
| Lamps .................... | 3d. | ,, ,, |
| Interest and repairs ...... | 4d. | ,, ,, |
| Sundries and attendance .. | 2d. | ,, ,, |
| 200 c.p. total cost .... | 13d. | ,, ,, |

An arc light of the same power, though very much cheaper, might not be so effective; but an efficient and economical light might be got by adopting a combination of the two systems. The most suitable arrangement, however, would depend on the nature of the operations carried on.—BOBADIL.

[56546.]—**Magnetic Moment.**—The answer to this question should be 30, and not 300, as given. Magnetic moment is the length of the magnet multiplied by the strength of its poles; and as the magnet was 10 c.m. long and 3 units in strength, the product is 30. The intensity of the field does not enter into the question of magnetic moment.—WM. JOHN GREY, F.C.S., Analytical Chemist, Newcastle-upon-Tyne.

[56547.]—**Geometrical.**—"J. C." has now two views of Todhunter's "Exercise" before him. From whichever point it be looked at, it will be seen that the exercise is little less than a cram. "J. C." may fairly object to L. Edmond's statement, since the least number of lines required to form the four triangles (exclusive of overlapping ones) amount to nine. For my part, I do not think Todhunter had Miquel's theorem in view at all when he wrote exercise 570; but be that as it may, if "J. C." turns to p. 80, "The Common Sense of the Exact Sciences," by Prof. Clifford (International Scientific Series), he may be enabled to form his own opinion on the matter.—EX-BLACKSMITH, Gorton Brook.

[56547.] — **Geometrical.** — Todhunter is quite right. Four straight lines in a plane form what is called a "Complete Quadrilateral," in which there are four triangles. Thus, in the figure, A E D, A F B, E B C, F C D are the four triangles. The proof is immediate. Let O be the other common point of the circles round A E D and A F B; then since the points O F A B are concyclic, the angle O F B = the angle O A B. Again, because the

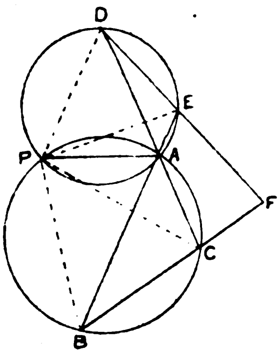


points O E A D are concyclic, the angle O A B = the angle O D C.

∴ the angle O F B = the angle O D C;
∴ the points O F D C are concyclic.

Or O is on the circle round F C D; similarly it is on the circle round E B C.—Hemisus.

[56547.]—**Geometrical.**—I cannot understand "J. C.'s" difficulty. There appears to be no mistake. Let AB, BC, CD, DE be the four straight lines, forming the four triangles ABC, ADE, BEF, DCF. Let the circles circumscribing ABC, DAE, intersect in P; join PD, PE, PA, PB. Then ∠ APD = suppt. of ∠ AED = ∠ AEF; also ∠ APC = ∠ ABF



∴ ∠ DPC = ∠ BEF + ∠ EBF = suppt. of DFC ∴ the circle circumscribing △ DFC passed through P. Also ∠ APB = ∠ ACF and ∠ APE = ∠ ADF ∴ ∠ EPB = ACF + ∠ CDF = suppt. of ∠ EFB. ∴ the circle circumscribing △ EBF passes through P. Hence the four circumscribing circles passes through one point. *Q.E.D.*—T. H. L.

[56547.]—**Geometry.**—If "J. C." will refer to the 5th prop. of Euclid, he will find his difficulty explained by the fig. of the Pons Asinorum. Leaving out the base B C in the figure, we have the four lines A F, A G, B C, C F, the two last intersecting in a point H, say. Then the four triangles are A B G, A C F, B H F, C H G. Circles circumscribing these triangles all pass through one point, as "J. C." will find if he is clever at describing intersecting circles with accuracy.—L. S.

[56547.]—**Geometrical** — Many thanks to L. Edmunds and "Ex-Blacksmith" for their endeavours to help me; but I must point out that L. Edmunds's triangles require 12 straight lines of 4 lengths for their formation; or, if some of the sides are made to do double duty, 9, or at least 8. If the lines were all equal, according to L. Edmunds, we could make 4 triangles with only one straight line. I also will point out to "Ex-Blacksmith" that in the question Todhunter does not state that the plane is 4 sides, or, indeed, that it is bounded in any way whatever, and that anyhow the triangles would not be formed by the 4 straight lines, but by them together with the supposed sides of the plane; thus, in all, making really 8 straight lines. I am afraid I have, at last, caught Todhunter tripping.—J. C.

[56547.]—**Geometrical.**—"J. C." will probably be surprised at the replies of Mr. L. Edmunds and "Ex-Blacksmith" to his query. The former coolly uses twelve lines, and because they happen to be equal in threes, thinks he has overcome the difficulty. The latter uses only eight lines, but he ascribes to Todhunter the absurdity of giving for an exercise a most watery repetition of a plain proposition. "J. C." will find a proposition more suitable to his taste in the following. Let *a b* and *a c* be two straight lines, meeting in the point *a*. In them take points *d* and *e* respectively. Join *b e* and *d c*, and let these lines cut in *f*. Prove that the circles circumscribing the triangles *a d c*, *a b e*, *d b f*, and *e f c*—all pass through a common point.—J. L. Dwyer.

[56553.]—**Gasoline for Gas-Engine.**—I will give you with pleasure the sizes you ask. Supposing the engine to be non-compressing, I should advise a 9in. cylinder and 14in. stroke. The tube you name would not, in my opinion, be suitable. I should require tube at least ½in. thick when bored, so that the tube you name would be too thin. Again, metal tube would be not anything so suitable as cast iron for such a job; and I think that, looking at the question all round, there would be so many difficulties with a built-up cylinder, that the first cost of a pattern and a cast-iron cylinder would be much the cheapest in the end. All engines on the lines of the Bischopp absolutely require a cast-iron cylinder, as no lubricant is used, and the high temperature of the exploding gases render a metal cylinder impracticable; otherwise it would be far easier to make it in metal rather than cast iron, if it were possible, which it is not. I am always happy to help you at any time.—Invicta.

[56557.]—**Coefficient of Centrifugal Force.**—I have not got the book that Mr. Wm. John Grey refers to, but I presume he requires to know from whence the coefficient ·000341 is derived. Now, if we examine the formula for centrifugal force, viz., $C = \frac{W v^2}{g R}$, we see that for revolving bodies connected with engine work, such as governor balls, flywheels, &c., where the revolutions per minute are known, we should first have to find the velocity in feet per second before we could apply the above formula, thus entailing two calculations instead of one. Let us work out the formula, and bring in revolutions per minute instead of velocity in feet per second.

$$\text{Centrifugal force} = \frac{W v^2}{g R} \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

$$\text{Now, } v = \frac{2 \times 3{\cdot}1416 \times R \times N}{60}, \text{ therefore,}$$

$$v^2 = \frac{4 \times 9{\cdot}87 \times R^2 N \times {}^2}{3{,}600} \ldots\ldots\ldots\ldots \quad (2)$$

Substituting (2) for $v^2$ in (1), and working out, we get—

$$\text{Centrifugal force} = \frac{W \times N^2 \times R \times 39{\cdot}4784}{115{,}920}$$

$$= \frac{39{\cdot}4784}{115{,}920} \cdot W N^2 R = {\cdot}00034\, W N^2 R;$$

*i.e.*, the multiplier ·00034 is a constant co-efficient of centrifugal force.—George H. Strong.

[56561.]—**Electric Pen Battery.**—The fault is not originated by the form of battery, but is consequent on the texture of the porous pots or plates. At one time I had several of these in daily use, and I had to find out many wrinkles about them. After thinking the matter over, I laid my ideas before a professional electric-pen printer with whom I was intimately acquainted. His views, founded on a far more extensive use than my own, entirely justified my theory. And this was, that pots too soft or too porous caused the battery to quickly become exhausted; pots too hard, on the other hand, were the cause of a weak current; whilst with pots of a suitable hardness the battery would run for months without more attention than the withdrawal of exhausted solution. If the bichromate fluid turned a purple colour we considered it exhausted, whilst at short intervals we withdrew from the porous pot a small quantity of the solution, displacing it with pure water, thus keeping the sulphate of zinc from reaching too high a density. No doubt your troubles are traceable to the causes I have briefly shadowed forth. At any rate, I do not think you will beat the Fuller cell.—Invicta.

[56563.]—**Medical Coil.**—The terms "positive" and "negative," as applied to currents, are often confusing. They have certainly confused Mr. "Bobadil." Pray do not attempt to reply to queries again before laying well to heart the advice given by Montaigne, which appears every week under "Letters to the Editor." Wherever did you obtain the information you give us?—"Positive electricity is that which leaves the battery by the wire connected with the carbon plate, and negative current that which leaves by the wire connected with the zinc." Dear me! Extraordinary! What do the "positive and negative currents" do when they meet? Pray explain this new theory of yours. How many electricities are there? You already speak of four. Try and discover a few more by next week. It is perfectly astounding that in these days of information anyone who presumes to enlighten others should have written such a farrago of nonsensical rubbish.—C. D. R.

[56566.]—**Iron Moulding.**—Green-sand moulding is the ordinary or plain way of moulding pipes, pillars, girders, plates, wheels, and all cheap castings, as they could not pretend to make the castings named in dry sand for the price usually paid. We generally make such as cylinders, marine pumps, calender bowls, mill rolls, and all castings that want to stand a great strain, or have to be bored and turned; also, we usually cast dry sand on the end, as they are both stronger and cleaner, as the dirt rises to the top. Then we have loam mouldings; this we usually do what we cannot do in sand. For instance, I want to make a pan for a chemical works. I have two boards, but no pattern at all. It is worked from a spindle, and built like a house is built, only with loam instead of mortar. I sometimes think of writing a letter or two on Moulding. For green sand, get fine-ground, soft, yellow stone or scraping of macadamised road and coaldust, horsedung, and part old black sand, grind together and riddle for facing pattern. Dry sand is horsedung and red rock and two spadefuls of coaldust to a barrowful of sand. Loam is red rock, and two spadefuls of clay, and a bucketful of thin clay-water ground up.—Sand Rat.

[56567.]—**Wooden Sink for Dark Room.**—First, get the wood thoroughly dry and free from dirt or grease, and then run over its surface the following mixture:—Heat together in an iron vessel a quantity of brown resin, with a quarter of its weight of beeswax. The ingredients should be constantly stirred, and when thoroughly melted and incorporated, may be applied. It will stand the action of water and most chemicals, but might succumb to the action of turpentine or alcohol left on it.—Faber Fabrum Adjuvet.

[56572.]—**Lathe Mandrels.**—To "A. L."—In view of the able and lengthy discussion of late on the subject of lathe anatomy, I should not have ventured my opiniens had my name not have been mentioned. From my own actual experience of lathes, both of English as well as foreign make, I have had all sorts of mandrels in work. As you ask my opinion on the question of cones, I will give it. And it is this: Cones to be of practical use on an everyday lathe should be fitted so that the maximum of bearing surface be obtained, and beyond this each cone should be so arranged that the wear can be taken up independently. Now the old-fashioned plan of a taper cone, the taper running in the direction of the tail-pin, with a second cone reversed in the back bearing, best fulfils the first requirement—viz., that of ample bearing surface. Now I have had also good practical mandrels with reversed cones, having the taper running exactly reversed, that is to say, the front bearing, or the one next the face-plate, tapering down to, instead of from, the mandrel screw. The mandrel, as you mention, having a second reversed taper formed on it out of its own thickness, and the bearing or bush being made adjustable to move towards the face-place to take up the wear of the second cone, a tail pin in either case taking the end thrust. With a fairly long mandrel, this last form ran well enough; but the limit is soon reached of the taper and length of bearing it is possible to give, and this therefore introduces an element adverse to the plan beyond certain limits. Now, taking your case, I should not hesitate an instant to use an unhardened steel mandrel. In fact it would be the correct thing. Phosphor bronze bearings would, however, need being not too hard. The front bearing I should like a little longer, but the other one is right enough for a lathe the size you name. If you have both cones running the same way, and also towards the tail-pin, you would of course have a collar set up by lock-nuts, or an equivalent to prevent end shake from the tail-pin. This is, of course, a necessity in the plan you suggest. Happy to help you further, if desired.—Invicta.

[56576.]—**Insulators.**—The simplest cement is plaster of Paris; but it is not the best, owing to its property of expanding on setting. A good cement is made of plaster of Paris, Portland cement, and sand. The cement known as Muirhead's is composed of Portland cement and rough sand, of each three parts; smith's ashes and brown resin, of each four parts. Another cement consists of resin and smith's ashes, equal parts of each.—Faber Fabrum Adjuvet.

[56577.]—**Soap.**—So far as I have been able to ascertain, cotton-seed oil is not used in soap-making. It might possibly be used in conjunction with other fatty matter, and with the addition of resin.—Faber Fabrum Adjuvet.

[56578.]—**Electric Bells.**—This, as proposed, would be a rather expensive circuit. For the relays I do not think "Electra" could do better than get one of those sold by advertisers in this journal at about 6s. 6d., as a pattern to work by. The resistance of these relays runs, I believe, to about 40 or 50 ohms. Using the size and length of wire he mentions for the "line," the resistance would be 200 ohms; this, with six relays, would bring the total resistance up to 500 ohms. Less than ten Leclanché cells would not work efficiently through this. The circuit would, I presume, be joined up as for single current Morse with relays, but having the bells substituted for the Morse-inker. No. 28 s.c. wire will do very well for winding the bells. Two or three of the cells could also be utilised for the local (bell) circuit. Query.—Are the bells very large and wanted to give large signals? How would a "closed circuit" without the relays suit? If the querist requires a diagram of the connections he can have it with pleasure.—H. S. Beach.

[56580.]—**Tricycle Pedals.**—Why not put in ordinary iron washers? You do not want the pedals to give with a side motion, and therefore springs are of no use to you. Put in the iron washers until you get a good fit, and renew them when worn. I suppose you lubricate the wearing parts.—C. D. R.

[56580.]—**Tricycle Pedals.**—As an old rider on the three-wheeler, I know exactly what is the trouble. The best way to cure it is to take off the offending pedals, and either braze or solder on the outer end of each a piece of wrought iron or brass, the former preferred. Then carefully fit the pedal to the turned part of the shaft, and all end-shake will disappear. The shoulders of the round part should be, and nearly always are, rounded out. This will make it, of course, necessary to file out the ends of the existing pedals, and the new collar brazed on to fit it nicely. Do you know how to do this and make a good fit?—Invicta.

[56585.]—**Boring for Water.**—Say £1 to £3 per foot for sinking. As to mechanism, had better inquire of Appleby, Tylor, Warner, or Jennings, all of London. There is some variation in prices. See Laxton, &c.—Bream's Buildings.

[56586.]—**Brick-Setting.**—The difference per rod (equal to, say, 4,352 stocks) is £3—say £14 in mortar, and £17 in cement. In place bricks say £2 cheaper. In Kentish gault, or blue Staffordshire, dearer. See Spon, Laxton.—Bream's Buildings.

[56586.]—**Brick-Setting.**—The difference in cost is usually charged at so much per rod. The following will answer what "Ignorant" wants:—Obtain cost of cement per bus., sand per yard, and lime per yard (note that hydraulic lime costs more than the common limes), as as 1 rod of brickwork requires 3 yards sand to 1 yard lime, or 36 bus. cement to 36 bus. sharp sand (if in cement), obtain the difference, and ⅗ will, for all practical purposes, give the difference in cost per bricks laid.—Another Student.

[56589.]—**Cost of Cottage.**—Prices vary according to circumstances; but "O." should not pay more than 2½d. to 3d. per cubic foot for his cottage—*i.e.*, as it will contain roughly 10,000 cubic feet, he should get it thoroughly well built for from £100 to £125.—Another Student.

[56590.]—**Soap for Hard Water.**—There is a soap made for salt-water travellers that might answer for toilet purposes, and Hudson's preparation for households. Inquire of Mr. J. R. Greaves, 60, New Oxford-street, London, W.C. He, from his long experience in the trade, may be best able to offer valuable suggestions.—Bream's Buildings.

[56590.]—**Soap for Hard Water.**—"M. C. H." should soften his water by Clarke's process, thus:—Take one or two pounds of well and freshly-burnt lime, and add to it as much water as it will absorb. This will slake the lime in such a manner that it falls down to a moist powder. Add as much of this powder as will lie on a florin to two gallons of the water; stir, and allow the sediment to settle. By performing the operation in the wash-jug at bed time, the water is clear and ready for use in the morning. If the water does not seem to be sufficiently softened, vary the quantity of lime, until you find the proper proportion, as this varies with the hardness of the water. Too much lime is to be avoided. The lime should be kept in an air-tight tin. Water thus softened is also quite suitable for drinking purposes. Water may also be softened by adding to it liquor ammoniæ, avoiding excess of the reagent. The softened water should not have more than a faint ammeniacal smell.—Chromio.

[56592.]—**Electro-Motor.**—A very good plan for "M." to adopt will be the cross of iron, and then he must have four connections on the spindle so placed that contact is made just when a piece of iron is coming to the pole of mag., and as soon as it reaches it the contact must be broken. It may be done by cutting a piece of brass tube, so that there are four pieces of brass and four hollows (do not cut all the tube), and a little inspection will show how it is to be placed.—F. W. A. Taylor.

[56592.]—**Electro Motor.**—Why not construct a motor such as described in "Ours" on several occasions. What you have is simply a toy. Contact should be made so that it is broken as the armature passes over the poles, and not as you appear to have it. On the other hand, if contact is made when the armature is midway between the poles, each pole will have the same influence upon it in both directions, and it will again become stationary. You must therefore arrange the contact midway between the two points. The same remarks apply whether there be one or a dozen armatures.—C. D. R.

[56593.]—**Roofing Rafters.**—Find how many squares of 100ft. super. each. Multiply length by slant, and the product by two, if both sides of roof are alike; if not, make a separate calculation of each by multiplying the length by slant height, and add the results. It takes 1,200 per M. of Countess 20in. x 10in., to cover 72 square yards; weight about 2 tons. See Spon, Rouse, Laxton.—Bream's Buildings.

[56596.]—**Leaky Dark Slide.**—It depends a deal upon where the leakage occurs. If in the wood (not at the hinges), a piece of thick cloth glued over it on the inside answers well. Cloth will do at the hinges also, if you glue it on so as not to impede their motion. I have mended several dark slides this way.—R. A. R. Bennett.

[56597.]—**New Midland Engines.**—The *Engineer* for Feb. 6th has a double-page engraving of the above engines, with dimensions. Sections are given on page 164, Feb. 27. A working drawing with the No. for May 8th.—E. L. P.

[56597.]—**New Midland Engines.**—In reply to "Iron Horse," he will find in the *Engineer* for Feb. 6th, 1885, a two-page outside view of one of the 1675 class Midland engines; two transverse sections appear in the number for Feb. 27th, and a tracing-paper supplement, containing a longitudinal section and sectional plan is issued with the No. for May 8th, 1885; but this latter is not particularly clear or plain.—W. H. Thurlow.

[56597 & 56598.]—**New Midland and M.S. and L. Engines.**—The M.R. 1675 class and M.S. and L. 500 class were illustrated in *The Engineer* of Feb. 6 and Jan. 2, respectively. The M.S. and L. Co. have 12 engines of the type mentioned—viz., No. 399 (1882) and Nos. 500—510 (1883). Dimensions will be found as above.—R. N. H.

[56598.]—**M.S. and L. Single Engines.**—The principal dimensions of these engines are as follows:—Boiler (Yorkshire iron): Diameter outside, 3ft. 11in.; length of barrel, 11ft. 6in.; thickness of plates, ½in. Firebox shell: length, 5ft. 6in.; width between frames, 4ft. 0½in.; height (front), 6ft. 7⅝in.; height (back), 7ft. 1⅝in. Inside firebox (copper): length inside, 4ft. 10⅞in.; width, 3ft. 5½in.; height (front), 4ft. 11¼in.; height (back), 5ft. 5½in. Tubes: number, 195; diameter, 1⅞in.; length over tube plates, 12ft.; water spaces, ¾in. Heating surface: firebox, 87 sq. ft.; tubes, 1,057 sq. ft.—total, 1,144 sq. ft. Grate area, 17 sq. ft. Cylinders: 17½in. diameter, 26in. stroke; steam ports, 14½in. by 1⅝in.; exhaust port, 14½in. by 3¼in.; centres of cylinders apart, 6ft.; inclination, 1 in 12. Eccentrics: throw, 3⅛in.; diameter, 16in. Connecting-rod centres, 5ft. 7⅝in. Wheels: Diameter of leading and trailing wheels (on tread), 3ft. 8in.; diameter of driving wheels, 7ft. 6in. Wheel base: Leading to driving wheel centres, 7ft. 9in.; driving to trailing wheel centres, 8ft.—total wheel base, 15ft. 9in. Weights: On leading wheels, 11tons 3cwt.; on driving wheels, 17tons 11cwt.; on trailing wheels, 11tons 18cwt.—total, 40tons 12cwt. The leading and trailing axle journals are double-coned, those of driving axle straight. I think the number of engines of the 507 class is 15, but am not quite sure as to this. I hope the above information will give what "Iron Horse" requires.—W. H. Thurlow.

[56601.]—**Building Construction.**—There will not be an examination held under the Science and Art Department until next spring. I advise "A Student" to join a class if possible.—Wm. John Grey, Analytical Chemist, Newcastle-upon-Tyne.

[56601.]—**Building Construction.**—"Student" should, if he has not done so, obtain Rivington's "B.C.," Part 1, and the series of plates published by Spon on this subject (by W. Busbridge, at 7s. 6d. for the 30 bound in one vol.), will assist him considerably; but speaking as one who has passed the exam., "Student" should join one of the classes that are instituted in the winter months; it will enlarge his ideas instead of keeping them in a narrow groove, as it will inevitably do if he studies at home. Of course, it can be done privately, but I would strongly advise "Student" to adopt the course suggested.—Another Student.

[56604.]—**Differential Equation.**—There seems to be a misprint in this query. I presume the equation is meant for $\frac{d^2y}{dx^2} - a\frac{dy}{dx} = 0$. If so, the solution would be $y = c_1 e^{ax} + c_2$. Where $c_1$ and $c_2$ are arbitrary constants, and $e$ is the base of the Napierian logarithms. This may be proved by differentiating the last equation, thus—$\frac{dy}{dx} = c_1 a e^{ax}$. Again differentiating, we get $\frac{d^2y}{dx^2} = c_1 a^2 e^{ax}$, and from these two we get the original equation. "Boole's Differential Equations," edited by Todhunter, is a good book to read (Macmillan and Co.).—M.I.C.E., Bath.

[56607.]—**Lighting with Battery.**—You can light a small 2½ candle-power lamp (Swan or Darton's) with your battery for about three hours at a stretch, if you charge the battery with dilute sulphuric acid (one acid to eight water) in the zinc partition, and a saturated solution of bichromate of potash, to which quarter the bulk of strong sulphuric acid has been added in the carbon partition. Or you may use, instead of this latter mixture, what is known as "crystals for bichromate battery." See also reply 56379.—S. Bottone.

[56610.]—**Alloy for Watch Bearings.**—If "Murano" will look in the *Mechanics' Magazine* for Dec. 4, 1830, he will find a reply to the article he mentions, from the pen of no less a personage than Thomas Earnshaw, which will explain why Mr. Bennet's (not Sir John, I think) alloy never came into use. Mr. Earnshaw says he believes the compound may be good and as proper in all cases as brass; but his object is to guard the public against the belief that any other or a better metal than good brass is at all requisite. No doubt the alloy is a useful one, and easily made with all proportions of either silver, gold, or copper, or all three. Palladium, or an alloy of palladium, is used, or said to be used, for the large graduated circles at many observatories, and very likely for scales on philosophical instruments.—Nun. Dor.

[56614.]—**Trespass.**—If your correspondent "Ento," takes his botanical walks upon other people's property without their consent, he is undoubtedly trespassing, no matter what his object may be. It is always safest and easier to get permission. If, however, this is not first obtained, the proper thing to do, on being charged with trespass, is to admit the trespass, tender 1s. for any damage you may have done, and ask the nearest way off the premises. This is the *legal* thing to do, and may save any amount of trouble, as I have proved. The 1s. is rarely, if ever, taken, and you take the wind out of the owner's sails, if he determines to bring the matter before a magistrate, as you have already offered him compensation for any nominal damage done to his property.—Marcus.

[56614.]—**Trespass.**—How can such a question be asked? Had not the inquirer better have added, in the pursuit of pheasants, diamonds, precious stones, &c., &c.? How is it possible that the object which a man has in view can justify a trespass on another man's land? If such a trespass can be made on land, why not in a house? Say Lord A. has a fine collection of—well anything. Does "Ento" believe that because B. simply wants to look at the collection in the pursuit of knowledge, that he can enter Lord A.'s house and private apartments? If he tried it at my house, he would be turned into the street; and if I had land, and he trespassed with a similar idea, I should treat him as a trespasser.—R. S. T.

[56615.]—**Air Pressure at High Temperatures.**—Keeping the pressure on a given weight of air constant, its volume varies directly as the absolute temperature; and hence, if its volume be kept constant, the pressure will vary in the same way. Thus, a cubic foot of air at zero Centigrade under 15lb. pressure, would exert a pressure of 30lb. if heated to 273° Centigrade. A small correction would have to be made for expansion of the containing vessel if *very* great accuracy was needed.—Wm. John Grey, F.C.S., Analytical Chemist, Newcastle-upon-Tyne.

[56616.]—**Greek.**—"L. C." should pronounce all the vowels separately in the first syllables of the Ionic Greek words he mentions; but the upsilon is very slightly sounded. He propably knows that epsilon is pronounced like *a* in baker, and upsilon like *u* in lute.—G. J. W.

[56616.]—**Greek.**—"L. C." asks, how is ωυ to be pronounced in words which occur in Herodotus, &c. If this means, as I suppose it must, How did Herodotus himself pronounce it? it becomes a question of history, and one which it is extremely difficult to answer. We do not knew for certain what ought to be more easily ascertained than the pronunciation of Greek—namely, how Latin is to be pronounced. English scholars are by no means agreed upon this point; and, strange as it may seem, their pronunciation seems mainly to depend upon their religious views. Thus, for some three centuries the way in which the vowels *a*, *e*, *i*, &c., were pronounced by most Englishmen was with the same sound that they would have in English words. Catholics, on the other hand, give them the same sound that they have in Italian words. I was once told by a learned Protestant authority that the reason why Englishmen have diverged from the Italian and also from the usual Continental pronunciation, was the amiable peculiarity so commonly found in controversialists, whether religious or political, of doing everything as differently as they possibly can from what is done by those to whom they have an antipathy. Hence *i*, which formerly had the sound of *e* in the word *we* was made to sound as it does in *nice*. There are excellent scholars who follow each way, as also in the pronunciation of Greek vowels; but if we look to history to get an idea of how such as υ (upsilon) should be pronounced, the best thing to do will be to see what letter was substituted for it when such a word as πρεσβυτερος was Latinised; in early times, when both Greek and Latin were living languages. At school, we were taught that *υ* had always the sound that *eu* has in "deuce." Historically, however, it would seem to have the sound that *y* has in presbyter: as for the diphthong *ωυ* most likely its pronunciation depended upon its surroundings, as does that of *ou* in English. There are five different ways of pronouncing ough, and in Ireland there is yet a sixth, as in the name Colclough, pronounced Cokely.—W. G. P.

[56617.]—**Lighting with Battery.**—The best solution for your batteries consists of, for the porous-pot containing zinc, a semi-saturated solution of common salt in water, and for carbons a solution of bichromate of potash, with a little sulphuric acid added. A very good lamp will be one of the Edison-Swan lamps of about 5-candle-power. —F. W. A. Taylor.

[56618.]—**Salicylic Acid** requires about 1,800 parts of cold water to dissolve it; but in hot water it is much more soluble. It crystallises from its aqueous solution in needles, and from alcohol, by spontaneous evaporation in large monoclinic prisms. —Wm. John Grey, F.C.S., Analytical Chemist, Newcastle-upon-Tyne.

[56619.]—**Oxyhydrogen Blowpipe — Steel Furnace.**—For small lots of metal, say up to 28lb., I should myself unquestionably use the Fletcher injector furnace, as being the simplest and quickest means. The oxyhydrogen blowpipe is a costly and unsatisfactory mode of dealing with the question. Neither is it suitable for quantities. The cost of oxygen gas would be a very heavy item whilst coal-gas is cheap enough. I am quite sure an injector furnace is by far superior to the blowpipe, as with the latter a furnace would be requisite. And the most simple and suitable form is certainly that used by Mr. Fletcher.—Invicta.

[56620.]—**Steam-Carriage.**—Weight, heat, and smoke, &c., all against steam-engine for common roads. A better motor for such purpose any machinist, with an engineer, could make to work with gas, air, electricity, or even hydraulics, on proper agreement about weights, powers, and price. If near London, "S. R." better see steam-coach at South Kensington Museum; investing in mere scrap-heap building does not pay nowadays.—Drummond Collier.

[56620.] — **Steam - Carriage.**—Before you attempt to construct anything of the sort, ascertain if you will be allowed to use it. Steam carriages would have been an institution years back were it not for the restrictions placed upon them. If "Steam Roadster" is satisfied to use his machine before 6 a.m. and after 6 p.m., and at a rate not exceeding four miles per hour, he may possibly obtain permission to run it on a public highway. If not, he must be content with the means of locomotion he now possesses.—C. D. R.

[56620.]—**Steam - Carriage.**—The restrictions unfairly and unjustly laid on the use of steam on the common roads are so intolerable and vexatious, that I do not think it would be worth your while going into the matter. I will just mention one or two points that will show you the one-sidedness of the law on the subject. For instance, the speed must not exceed four miles an hour, and you must have also a man with a red flag to walk in advance. You must always and instantly stop if a carriage passes and the horse or horses choose to be frightened. Then, again, many of the local authorities in rural districts have a code of by-laws which provide that no steamer shall pass over their roads only during certain hours, usually from 6 or 8 in the evening to a similar hour in the morning; but even then with the farce of the man and red flag and the funeral pace. Beyond this, the subject is surrounded by endless difficulties—difficulties directly traceable to the influence and injustice of those who make our laws, and who make them for themselves and not for us. If any evidence were needed of the injustice and illegal tyranny of the Great Unpaid, let any doubter investigate the doings of some of the Cheshire magistracy, and the mode they adopt as against both bicyclists and tricyclists. That an efficient and satisfactory steam carriage can be produced is undoubted. Any assistance in that direction I would freely give the querist, supposing that he cares to undertake the matter in the face of the facts. Now, supposing I was about to construct such a motor, I should use either three or four wheels, with a vertical boiler, the frame of charcoal iron, and everything reduced to the simplest form possible. Gearing means noise and multiplication of parts. And as before advocated, I should go for direct action; a cylinder, therefore, of small bore and long stroke would be requisite. With coke firing no appreciable amount of smoke need show, whilst the exhaust steam might easily be got rid of without showing. Water and coke are easily carried out of sight, so that difficulties of construction and arrangement are not by any means insuperable. The idea of making it resemble an ordinary brougham is very good; but it means extra weight and resistance, which in time means more engine power. I will give the matter some further consideration, and will, failing anyone else dealing with the subject, fairly give you the result of my ideas.—Invicta.

[56622.]—**Lightning Conductors.**—Don't use insulators. Tape is best, then stout wire rope; tube is bad, except for upper terminals. Area protected is rather doubtful, probably a radius equal to the height; but see "Report of Lightning Rod Conference," published by Spon.—T.

[56622.]—**Lightning Conductors.**—A lightning conductor protects an area inclosed by a circle having a radius = to height × 2; and therefore a conductor 80ft. high would protect an area = to 80 × 2 × 3·1416 × 2ft.—F. W. A. Taylor.

[56622.]—**Lightning Conductors.**—The following precautions must be taken:—1. The top must be well pointed; in fact, it should have a fine sharp point; must be well elevated above any other part of the building. 2. Must have a continuous connection with the ground; should terminate in moist ground, or should have branches from base running into coke. 3. Must not touch pipes supplying the building. 4. Metal roofing should be attached to it. It is not necessary to insulate supports and holdfasts. The tape form is best; if of copper should be at least 0·15in. thick; iron should be at least six times as thick. A conductor 80ft. high will protect a circle of 80ft. radius round the base. The whole space protected is conical, having the circle of 80ft. radius as base.—J. Rance.

[56625.]—**Steam.**—In dealing with problems of this kind it is necessary to obtain an expression for the heat evolved, and another expression for the heat absorbed; by equating these two together the desired result is obtained. In the first case let $t$ = resulting temperature, then $540 + (100 - t)$ = heat evolved by 1lb. of steam at 100° in cooling down to $t$; and obviously the heat absorbed by the water is $11\,t$. Hence $640 - t = 11\,t$, or $12\,t = 640$, and $t = 53\frac{1}{3}°$ Centigrade. In the second case the heat evolved is $\frac{540 + (100 - t)}{3}$, and the heat absorbed is $12\,(t - 20)$; whence—

$$640 - t = 36\,t - 720$$
$$37\,t = 1360$$
$$t = 36\tfrac{28}{37}° \text{ Centigrade.}$$

—Wm. John Grey, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[56625.]—**Steam.**—The following is the formula for working problems like yours:—

$$(536 \times W) + [W \times (100 - t)] = W^1\,(t - T).$$

Where W = weight of steam, $W^1$ = weight of water, and $t$ = resulting temp., and T = temp. of water at commencement. Then the workings are—$(536 \times 1) + [1 \times (100 - t)] = 11 \times (t - o) = 536 + 100 - t = 11\,t$.

$$\therefore 12\,t = 636,\ \underline{t = 53° \text{ C.}}$$

And for No. 2—

$$(536 \times \tfrac{1}{3}) + [\tfrac{1}{3}\,(100 - t)] = 12\,t - 12 \times 20 = \frac{536}{3} + \frac{100}{3} - \frac{t}{3} = 12\,t - 240 = 536 + 100 - t = 36\,t - 720;\ 35\,t = 536 + 100 + 720 = 1356\,t = \frac{1356}{35} =$$

38·7° nearly C.—F. W. A. Taylor.

[56625.]—**Steam.**—The number of units of heat given out by 1lb. of water vapour in condensing to water at 0° C. was found by Regnault to be represented by the following formula $606{\cdot}5 + {\cdot}305 \times T$. T is the temperature of the steam C. If the steam is at atmospheric pressure, T will, of course, be 100, and the heat given out in condensing will be $606{\cdot}5 + {\cdot}305 \times 100 = 637$ units of heat (the heat required to raise 1lb. of water 1° C.). In the first problem the 637 units of heat given out by the pound of steam will be divided among the 12lb. of water resulting after its condensation, thus raising its temperature to $\frac{637}{12} = 53{\cdot}083°$ C. In the second case it is clear that a pound of steam condensing at 20° C. instead of at 0° C. will only give out $637 - 20 = 617$ units of heat, and ⅓lb. will therefore give out $\frac{617}{3} = 205{\cdot}66$ units, thus raising the temperature of the whole by $\frac{205{\cdot}66}{12{\cdot}33} = 16{\cdot}675°$. This added to the original temperature gives that of the mixture = 36·675°. If the steam is at a pressure greater or less than one atmosphere, the corresponding value for T must be taken from a table and used instead of 100. For instance, at a pressure of six atmospheres, corresponding to about 75lb. in a steam boiler, T will be 157·02. In the above calculation no allowance is made for variations in the specific heat of water, as it is too small to be of any practical importance. Its tendency is to slightly lower the temperature of the mixture.—G. Jackson.

[56624.]—**Newmarket Direct Railway.**—I walked over the disused portion of this line, about 9 miles, in 1878. It was opened about 1848. It was soon found that a line from Chesterford was a mistake, and, on the opening of the Cambridge extension, its little traffic all vanished. There are three or four rather stiff chalk cuttings, and a good deal of low embankment. Much of the line is planted with trees, which were not very young in 1873. Two of the old stations, of the smallest kind, then existed. One was called Balsham-road, about 3 miles from Six-mile Bottom; the other was 3½ miles further south, and within a few yards of the present Pampisford Station (formerly called Abington), of the G.E R. Haverhill line. Had the latter then existed, the two must have crossed at right angles on the level. For some distance south of this spot the old line has been completely ploughed away. Many of its occupation-bridges have gone. The works are for a double line; but probably it was only single, as east of Six-mile Bottom the line was single down to 1877, or so. I have heard that the Jocky Club subscribed very largely to the "Newmarket Direct."—W. B. P.

[56628.]—**Heliograph.**—If "Magister Artibus" will look at a glass window of a house on a sunshiny day, he will see the principle of the heliograph. The Crystal Palace can be distinguished miles off by the reflection of the sun on the roof. If a cloud obscures the sun, the effect is gone. The heliograph can only be used when the sun is shining. You can obtain the code of signals from the War Department.—C. D. R.

[56628.]—**Heliograph.**—The following is extracted from the "Manual of Instruction in Army Signalling," price 6d., easily obtained through any bookseller. "A mirror is mounted with trunnions in a U-frame fixed to a plate, which moves horizontally on another plate fixed to a tripod stand. A tangent screw working between these plates gives the mirror a slow horizontal motion, so that it may follow the sun in its path. A vertical screw-rod attached to the back of the mirror draws the upper part slowly down, or again pushes it up, thereby altering the inclination of the mirror to suit that of the sun's rays. By the motion of these two screws the light from the mirror can be kept steadily fixed on any selected point. To make signals the above-named rod is pressed down against a spring, and after a short or long pause released, thus throwing the light on the station for the space of a dot or a dash." I may add that the description of "method of use" is accompanied in the manual by a figure, and complete instructions for working the apparatus. Any further information desired by "Magister Artibus" on the subject of signalling I shall have great pleasure in giving, as I have had considerable practice in the art.—A Volunteer Signaller.

[56632.]—**Stacks of Hay, &c.**—Oblong stack: Multiply length by breadth, and the product by height of body, and half height of roof added together, and the result will be given in cubic feet. In case of inequality in stack, averages must be taken. Oblong hipped stack: Only take ⅜ths of height of roof instead of entire height. Circular stack: Measure circumference half-way between ground and eaves; then multiply by perpendicular height of body added to ⅓th below point of stack. Should roof be flat, rather less than ⅓th.—Bream's Buildings.

[56636.]—**Australia.**—A good man will get plenty of work in Melbourne, probably wages from 8s. to 14s. a day; but there is not much room for inferior artisans. A man should take any special tools he may have; but ordinary ones can be bought at about London prices. Clothes and books are much the same as here, but books had better be taken. Several English companies are doing electric lighting work, so it might be possible to get a letter in England to a manager out there. This would be of the greatest use.—Rosicrucian.

[56637.]—**Electric Lighting by Batteries.**—A quart Daniell will give you one volt. Daniell cells are perfectly useless for lighting. Bunsen cells will last for about five hours, and then require to be recharged and the zincs reamalgamated. You had better not think of lighting anything above a small lamp, as the care and attention required in battery lighting is out of the question. If a "Young Beginner" wishes to make a few experiments in lighting, he had much better procure a small lamp of about five candle-power and light it up with a bichromate battery. The creeping salts in Daniell cells are always a source of trouble and annoyance. Several plans have been devised to obviate this, but without much success. As good a plan as any is to use very tall porous pots, and at the same time do not neglect to attend to them.—C. D. R.

[56638.]—**Cleaning Glass.**—The composition that seems to be required is made of five parts of spirits of wine and one part of ammonia, with enough Tripoli powder to make a thick cream.—Faber Fabrum Adjuvet.

[56638.]—**Cleaning Glass.**—So far as windows are concerned, if you put whiting on them, you give yourself quite unnecessary trouble, as unless they are very greasy indeed, a solution of soda applied with a sponge or wash leather will do all that is requisite in double-quick time. For polishing cloths use scrim canvas (paperhanger's canvas) which has been soaked and boiled until all the "dress" has been removed. See that your polishing cloths are clean, and then you need not have cloudy and dull-looking windows. To clean glass on which albumen is to be poured, or on which we wish to deposit a film of silver, is a very different matter; but after dusting we immerse the glass in a solution of nitric acid (10 to 1), and leave it there for some time. We then wash it under the tap, and while still wet pour the albumen on. In the case of silvering mirrors further precautions are taken. The photographer, however, who is very careful, polishes the plate after the nitric-acid bath with a cream of spirits of wine, tripoli, and ammonia liquor, while some use a mixture of bichromate of potash and sulphuric acid.—NUM. DOB.

## UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

Since our last, W J. Grey has replied to 56282.

56079. Lathe, p. 42.
56083. Telescope, 42.
56084. Canvas Canoe Building, 42.
56087. Dynamo, 42.
56088. Knife-Cleaning Machine, 42.
56090. Self-Lubricating Bearings, 42,
56092. Altering Dynamo for Plating Purposes, 42.
56094. Iron Brake Pipes, 42.
56101. Spinning Wheel, 42.
56107. L. and N.W. Locos, 42.
56113. Clock, 42.
56116. Brick Clays, 42.
56121. Canine, 42.
56123. Engine and Boiler, 42.
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56314. Strength of Gear Wheels, p. 135.
56315. Anemometer, 135.
56316. 8in. Spark Coil, 135.
56319. Expansion Valve, 135.
56325. Gyroscope, 135.
56330. Soluble Oil, 136.
56333. Scale Scoops, 136.
56343. Electrical, 136.
56345. Legal, 136.
56347. Centre of Percussion, 136.
56348. Colouring Terracotta, 136.

## USEFUL AND SCIENTIFIC NOTES.

**Galvanic Batteries.**—Mr. G. G. Blackwell, of Liverpool, has issued an illustrated catalogue and price-list of galvanic batteries, electric bells, &c., which is a great deal more than catalogues usually are, for it contains, within a small compass, a large quantity of valuable information, including a number of hints which will prevent beginners going wrong, although they may have strictly followed, as they believe, the directions which appear so simple in the books. Anyone who wants to make a battery should procure Mr. Blackwell's "Guide"—it deserves that title, although it is only called a price-list and illustrated catalogue.

**Prehistoric Structures in Micronesia.**—Capt. L. U. Herendeen, of San Francisco, communicates to *Science* the following notes on prehistoric structures in Micronesia:—"A few years ago I visited Ponapé Island, in the Pacific, in east longitude 158° 22′ and north latitude 6° 50′. The island is surrounded by a reef, with a broad ship-channel between it and the island. At places in the reefs there are natural breaks that served as entrances to the harbours. In these ship-channels there were a number of islands, many of which were surrounded by a wall of stone 5ft. or 6ft. high, and on these islands there stood a great many low houses, built of the same kind of stone as the walls about them. The walls are a foot or more below the water. When they were built, they were evidently above the water, and connected with the mainland. The natives on the island do not know when these works were built; they have even no tradition of the structures. Yet the works show signs of great skill, and certainly prove that whoever built them knew thoroughly how to transport and lift heavy blocks of stone. Up in the mountains of the island there is a quarry of the same kind of stone that was used in building the wall about the islands, and in that quarry to-day there are great blocks of stone that have been hewn out, ready for transportation."

THE following paragraph seems to have appeared too early in the season:—"Oranges coloured with fuchsine, so as to resemble the highly-prized 'blood orange' form the latest addition to adulterated edibles in Paris. Dyed tomatoes have also been offered for sale in Paris. The fruit not having acquired its usual deep hue, the producers covered it with red paint, for which on discovery they were fined 100 francs."

## QUERIES.

[56639.]—**Winnowing Machine.**—Would any of "ours" kindly give me instructions how to make a winnowing machine, such as is used for opening flocks, after being some time in use?—UPHOLSTERER.

[56640.]—**Detachable Stock for Revolver.**—I wish to fit a revolver I have with a detachable stock, for use as a small rifle. Can any reader give me a hint how to fasten the stock on, so that I can use it for both purposes without injuring the handle of revolver?—and oblige—W. D.

[56641.]—**Lease.**—A widow holding lease under will of late husband, desires to give it over to her two daughters during her lifetime. Is it necessary to have fresh lease drawn up, or by separate deed, or merely indorsed upon the existing lease, so as to be quite legal? Also, what would be the probable cost of the transaction? The value of the property would be about £300.—H. C.

[56642.]—**Petroleum.**—Will any of "ours" kindly inform me of any method or methods of detecting water in the presence of, and extracting it from, petroleum? After refilling, for a few weeks, the oil vessel of the lamp, I find that a quantity of water gradually accumulates at the bottom of the vessel, which water continues to increase until the light is entirely extinguished; the vessel has then to be emptied. How can this be obviated without emptying the oil vessel?—IN THE DARK.

[56643.]—**To Ostrich Feather Bleachers.**—If you would kindly give proportion of chemicals used and process for bleaching a small quantity of ostrich feathers, you would greatly oblige—JOHN THOMAS.

[56644.]—**Resistance Coils.**—To MR. BOTTONE.—I intend making a set of resistance coils as described by you in a recent issue. Could you please tell me what number G. S. wire to use, and also about what length of wire I should have to cut off for each number of ohms, so as to avoid cutting to waste?—AMATEUR.

[56645.]—**Small Gas-Engine.**—To "J. H."—Can you give us reliable information as to how to make patterns and fit up a small gas-engine, say ½-h.p.? I could constract one if I had reliable instructions how to do so, same as we are having on the steam-engine, but I am not in a position to purchase one at present.—THEO.

[56646.]—**Bicycle Painting, &c.**—Will someone kindly give me a few hints on mixing colours, especially lining colours? I mix with turps and varnish, but it seems to work stiff. Also how are the brass flanges secured to spindles?—C. B.

[56647.]—**Spring Jack.**—Will "Invicta," or some other kind reader of the "E.M.," inform "Spring Jack," how the strengths of springs vary (springs similar to a clock spring), also how to calculate for different strengths? Would the writer be correct in taking them as the squares of the thickness, and as the breadth, or how?—O.

[56648.]—**Bichromate Battery.**—I have two bichromate cells, which I wish to connect up and use together. One is a square pint, and the other a bottle bichromate, quart size. The former has of course the most carbon and zinc surface. If I connect up for quantity, does the difference in the size of the cell signify? If I connect up for intensity, supposing I have the latter cell on full power, how can I tell to what height to fill the former cells, so as to get them both the same power, and can you please tell me the meaning of the internal resistance of a cell? An answer to the above would greatly oblige.—AN AMATEUR.

[56649.]—**To "Sigma."**—Would Mr. Sprague favour a student of telegraph engineering with his opinion? The first case in point, is the effect of joining electro-magnets (in telegraph apparatus) in multiple arc, for purpose of getting rid of the retardation due to the extra current generated in them at the making and breaking of the circuit. I can understand that, in looking at the coils as generators of current, in the same way as you would at a battery, and remembering that the extra current generated varies directly as the convolutions for the same magnetising current, the effect of joining a pair of coils in multiple arc will be to reduce the extra current to one quarter what it would be if the coils were in series; but in Preece and Sievewright, (page 308) it is said that the extra currents in the two coils being in each case in the reverse direction, tend to neutralise each other, and little or no retardation from this cause is experienced. My difficulty is that whilst I can see they are reduced, I cannot see how they neutralise. The second difficulty is the method of arriving at the insulation resistance of telegraph wires, by the P.O. system of receive current testing. The tangent galvanometer is joined to the wire to be tested, and a current of known strength is sent from the other end, the wire under tests having at each end 10,000ω R. added to it, so as to make its own R., I suppose, comparatively insignificant. The strength of the received current is noted, and from a table provided, the equivalent insulation R. is known (Preece and Sievewright, page 266). I quite see that all the current lost *en route* must be through defective insulation, providing derived circuit to earth; but I cannot ascertain how the insulation R, equivalent to this loss of current, is arrived at. The Wheatstone bridge method, where the distant end is disconnected, is more readily understood.—TELEGRAPHIST.

[56650.]—**Lead Burning.**—I have made a bellows and 6in. lead-burning machine, exactly similar to the one described by Mr. Davies, Vol. XXXV. 909, 910, "E M." but sorry to say fail to get same to work satisfactorily, through the gas becoming exhausted so quickly, in fact say 5min. Can it be that my sulphuric acid is wrong, and if so, how am I to find out the quality required? Have added five of water to one of acid, as per instructions, but it fails to act on the bar zinc for any time. I also notice the flame rather a sluggish yellow cast, and easily blown out by bellows. I regret having to trouble Mr. Davies; but if he would kindly repeat his article from Vol. XXXV. No. 910, Fig. 231, September 1st, 1882, I should feel very grateful, as I understand the numbers are now out of print. Would he also give a few instructions upon upright burning, &c.? I have tried to do a little of it, but with very bad results. I should also like Mr. Davies to tell me if the exhausted acid, obtained when emptying the machine, may be used a second time, by adding more fresh acid, or is it better to use fresh water and acid each time?—A BEGINNER.

[56651.]—**Boiler.**—Will any brother reader kindly explain the cause of a serious accident which occurred on Monday last at the works where I am engaged? The boiler is a Lancashire one, 30ft. long, and 7ft. diameter, with two flues or tubes running through it. The fires were damped on Saturday and so left until Monday. Shortly after the damper was drawn on Monday morning, the stoker opened one of the fire-doors to ascertain how the fire was burning, when a most violent explosion occurred, shaking the whole place, and lifting the boiler from its seat. I shall be very thankful to know the cause of this, and to adopt any suggestion by which a repetition may be avoided.—ALBERT TURNER.

[56652.]—**American Organ Fix.**—Would be very thankful for practical information. I have a small one with one set of reeds of 4ft. diapason. I should like to add another 4ft. of same, and an octave of sub-bass; the bellows are smallish, and there is a little space on soundboard on top of them. I wish to know if I could place the reeds in an upright position, and connect the end of the reed tubes with the wind holes that have the pallets under in the soundboard. By this means I should gain a deal of room on soundboard; as it is, there is barely room to take two 4ft. sets, if laid flat as usual. If the reeds would sound well and do in this position, what would be about the least space of wind-hole I must have in soundboard, to supply each reed properly, as I want to economise all possible room, and find room for a vox humana?—AMERICAN O.

[56653.]—**Electric Bell.**—I am about to make an electric bell, with a gong 5in. in diameter, the poles of magnet to be ⅝in. in diameter, 2in. long, and 2in. apart from centre to centre. Will some of "ours" kindly advise me if this size is suitable, and also what quantity of wire I ought to wind the magnet with. Will No. 28 do, or is it too small? I intend using two cells Léclanche, and contact will be made by a clock close to the bell and battery, so that there will be comparatively no external resistance, other than the bell?—BEDFORDIAN.

[56654.]—**Portraiture.**—I have been trying to take portraits with one of Lancaster's ½-plate landscape lenses but cannot obtain any good results; so will some of my photographic friends give me a few hints, length of exposure, &c.? My failures are briefly this: In an ordinary well lighted room, with the stop in, and exposures up to ten seconds no image at all, up to 90 I get detail in dress, but the features come out dark in printing? How is this? Outdoors I do not succeed much better with the stop entirely removed giving 20 seconds exposure; but groups I get tolerably well, in from 8 to 10 seconds with the stop in. How do you account for this? Does a near object take longer to impress itself upon the plate than a more distant one? The plates I am using are the Uranium.—CAMERA.

[56655.]—**Cork Frames.**—I have taken to framing pictures with cork, but find it difficult on account of the cork being so hard and brittle. I beg to ask if any of your numerous readers could inform me if there is any way by which the cork could be softened and made more pliable?—MANXMAN.

[56656.]—**Planishing Tin-Plate.**—Will some practical plate-worker kindly inform me how to fasten a tin-plate that has been punched with small holes about ⅜in. apart? I find by hammering, that the plate becomes hollow in the middle, which I wish to remedy. Any information will oblige.—PLATE WORKER.

[56657.]—**Wirework.**—Will some kind reader inform me if over and under wirework is done by hand or machinery, and how is it managed to be done so regular? Is there any book on wireworking? Any hints would oblige.—PLATE WORKER.

[56658.]—**Boiler Enamel.**—Kindly let me know if there are any enamels or varnishes, for coating the inside of open boilers (cast iron) to prevent rust colouring materials used?—WM. FORSYTH.

[56659.]—**Cutting Ebonite.**—When turning up ebonite in the lathe for various electric apparatus, I find it almost impossible to keep any edge to the tools. Would some kind reader of the "E.M." kindly tell me if there is any special tool and method for overcoming this difficulty?—W. J.

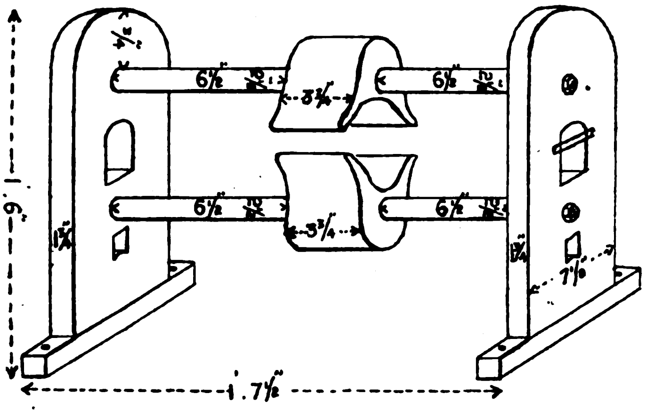
[56660.]—**Eclipses of Small Hand of 24h. Clock.**—In a 24h. dial, how can I find the time each hour at which the minute hand eclipses the hour hand, supposing the 24th hour, or zero, to be at the bottom of the dial?—C. H. T.

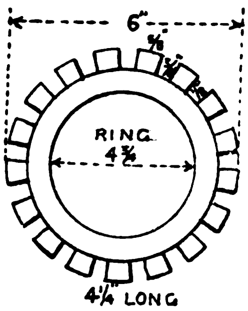
[56661.]—**Bending Iron Gas and Steam Tubing.**—I asked in some back number, how iron tube might be bent without reducing the size of the bore. I have tried the plan suggested, but cannot succeed with it. I have heard there is a method of bending while hot round a grooved pulley; but never having seen it done I should be glad of a description of the process.—C. H.

[56662.]—**The Nottingham Caves.**—In the town of Nottingham there are many large caves, caverns, or huge cellars, hewn out of the solid rock, it is said, by the ancients. Can any of "ours" inform me of the probable antiquity of these excavations, the purpose for which they were made, the tools used in the work, and what use our ancestors probably made of the loose stone chippings, &c., got out of these workings? As it is said none of this refuse has ever been found, and the quantity must have been immense.—C. H. T.

[56663.]—**Iron Planishing Machine.**—Will any correspondent give sketch and description of the planishing machines used for making rolled shafting? I suppose they are pairs of revolving discs peculiarly arranged, and I cannot, from a bare verbal description, understand their action on the iron bar.—KUNST MACHT GUNST.

[56664.]—**Dynamo.**—To MR. LANCASTER OR MR. BOTTONE.—I am constructing a dynamo on the Gramme four-pole type, but the armature has a Pacinotti ring, size of ring including cogs, 6¾in. diameter, and 4½in. long, and has 30 spaces for wiring, each space 4½in. long, ⅝in. deep, ⅜in. wide. I want to know how much double cotton-covered wire I shall want for the F.M., and also how much





and size for the armature, to be shunt wound? Could I run incandescent lamps and arc lamps at the same time if wound as above? Weight of machine when finished, 2cwt. How much light, incandescent and arc, may I expect if run by a half or one horse-power engine? A sketch showing how to commence wiring the F.M., and the direction to be wound in on each of the four poles, will oblige.—QUANTUM LIBET.

[56665.]—**Strad. Model Violin.**—Thanks to Mr. Leslie, but reply is not definite enough. Stradivarius, I am led to believe, made all his best violins a uniform thickness throughout. Would someone who knows, or who has had the opportunity of gauging one of those splendid instruments, please to let me know the exact sizes of such, as the ordinary model now made of Strad. is only an outside resemblance of the real thing, as mechanics can easily take a copy of that; but the inside measurement is what is hard to come at. One would require the use of a valuable old violin for that purpose.—J. TOWNS.

[56666.]—**Valve-Gear.**—I have an idea for a new valve-gear, which does away with the eccentric, and is worked by the piston itself, but at most it only admits steam during ½ of the stroke? Would it expand enough if at good pressure? and what is the usual cut-off on stationary engines for speed?—RIP.

[56667.]—**Drill-Chucks.**—I should be obliged if "J. K. P." or other practical contributor to the "E.M." could tell me which is the best kind of drill-chuck for holding power, durability, and truth of centring. I have been using a scroll-chuck for some time, but find that it has worn quite untrue, and never possessed much holding power.—W. E. F.

[56668.]—**Powerful Bichromate Battery.**—I want to fit up a bichromate battery to work a small motor intended to drive a model boat. As the carrying capacity of the boat is limited to about 20lb., perhaps some electrical contributor to the "E. M." would kindly advise. I find that four Fuller quart cells will drive the motor at great speed, but there is very little power to drive the propeller. The motor can readily be stopped by the slight pressure of a finger, although advertised to drive a sewing machine which would require far more power than to drive the boat. This form of battery appears unsuitable. How would six carbons and four zincs in one cell be likely to act? Would it be advantageous to have two cells of three carbons and two zincs each, rather than one as above? Is it also necessary there should be a certain volume of exciting fluid?—or (as weight is an object) could not the plates be arranged as closely together as possible, limiting the bulk and weight of solution? What object is there in surrounding a carbon and zinc with a great bulk of solution, apparently out of proportion to the size of the plates?—Q. S.

[56669.]—**Expansion of Metals.**—Could any of your readers inform me what would be the length of a rod of wrought iron when heated to 100deg. Fahr. if 36in. long at 32deg. Fahr., and if, when being heated, it would expand the same amount with each degree of heat? Also the same with regard to a rod of brass.—A.

[56670.]—**Groynes.**—Can any reader inform me of the best way to protect land which is being washed away by the sea? I am told there is a new system called "Dowson's Groynes." Can anyone give me particulars?—NO SIG.

[56671.]—**Porous Cells.**—I have a number of porous cells out of order, which I consider is due to the exhaustion of the peroxide of manganese. I have refilled them with a mixture of peroxide of manganese and carbon in coarse powder, but they do not work so good as when new. Will any kind reader tell me why, and assist me how to obtain the best possible results from them again?—DIFFICULTY.

[56672.]—**Tarpaulin.**—I have a tarpaulin, of which the dressing is worn off. How can I renew the surface so as to make it waterproof again.—CHROMIO.

[56673.]—**Mechanics.** — Can any correspondent furnish me with a full answer to the following question from Todhunter's Mechanics? I have succeeded in the first part, but cannot complete. "Parallel forces act at the angular points of a triangular pyramid, each force being proportional to the area of the opposite face: show that the centre of the parallel forces is either at the centre of the inscribed sphere, or at the centre of one of the described spheres."—J. O.

[56674.]—**Carbonado, Bort, Diamonds (Gems).**—Will Mr. Wenham, "S. E. S.", and all others interested in the use of the above as tools, give me all the information they can on the subject? 1. As to persons in England or abroad using them, or either of them, as tools for hard steel, or for stonework, or other purposes. 2. As to price of carbonado. I heard that Sir H. Bessemer was using the diamond for cutting lenses. Has anyone else heard of this, or did he use carbonado? Information of every kind will be appreciated.—A. P. BOWER, 35, Mecklenburgh-square.

[56675.]—**Lemon Juice.**—Will any kind reader tell me how I may preserve lemon juice so that I may keep it in bottle throughout the summer?—JULIA.

[56676.]—**Free Reeds.**—Will G. Fryer kindly say how I can make a tuning apparatus for harmonium reeds? Could I do this with a flutina bellows, as I want to make a cheap one? Could it be done by letting the bellows into a small table level with, or a little higher than, top, and have bellows closed by elastic cords at the ends, or by some other means, so that (having valve hole or holes at the bottom) I could work them with foot? I would like to have the top so that I could have several slide boards with slots on each side of them of different sizes, so that I could tune other reeds as well. What would be the best kind of wood, and thickness; and how many holes could I make do, and what size?—A POOR AMATEUR TUNER.

[56677.]—**Boring Small Wood Handles.**—Would any reader oblige with any information, or a sketch of an attachment to a lathe, for boring small wood handles, 4in. long, and what bits would be most suitable?—J. C. K.

[56678.]—**Hardening Jaws of Chuck.**—Will any of your readers tell me how to harden the jaws of a four-jawed chuck, 10in. in diameter, so that they will not warp in the process?—ALFRED WEST.

[56679.]—**Supported Beam.**—In the Honours Paper in Applied Mechanics set this year by the Science and Art Department, the following question is given: "A horizontal uniform bar, 18in. long, is laid over two supports, each 4in. from its ends. Find two points at which it has no tendency to break." Would some fellow reader kindly give the correct answer to it?—H. T. N.

[56680.]—**Induction Coils.—Vertical Plan.**—Will any of your readers tell me how they manage to see between the discs when they are about 1-20in. between, or do you let the wire run on anyhow?—L. W. WILLIS.

[56681.]—**Trueing Steel Square.**—I have a steel square, 6in. blade, which is not true. Will some reader kindly inform me of the best method to true the same,?—ONE ANXIOUS TO KNOW.

[56682.]—**Struck by Lightning.**—In December last I had the misfortune to be struck down by lightning, my feet, leg, and one arm being burned; but am thankful that all are well again; but there is an old scale left on the bottom of one of my feet. The bottoms of both feet are very tender, for when I get my shoes off I can hardly walk, as it gives me much pain. I am washing them two or three times a week in Tidman's sea salt and water, to harden them. When storms come on they are very painful; pains fly all over me (I believe some of the pains to be rheumatic); they seem to fly to the old wounds; my knee and right hip are very painful. Can ady of the readers of the "E.M." give me any advice to remove those pains and strengthen my feet?—A BRAND PLUCKED FROM THE BURNING.

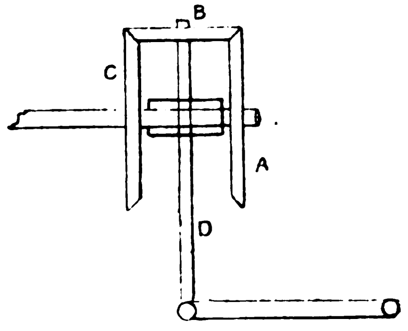
[56683.]—**Magneto Machine.**—To MR. LANCASTER, MR. WIESENDANGER, AND OTHERS.—I am about to try to construct one of the above, and to apply the electricity so produced in the form of an electro-magnetic engine, and am seeking information on the following points: 1. What amount of power could I hope to secure by employing ¼h.p. to revolve the armature? 2. What is the best form of magneto to employ? 3. Respecting the permanent magnets, any hints as to the quality of steel, best methods of magnetising would be gladly received? 4. Is there a better method than that of Planté's for storing up electric energy?—if not, hints as to the management of Planté's arrangement, also the amount of surface required for power absorbed; for instance, what is the least amount of surface that would be required to store the energy given off by six quart Bunsens in one hour?—PRESTONIAN.

[56684.]—**Electro-Motor.**—To MR. BOTTONE.—I have fitted up an H armature dynamo according to your instructions in these pages, with the exception of wiring. Would you kindly tell me the weight and gauge of wire to wind it with, so as to use it for a motor to drive a sewing machine. How many bichromate cells, with zincs 6 by 2, will it take to drive it?—I. K.

[56685.]—**Stiffening Woollen Cloth.** — Will some obliging fellow-reader tell me the very best material that can be used for stiffening thick woollen cloth? The addition of weight to the cloth is no object, a really hard feel only being required. I have been told it can be made as firm as a board. Farina and glue have both been tried, but the results are scarcely satisfactory.—ANGLETERRE.

[56686.]—**Bending Wood.**—I want to frame a thin square iron plate of about 30in. circumference with hardwood frame of birch, cedar, maple, or any other hard or medium hard wood. The frame to be ⅜in. wide and thick. When made with joints at each corner, it does not work well, and I am told that it is possible to bend the frame by some process, so that I shall have only one joint. Can any of your readers enlighten me as to the way of doing same, or refer me to some books on the subject?—FRAME.

[56687.] — **Wheel Calculations.** — Could any correspondent tell me how to speed wheels of this description? A being fast on the shaft, B loose on the handle, C fast on the shaft; A is stationary, D is the handle, wheels A and C are larger than B. Suppose A and C to be 50 teeth, B 28, what speed will C be? Example in plain figures will oblige.—SAMMY.

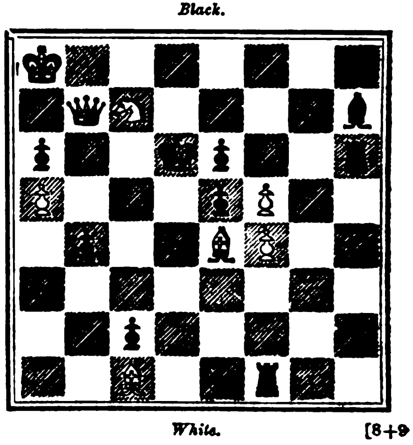


## CHESS.

ALL Communications for this department must be addressed to J. PIERCE, Langley House, Dorking.

PROBLEM DCCCCXL.—DOUBLE PAWNS.

*Black.*



*White.* [8+9

White to play and mate in three moves.

SOLUTION TO 938.

| *White.* | *Black.* |
|---|---|
| 1. R-R 7 | 1. B takes R (a) |
| 2. Q takes B | 2. Anything |
| 3. Kt mates | |
| 2. Kt takes P (ch) &c. | (a) 1. Kt-B 2 (b) |
| 2. Q-K 5, &c. | (b) 1. K moves (c) |
| 2. Kt takes P (ch) &c. | (c) 1. Kt-B 3 |

NOTICES TO CORRESPONDENTS.

CORRECT solutions to 937 by I. H., S. L. Chivers, Exon (good), F. O'N. H. (a good study), H. Culmer; to 938, by F. O'N. H., Exon (pleasing, an unlikely key), I. H., A. W. Orr (spoilt by two move mates, otherwise good), A. A. B. Lecluse (there is a master-hand touch about this ingenious problem), B-B 2 nearly solves it), J. A. M. (wants a W P at Q R 4, to prevent dual moves of Kt in main play; poor, wanting in variety), G. T Stringfellow, Rev. W. Anderson (Old Romney), J. E. Piper, F. A. Vincent, H. Culmer, and A. S. Olver; to 939, by E. S., J. E. Piper (very pretty), F. A. Vincent, F. B. Webb, J. A. M., A. S. Olver, Streetgate, and R. A. Bennett.

R. A. BENNETT.—In your solution of 938, you have overlooked that when 1 $\frac{\quad}{\text{Kt-Q B 2}}$ 2 $\frac{\text{Kt takes P (ch)}}{\text{K moves}}$ if 4 Q-Q Kt 4, there is no mate on account of B P at Q-R 4.

E. STANLEY FOLLWELL.—See above notice.

BEGINNER.—2. Kt-Q 3. mate.

I. H.—If in 936 1 $\frac{\quad}{\text{R-R 6}}$ mate follows on the move.

A. S. OLVER.—It should have been four.

A LIVE albatross, the first ever brought to Europe, has just been received in the Paris Jardin d'Acclimatation.

## ANSWERS TO CORRESPONDENTS.

⁂ *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand*, *W.C.*

### HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

⁂ Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, May 20th, and unacknowledged elsewhere :—

Rev. C. J. Jones.—Rev. J. Rawlins.—J. B. Medland.—W. Astbury and Co.—Electric Apparatus Co.—Turner.—Alabama.—Trophy.—Capt. King.—Vulcan.—Vandu.—Vulcanite.—J. Townley.—A Convert from the Theory of Evolution.—Ignorant.—John Ballot.—St. Helens.—Edward Hines.—Cathode.—W. Sykes.—Verax.—Pure Food.—H. A. Wassell.—K. J. Tarrant.—Glatton.—Sammy.—M.I.C.E.

### CAUTION.

We regret to have to put our readers on their guard against a swindler who has recently been making use of our Sale Column. We particularly caution readers *not to send money before they get their goods* except by means of a Post-Office Order made payable ten days after date, and to stop the order and get their money back if the goods do not reach them before the ten days expire. We do our best to keep swindlers out of our advertisement columns, but they easily evade us by changing their names and addresses. Especially during the next few weeks we warn readers against "bargains." People who are ready to part with apparently valuable goods at ruinous prices should always be inquired about before money is sent them.

C. H. (If the wheels and the pinions on the two shafts are alike, as placed in your sketch the second shaft will revolve four times as fast. It is a simple matter of calculation. 2. It is almost invidious to answer such a question as "What is a good rudimentary work on astronomy?"; but possibly Sir E. Beckett's "Astronomy without Mathematics" (Society for Promoting Christian Knowledge) would suit you. Main's "Astronomy," published by Lockwood and Co., is a cheap and very useful treatise. 3. The chemical you mean is probably bisulphite of lime, but we were not aware it was used for "ageing" malt liquors. 4. The tendency to alter shape in surface plates is corrected in the Whitworth patterns. See the indices.)—C. H. Thompson. (What advantage is to be gained by combining "air, steam, and gases"?)—C. Henry. (Attempts have been made to start societies of the kind, and some of them have been successful in the provincial towns. They meet, however, at stated intervals. You should join one of the mechanics' institutes, or a workman's club. 2. It is done easily enough with surveying instruments, point by point.)—C. H. T. (Remains of the kind are found in various parts of the country. It is usually considered that the vicinity has been the site of some great battle, and the bones have been collected and put into the charnel-house. 2. It would strike against the side of the bore first, and finally rest in the centre. 3. The centre of the country could probably be found by that means as nearly as any other; but *cui bono*?)—J. H., Manchester. (We are not acquainted with anything of the kind. Even in the case of the larger automatic instruments, springs are always used.)—F. A. W. (For methods of preserving eggs see p. 469, Vol. XXXIII., pp. 503, 551, Vol. XXXVI. The commonest plan is to preserve them in a thin cream of lime, but many householders use solid paraffin or butter. The object is to close the pores of the shell from access by the air. At p. 551, Vol. XXXVI., you will find directions for keeping them by the thousand; but they may also be preserved in water dosed with either boro-glyceride or salicylic acid.)—W. C. (It is not clear from your query exactly what you want to do, but you will find full directions for all kinds of bronzing in comparatively recent numbers.)—Novice. (The query has been frequently answered. Coat with size or glue water first, and when dry, go over with gold size or varnish (copal). When that is tacky, dust on the bronze powder, and when all is dry and firm, brush off the superfluous bronze.)—A. J. Sells. (It is printer's or lithographic ink thinned, when it has to be driven through holes in a sheet of paper.)—Fuller's Earth. (Yes, it is used for oil-refining. We do not know where you could obtain crude petroleum.)—A Reader 2468. (The resistance of No. 15 B.W.G. copper wire is ·12679 ohm per lb., and 7·887lb. give one ohm resistance. Of No. 20, ·440lb. (nearly half a pound) gives one ohm resistance.)—G. B. (You must use paint ground up with varnish, or the ordinary ground colours, strained, and thinned with turpentine varnish or copal.)—Epping Forest. (We cannot accept the responsibility of advising. There is work and good pay for the right sort of people. Address the inquiry to the Crown Agents for the Colonies (Tasmania), Colonial Office-buildings, Downing-street, S.W., or to the Emigration Agents for the Colony, The Emigrant and Colonists' Aid Corporation, 25, Queen Anne's-gate, S.W.)—J. Hales. (See indices, or procure such a book as Watts's "Electro-Metallurgy," Lockwood and Co., Stationers' Hall-court, E.C.)—D. G. Jones. (See Electro-motors in the indices, and numerous replies under similar heads. You speak of an electric railway, when it is only a motor, and fail to state how much wire you have wound on the magnets and armatures.)—Safety. (Gasoline is one of the light constituents of petroleum, having a gravity of 87°. It is the third distillate, the fourth being naphtha, gravity 74°, and the fifth benzoline, with a gravity of 64°. Benzoline is really safer than gasoline, which is conveyed by the railway companies only under certain conditions, and can only be obtained, we believe, in large cans or barrels. We believe you will find an illustration of the identical furnace on p. 332, No. 925.)—Wm. Chisholm. (We do not remember it. You do not repeat the query; but as it is something about telephones we might suggest a perusal of the back volumes.)—E. Booth. (Most of the modern textbooks contain explanations of the principle of the telephone, and our back numbers have many notes and illustrations in connection with both receivers and transmitters. We do not know of any book giving instructions for keeping them in order.)—J. Prout. (Savart's violin was built up of two flat plates for both back and breast. These plates were made of two pieces ⅛in. thick on one edge and 1-12in. on the other. The thick edges were glued together. The length of body was 14in., width at neck 6in., at tail 8⅜, depth (outside) 2½in., bass bar in centre on joint of breast plate; soundpost near one of the straight holes. Materials: pine, and any suitable wood, but preferably maple for back.)—E. A. Williams. (Instances of the kind have been recorded; but it is generally believed that the "figures" are produced by congestion of the superficial veins.)—G. C. Fox. (Col. Ross's book is the best. It is published by Lockwood and Co., of Stationer's Hall-court, E.C.)—Nauticus. (Camphor carried about the person is perfectly useless as a disinfectant.)—Arnold T. Reed. (Several such scientific societies have already been successfully started under the auspices of the English Mechanic. For particulars, see indices of back vols.)—S. Stokes, G. Fryer. (In type.)

## USEFUL AND SCIENTIFIC NOTES.

**Composition Frame Ornaments.** — The following recipes for compositions of the above character may be found useful: Dissolve 1lb. of glue in 1 gal. water. In another kettle boil together 2lb. of resin, 1 gill of Venice turpentine, and 1 pint of linseed oil; mix all together in one kettle, and boil and stir until the water has evaporated. Turn the whole into a tub of finely-rolled whiting, and work it until it is of the consistency of dough. 2. Boil 7lb. of best glue in 7 half-pints of water. Melt 3lb. of white resin in 3 pints of raw linseed oil. When the above have been well boiled, put them into a large vessel and simmer them for half an hour, stirring the mixture and taking care that it does not boil over. The whole must then be turned into a box of whiting rolled and sifted, and mixed until it is of the consistency of dough. To use these compositions, proceed as follows: The proper moulds being prepared, they are thoroughly rubbed upon the inside with sweet oil, and the composition firmly pressed in. After removing the mould, the cast may be dried by a gentle heat, or while still plastic it can be applied in its proper place and bent into any position.

One thousand cubic feet of nitrogen weigh 80lb. at a temperature of 32° Fah. and a pressure of 15lb. per square inch; oxygen weighs 90lb.; the mixture of 770lb. of nitrogen and 230lb. of oxygen makes 1,000lb. of common dry air. As the oxygen is heavier, it occupies less bulk in proportion, so that if we take the air by bulk, 790 cubic feet of nitrogen and 216 of oxygen make 1,000 cubic feet of air, which will weigh 82lb. The amount of watery vapour is very variable, changes from hour to hour, and differs in localities; but the small amount of carbonic acid is less variable, and changes only from 1-2500th part to about double that amount.

In the absence of a duly authorised and official standard of filtration regulating the volume of water to be passed through a given area of sand in a given time, it has been found during the past twelve years that when the rate of filtration does not exceed 540 gallons per square yard of filter bed each 24 hours, the filtration is effectual; and this has been generally recognised as a tentative standard rate of filtration. The water companies all keep within this limit.

The experiments made at Vörösvar with the new five-barrel Nardenfelt mitrailleuse have, according to the *Times* Vienna correspondent, given the following results:—At 1,000 yards range 26 per cent. of the shots took effect on a target two mètres high. At 600 yards 70 per cent. of the shots struck. In the time firing 100 shots in twelve seconds and 480 in one minute were registered.

The *Miller* states that a large bakery on the Scotch steam bakery system is to be started in the south of London next autumn. There will be eleven ovens, besides an American reel oven, and the capacity will be at first 100,000 loaves a week, but provision will be made for increasing this fourfold if necessary.

**Every Workman** connected with the Building Trades requiring a Situation should advertise in "THE BUILDING NEWS," published every FRIDAY, price Fourpence, at 332, Strand, London, W.C.

"THE BUILDING NEWS" is the Principal Journal representing Architects and Builders, and has the largest circulation of any Professional Journal in the kingdom.

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3in. Vertical **Engine**. Exchange for brass LUBRICATORS and Oil Cups, new or second hand, value £3 10s. Offers.—J. L. GREENWOOD 14, Clarence-street, Cheetham, Manchester.

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**Incandescent Lamp** in Scarf Pin, 20 stamps.—NEW and Co., 24, Dean-street, Soho, London.

**Incandescent Lamp**, 8d. post free. Only a few left.—NEW and Co., 24, Dean-street, Soho.

**Incandescent Lamp**, Battery, Wire, Chemicals, Instructions, &c., in box, 2s. 6d. free.—NEW and Co., 24, Dean-street, Soho.

**Assistance Given** upon moderate terms by experienced practical engineer and draughtsman.—630, Commercial-road, E.

**Optical Glass** of finest quality, crown and flint; all sizes in stock to 14 inches diameter, discs and sheet.—BUCKINGHAM, Blenheim-grove, Peckham.

Cotton-covered **Wire**, D.C. 10 to 18, 1s. 9d.; 20, 22, 24, 26, at 2s., 2s. 3d., 2s. 6d., and 3s. per lb.—C. DARVILL, 6, Brent View-road, The Hyde, London, N.W.

**Organ** (small chamber); must be sold, entire or in parts.—W. LEDSHAM, Grocer, Whitchurch, Salop.

Celebrated Kerry **Ferns.** 12 varieties, including Tunbridge filmy, 1s. 5d. free.—FITZPERY, Rathanny, Tralee, Kerry.

**Cyanotype Paper**, 4d. per sheet. Specimen and list free.—HUMPHRIES, Photographer, 44, Cornwallis-road, Holloway, London.

Good **Violin**, with bow, case, complete; also Music Book, cash 25s.—Rev. BURLON, Jarrow-on-Tyne.

"**Man, Know Thyself.**"—Obtain the only correct way of reading your character. Full instruction with chart, 7d.—H. DYKE, 46, James-street, Taunton.

**Reflector Telescope**, 6¼in. Calver, with several eyepieces, to be sold owing to illness of owner.—Address, G., 4, Philbeach-gardens, S.W.

**Odd Spiral Springs** made to order. Mattress Spring, 9d. per dozen.—JAMES PARISH, 52, Bard-street Park Sheffield.

**Pamphlet**, "Polarised Light as Applied to the Microscope." simple explanation. Three stamps.—E. HOLMES, 149 Essex-road.

Fine 3¼ **Astro. Telescope**, by Wray, £13; excellent definition. Tests given.—T. CLAPHAM, Austwick Hall, Lancashire.

**Formulas Worked Out** for winding Dynamos from 10 c.-p. to 500 c.-p., 8 stamps each.—H. JONES.

**Dynamo Castings**, Jones's patent H: 8 c.-p., 5s.; 16, 5s. 6d.; 20, 6s. 6d.; 30, 7s.; 70, 16s. a set.—H. JONES.

**Dynamos**, finished: 8 c.-p., 30s.; 16, 36s.; 20, 40s.; 30, 50s.; 70, 100s. each.—H. JONES.

**Dynamos** for house lighting.—Jones's Patent Laminated Fields and Armatures, 5, 6, and 7 lights, £6, £7, and £9 each.—H. JONES.

**Dynamo Machines Repaired.** Motors, with wire, 5s. 6d.—H. JONES, 48, High-street, Lambeth, S.E.

**Coca Leaves.**—You require nothing but these at Whitsuntide. No necessity to carry heavy luncheon bags.—MARKS and Co., 17, Newcastle-street, Farringdon-street, E.C.

**Coca Leaves.**—The Bolivian Consul-General has sent a splendid testimonial this week in favour of their stimulating properties.

**Coca or Cuca Leaves.**—Many M.P.'s and Clergymen take them constantly. To Cyclists they are a positive necessity.

Persons afflicted with **Indigestion** should chew Coca instead of eating a hearty dinner, and they would soon be cured.

**Coca Leaves.** — Sample packet, with medical and scientific opinions, 13 stamps.—MARKS and Co., 17, Newcastle-street, Farringdon-street, E.C.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
FRIDAY, MAY 29, 1885.

## TOOLS AND CUTTER BARS.

RECURRING to the contents of the last paper on this subject, it will be evident that the relief angle, or, as it is commonly called, the *clearance*, is not even in "end on" tools needed in front only or chiefly, but on the two lower faces of the tool, which are respectively opposite to the shoulder and the cylindrical portion of the work; that is, in a cranked tool, A, Fig. 16, the clearance is needed on *a*, *b*, the lower faces, and not on the front line, *c c*; but in grinding the former, the latter will share the effect.

It is, however, as "D. H. G." used to point out, an accidental line formed by the meeting of the two front faces of a tool. It, nevertheless, comes into importance when the top face is ground to give the required degree of sharpness to the cutting edges, as the angle of these edges is dependent upon it. The angle contained between *a* and *b* in the sectional drawing (B) of this tool determines the angles of the two cutting edges. The proper way to grind such a tool is, therefore, to form first the two lower faces, so as to give the required clearance to both, and then, having thus obtained this front or guide-line, to grind off the top face at a given angle to it, forming at once the two cutting edges. After this has been done, the extreme point may be rounded, and the result will be the production of the best round-end tool that can be made upon a grindstone.

There is, however, one method not likely to be adopted, perhaps, but theoretically correct, by which an ordinary round-ended tool, ground to a proper clearance angle, can have an edge made equally acute all round the curve—viz., by grinding its upper face as a hollow cone (Fig. 17, A) by means of a conical grinder like an obtuse-angled countersink. This would form an excellent tool; but all beyond the line *a b* should be removed to facilitate the escape of the shavings. The tool will then appear like B of this Fig. We may now desert for a time the solid tools, and consider the cutters, made of short bits of steel held in some sort of bar, which is to be considered merely as the handle. "D. H. G.'s" first lesson, indeed, was always to this effect—that nothing need be considered but the actual cutting edges, and that all the rest of the tool was merely a holder or handle by which these edges were supported and placed in position. Hence, it was allowable, and often advisable, to file away all the parts adjacent to the edge that were likely to be in the way; to ignore shape and beauty of form, and the symmetry of the two sides or edges, and to sacrifice everything to the parts intended to be brought into action; to form these correctly for the special work required of them, and then to bend, or file, or twist, or do as you please with the rest of the tool,

FIG. 16.

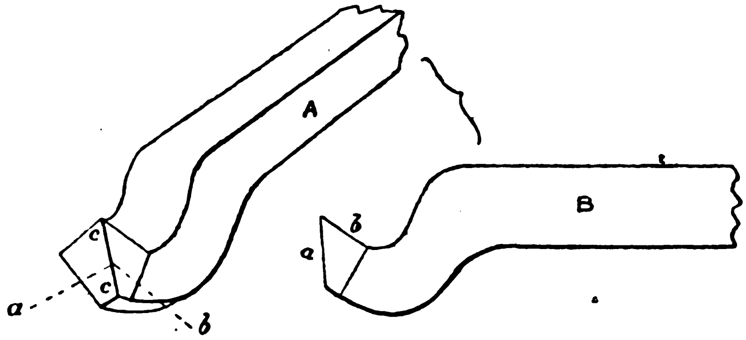


FIG. 17.

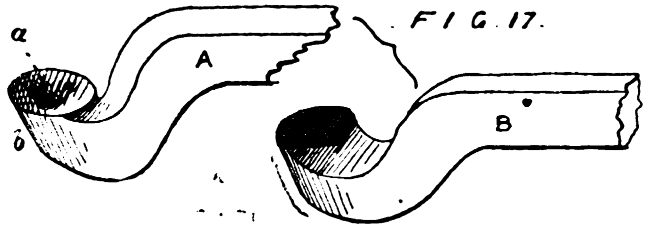


FIG. 18.

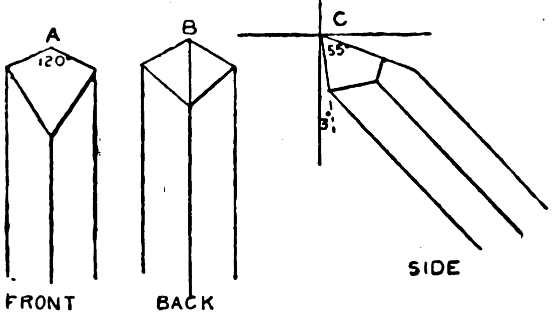


FIG. 20.

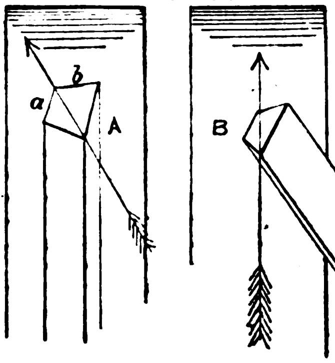


FIG. 25.

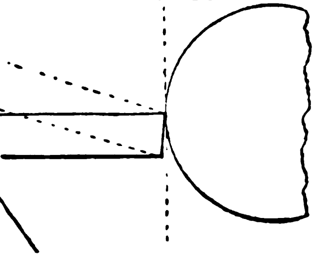


FIG. 19.

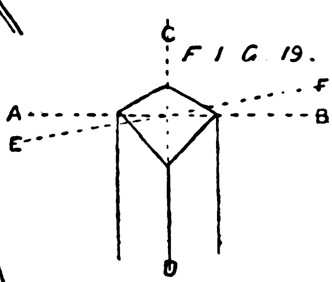


FIG. 22.

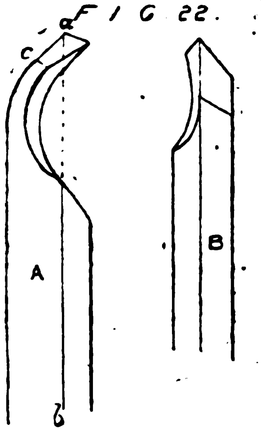


FIG. 23.

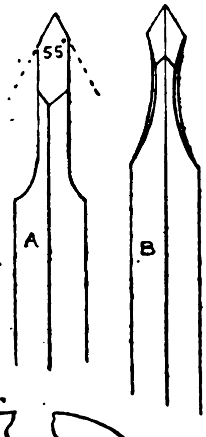


FIG. 24.

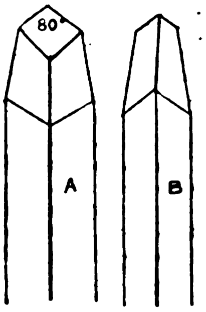


FIG. 21.

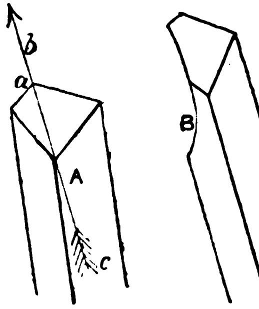
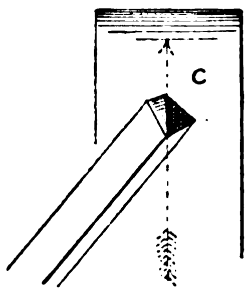


FIG. 20.



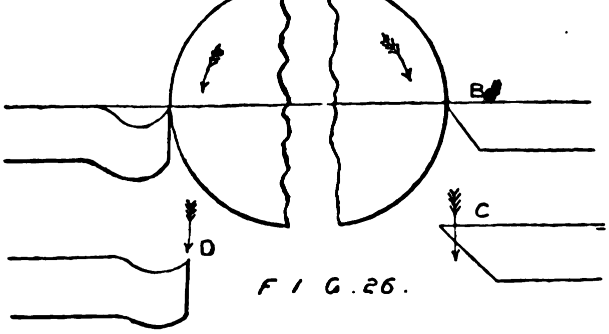
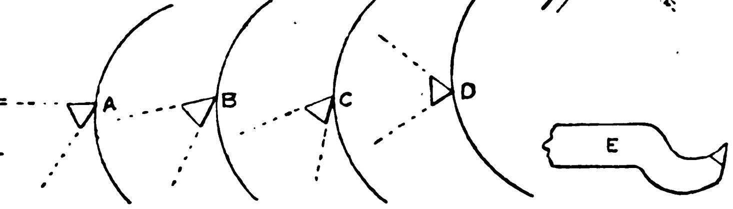


FIG. 26.

FIG. 27.



so as to make it serviceable for its purpose as a holder of the actual cutter.

Haydon's normal cutter (Fig. 18, A B C) has a front or plan angle of 120°. The upper face makes with the front line (formed by the meeting of the lower faces) an angle of 55°, giving cutting edges of 60°, forming a tool for turning up a cylinder or shaft of wrought iron.. The extreme point was generally slightly rounded upon an oil-stone. It had a clearance of 3°. The following edge was placed nearly parallel to the work, except sometimes in taking a rough cut, when the tool was worked to and fro, cutting in both directions. This was never the case in finishing cuts, nor generally in early stages of the work. To insure equal edges the line A B, Fig. 19, must be perpendicular to C D. If the upper face is inclined as E F, the right-hand edge will be sharpest, and *vice versâ*. The line B C bisecting the point must always for this reason lie in the run of the grindstone. The importance of this apparently self-evident fact is often overlooked, and should, therefore, be thoroughly understood. Suppose, e.g., the tool formed with one edge further round to the left (Fig. 20, A), only, of course, the face will be turned down on the stone, the natural way would be to lay it with the shank parallel to the run of the stone, as shown; but the edges *a b* would not be equally sharp. The arrow bisecting the point is the proper grinding line, and this, and not the shank, must be in the run of the stone. The tool must consequently be as at B—face downwards (as in practice it would lie upon the stone) it would appear as C. Although in practice it will not be necessary always to start with the normal tool, and then by filing and grinding to model it according to necessity, yet it is as well to this at first, in order to keep the principle fairly before the mind. A set of wooden cutters as models will teach the lesson as well as metal ones, as it will soon be found that out of the normal tool many others can be formed suitable for special circumstances or difficult and awkward jobs. Taking the normal tool represented at Fig. 18, A and B, it is evident that there is no positive necessity to have the point central. We can make it at *a* (Fig. 21, A), and the grinding line will be *b*, *c*, bisecting the point as explained. We may then file it out on one side till we get such a side tool as Fig. 21 B, whose parentage few but the initiated would discover. But it is plain that its angles will be as correct as those of the normal tool which originated it, as the actual edges remain unaltered. Again, as the normal tool must lie on the table of the rest at an angle, and not perpendicular to the axis of the work, in order to place the following edge parallel to it, "D. H. G." was accustomed to get the leading edge round somewhat to one side, so as to bring the following edge parallel while the tool lay in its more usual position at right angles to the work, thus, in reality, making it somewhat of a left-hand tool, if intended to travel in that direction only. This is a mere question of convenience. The tool shank *need* not lie perpendicularly to the line of centres, unless in taking a slanting position it is in the way at all; but I speak of it to show how entirely independent of circumstances the workman is, and how readily he can, without the use of forge, shape his cutters to suit his work. Of course, an angle of 120° is useless for rectangular corners; but so satisfactory is this normal tool in other respects that "D. H. G." advised its use always as far as admissible, only changing it for one of smaller angle when the corner would no longer admit it. Once again taking the normal tool as the foundation, the round-end tool is made in this way to render it as nearly as possible theoretically correct—*i.e.*, with equal edges. The "end on" round tools result from simply rounding slightly the apex of the tool of 120°. The edges first formed are already equal, and only the apex is affected, and that not materially. A right and left pair of similar round tools are the result of grinding the first or leading edge considerably to one side, then grinding the second at a large angle, and rounding off the point, filing away all that is not needed. Fig. 22. A B are two views of a side tool from "D. H. G.'s" drawings, and here again *a b* gives the grinding line bisecting the point, the cutting edges being *a c* and *a d*.

Departure from the normal 120° sliding and surfacing tool is, of course, necessary in very many instances, there being no hard and fast line or rule without exception in this matter. Here, for instance, also copied from a sheet by "D. H. G.," kindly lent me for the purpose of this paper by "J. K. P.," is a screw tool, the angle of which is 55°. Fig. 23, A, is the top or front, B the under side or back, showing the two lower faces. Then again, from the same source, in Fig. 24 are two views of an 80° tool for brass. These ground at a still larger angle may be made to scrape instead of cutting. The method of grinding these cutters I must postpone until I have given an account of the bar or holder for which they are designed, as they are ground when clamped in it. This will form the subject of the next paper. Fig. 25 is added to illustrate the result of tilting the shank of a tool in order to give more clearance or to lower slightly the edge—a practice exceedingly common and highly to be reprehended. The consequence of this alteration in position is to convert the tool more or less into a scraper, as shown by the dotted lines. This will be the same if the tool is like Fig. 16, and if the edge is at all thin, the tendency to break it will also exist, as the strain will come directly across it in its weakest part. Very probably some of my readers will say that too much is made of these theoretical tendencies, and that in actual practice it answers very well to tilt a tool. The writer has often done it when lazy, *and it does not answer, and it never will*. Given power enough, a tool may be made to tear off chips when it is badly ground and badly placed; but it will not cut clean and make the best work, which is what we are now endeavouring to teach. Fig. 26 is intended to show how the tool is weakened by excessive clearance, yet I have myself bought sets of slide-rest tools ground ready for use with even more clearance than is represented at B. The arrow at C shows the direction of the strain, and the point being unsupported could not possibly stand long. D shows a small clearance angle, and it will be seen that there is ample metal below to support the edge, and the smaller the clearance the greater will this support be. This is to be remembered quite as much with respect to cutters to be used with cutter-bars, as with solid tools, the principle of cutting-edges being the same in all cases; but here, again, comes into effect the position of the tool in regard to height of centres. If it is placed to cut exactly at the height of centres, the tool can have the smallest clearance angle and the keenest edge, because this will have efficient support, and may consequently be keener. Again, the direction of cut in wood or metal should be as nearly tangential as possible, which it cannot be with a fixed tool in the slide-rest, unless the clearance angle is small. A very convincing experiment—at least it was so to me—may be made by grinding a 3-square file so as to remove the teeth. This will give a tool with cutting edges of exactly 60°. Place it across the Tee of a hand-rest in two or three positions, A B C D, Fig. 27, applying it at the end of a bar or on the edge of a disc. The position A will give too much clearance, and the upper face will be also too horizontal, and the tool will merely scrape as it will at D, where these conditions are still more exaggerated. Placed as B, with diminished clearance angle, the upper face will now cut, and if the clearance is still further diminished, as at C, the upper face is more nearly tangential, and the cutting power will be at its best. This experiment shows how mutually dependent are the clearance and the position of the upper face. And if we were now to transfer the little equilateral triangle to form the tip of a cranked tool E we get exactly the same conditions. Now when the tool is a double-edged cutter the same rules apply; but instead of the point it is each face which has to be dealt with in this matter of clearance and cutting edge. The two lower faces are those on which the clearance has to be obtained, the upper face common to both of these stands in the same relation as that of the upper face of the 3-square file. It is true that in turning a cylindrical bar one edge attacks the cylinder and the other the flat face of the shoulder; but observe that we first tried the 3-square tool on a flat face, and then on a cylinder, and in each case we have found the same conditions necessary, and to exactly the same degree.

O. J. L.

(*To be continued.*)

## ASTRONOMICAL NOTES FOR JUNE, 1885.

### The Sun.

| Day of Month. | Souths. | At Greenwich Mean Noon. | | |
|---|---|---|---|---|
| | | Right Ascension. | Declination North. | Sidereal Time. |
| | h. m. s. a.m. | h. m. s. | ° ′ ″ | h. m. s. |
| 1 | 11 57 34·52 ,, | 4 38 7 | 22 7 2 | 4 40 32·00 |
| 6 | 11 58 24·45 ,, | 4 58 39 | 22 42 9 | 5 0 14·78 |
| 11 | 11 59 22·42 ,, | 5 19 20 | 23 7 20 | 5 19 57·57 |
| 16 | 0 0 25·60 P.M. | 5 40 6 | 23 22 21 | 5 39 40·35 |
| 21 | 0 1 30·48 ,, | 6 0 54 | 23 27 5 | 5 59 23·14 |
| 26 | 0 2 34·16 ,, | 6 21 40 | 23 21 29 | 6 19 5·92 |

The method of finding the Sidereal Time at Mean Noon at any other Station will be found on p. 355 of Vol. XL.

At 7 a.m. on June 21st the Sun is said (technically) to enter Cancer, and Summer is supposed to commence. At this instant he will really be a little to the north-west of η Geminorum. This is the longest day, the Sun being above the horizon for 16h. 33m., and, of course, only 7h. 27m. below it. There is no real night in the British Islands during the entire month. Spots and faculæ, in somewhat diminished numbers, continue to appear on the Sun's disc.

### The Moon

Enters her Last Quarter at 4·8m. after midnight on the 5th, and is New at 10h. 42·1m. p.m. on the 12th. Tolerably high tides may be looked for about the 13th. She will enter her First Quarter at 1h. 48·5m. in the afternoon of the 19th, and be Full 42·1m. before noon on the 27th.

| Day of Month. | Moon's Age at Noon. | Souths. |
|---|---|---|
| | Days. | h. m. |
| 1 | 17·9 | 2 30·1 a.m. |
| 6 | 22·9 | 6 17·1 ,, |
| 11 | 27·9 | 10 32·7 ,, |
| 16 | 3·6 | 3 36·2 p.m. |
| 21 | 8·6 | 7 44·2 ,, |
| 26 | 13·6 | 11 39·5 ,, |

The Moon is in conjunction with Mars at 1 a.m. on the 11th; with Mercury at 4 o'clock the same afternoon; with Saturn at 6 a.m. on the 13th; and later on with Venus at 5 p.m.; lastly, she will be in conjunction with Jupiter at 3 p.m. on the 17th.

### Occultations of Fixed Stars by the Moon.

| Day of Month. | Name of Star. | Mag. | Disappearance. | Moon's Limb. | Angle from N. Point. | Angle from Vertex | Reappearance. | Moon's Limb. | Angle from N. Point. | Angle from Vertex. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | h. m. | | ° | ° | h. m. | | ° | ° |
| 29 | 13 Capricornii | 6 | 12 0 p.m. | Bright | 138 | 119 | 1 7 a.m. | Dark | 248 | 239 |
| 30 | 14 Capricornii | 5 | 1 36 a.m. | Bright | 162 | 158 | 2 22 ,, | Dark | 229 | 233 |

### Jupiter's Satellites.

| Day of Month. | Satellite. | Phenomenon. | H. | M. | S. | Day of Month. | Satellite. | Phenomenon. | H. | M. | S. | Day of Month. | Satellite. | Phenomenon. | H. | M. | S. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | II | Tr I | 10 | 50 | P.M. | 11 | *II* | *Oc D* | 8 | 36 | P.M. | 21 | *I* | *Oc D* | 9 | 9 | P.M. |
| 4 | II | Ec R | 11 | 14 | 19,, | 13 | I | Tr I | 10 | 0 | ,, | 22 | *I* | *Tr E* | 8 | 47 | ,, |
| 5 | I | Oc D | 10 | 43 | ,, | 13 | *I* | *Sh I* | 11 | 10 | ,, | 22 | I | Sh E | 9 | 53 | ,, |
| 6 | *I* | *Sh I* | 9 | 16 | ,, | 14 | *III* | *Tr I* | 8 | 15 | ,, | 25 | *III* | *Ec R* | 10 | 30 | 7,, |
| 6 | I | Tr E | 10 | 22 | ,, | 14 | I | Ec R | 10 | 37 | 11,, | 27 | *II* | *Tr I* | 8 | 23 | ,, |
| 6 | *I* | *Sh E* | 11 | 35 | ,, | 16 | IV | Ec D | 10 | 24 | 57,, | 27 | *II* | *Sh I* | 10 | 28 | ,, |
| 7 | *I* | *Ec R* | 8 | 42 | 3,, | 18 | *II* | *Oc D* | 11 | 17 | ,, | 29 | *I* | *Tr I* | 8 | 26 | ,, |
| 7 | *III* | *Sh I* | 9 | 2 | ,, | 20 | *II* | *Tr E* | 8 | 33 | ,, | 29 | I | Sh I | 9 | 28 | ,, |
| 7 | *IV* | *Tr I* | 12 | 2 | ,, | 20 | *II* | *Sh E* | 10 | 46 | ,, | 29 | *I* | *Tr E* | 10 | 46 | ,, |
| | | | | | | | | | | | | 30 | *I* | *Ec R* | 8 | 56 | 8,, |

Ec Eclipse; Oc Occultation; Tr Transit of Satellite; Sh Transit of Shadow; D Disappearance; R Reappearance; I Ingress; E Egress. The printing of a phenomenon in *italics* indicates that its visibility is rendered doubtful, either by the brightness of the twilight or by Jupiter's proximity to the horizon.

### Mercury

Is a Morning Star during the first three-quarters of the month, but comes into superior conjunction with the Sun at 3 p.m. on the 27th; and, of course, afterwards travels to the east of him. Mercury is high up in the sky, but, save at the beginning of June, is too near the Sun, and his nearly circular disc subtends too small an angle (a little more than 5″) for him to be either easily picked up or worth looking at when he is found.

| Day of Month. | Right Ascension. | Declination North. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 3 3·7 | 14 10·4 | 10 23·5 a.m. |
| 6 | 3 31·6 | 16 38·6 | 10 31·7 ,, |
| 11 | 4 5·0 | 19 14·5 | 10 45·2 ,, |
| 16 | 4 43·9 | 21 40·5 | 11 4·4 ,, |
| 21 | 5 28·2 | 23 33·5 | 11 28·9 ,, |
| 26 | 6 15·8 | 24 30·0 | 11 56·7 ,, |

Hence Mercury, starting from a barren part of Aries, will travel entirely across Taurus, and for a considerable distance into Gemini. He will be in conjunction with Neptune at 7 p.m. on the 5th, and with Saturn at 4 a.m. on the 24th.

### Venus

Is an Evening Star, setting more than an hour after the Sun towards the end of June. Her angular diameter increases from 9·7″ on the 1st to 10·2″ by the 30th, and by the last-named date she has become perceptibly gibbous.

| Day of Month. | Right Ascension. | Declination North. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 5 10·1 | 23 17·4 | 0 29·5 p.m. |
| 6 | 5 36·8 | 23 52·3 | 0 36·5 ,, |
| 11 | 6 3·7 | 24 9·6 | 0 43·7 ,, |
| 16 | 6 30·7 | 24 9·1 | 0 50·9 ,, |
| 21 | 6 57·5 | 23 50·7 | 0 58·0 ,, |
| 26 | 7 24·1 | 23 14·7 | 1 4·9 ,, |

The path indicated by the above Ephemeris extends through a good deal of Taurus and right across Gemini. Venus will be to the north of η Geminorum on the 12th, and of μ the next evening. On the 24th she will be 1° 20′ north of δ Geminorum; but these are the only stars of any size to which she will approach moderately near. She will be in conjunction with Saturn (1° 32′ N. of him) at 10 p.m. on the 7th.

### Mars,

For the observer's purpose, continues invisible.

### Jupiter

Now rises and souths in bright sunlight, and to be seen at all must be looked for as soon after sunset as possible, even at the beginning of the month. His diameter continues steadily to decrease from 33·3″ on the 1st to 31″ by the end of June.

| Day of Month. | Right Ascension. | Declination North. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 10 3·2 | 13 7·3 | 5 21·8 p.m. |
| 6 | 10 5·5 | 12 54·4 | 5 4·4 ,, |
| 11 | 10 7·9 | 12 40·4 | 4 47·2 ,, |
| 16 | 10 10·5 | 12 25·4 | 4 30·1 ,, |
| 21 | 10 13·3 | 12 9·2 | 4 13·3 ,, |
| 26 | 10 16·3 | 11 52·7 | 3 56·5 ,, |

Starting thus from a point less than 1° north of Regulus, Jupiter will describe a short arc in Leo in a south-easterly direction from that star.

### Saturn

Comes into conjunction with the Sun at 11 p.m. on the 18th, and is hence absolutely invisible.

### Uranus

Is now so rapidly approaching the west, that, like Jupiter, to be seen at all, he must be observed immediately it is dark enough. He is in quadrature with the Sun at 2 a.m. on the 20th. His diameter subtends an angle of 3·8″ during the whole of June.

| Day of Month. | Right Ascension. | Declination North. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 11 56·8 | 1 9·7 | 7 15·1 p.m. |
| 6 | 11 56·8 | 1 9·6 | 6 55·4 ,, |
| 11 | 11 56·8 | 1 9·1 | 6 35·8 ,, |
| 16 | 11 57·0 | 1 8·0 | 6 16 2 ,, |
| 21 | 11 57·2 | 1 6·4 | 5 56·8 ,, |
| 26 | 11 57·5 | 1 4·2 | 5 37·4 ,, |

Whence it will be seen that Uranus remains almost sensibly stationary between β and η Virginis.

### Neptune

Is, for the observer's purpose, invisible.

### Shooting Stars

Are rare in June. The nights of the 6th and 20th are those on which indications of showers exist.

### Greenwich Mean Time of Southing of Eight of the Principal Fixed Stars on the Night of June 1st, 1885.

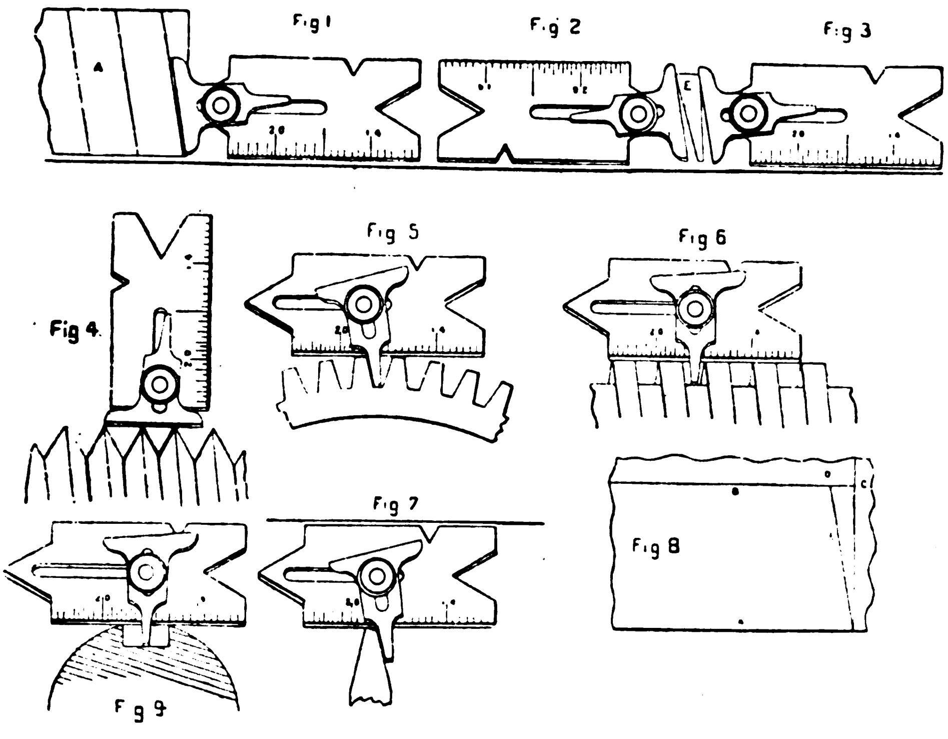
| Star. | Souths. h. m. s. |
|---|---|
| η Ursæ Majoris .. .. | 9 1 1·30 p.m. |
| Arcturus .. .. .. | 9 28 21·59 ,, |
| α Libræ .. .. .. | 10 2 22·76 ,, |
| α Coronæ .. .. .. | 10 47 32·99 ,, |
| α Serpentis .. .. .. | 10 56 18·83 ,, |
| Antares .. .. .. | 11 39 57·54 ,, |
| $\alpha^1$ Herculis .. .. .. | 12 26 51·97 ,, |
| α Ophiuchi .. .. .. | 12 47 0·19 ,, |

The method of finding the Greenwich Mean Time of Southing of either of the Stars in the above list for any other night in June, as also that of determining the local instant of its Transit at any other Station, will be found on p. 356 of Vol. XL.

## THE INTERNATIONAL INVENTIONS EXHIBITION.—IV.

### Prime Movers and Distribution of Power.

THE exhibits in Group IV., Prime Movers, and their numerous accessories, are located for the most part in the South Gallery of the Middle Court; but, as might be expected, some of the most notable of the prime movers are doing useful work in various parts of the Exhibition, and others are employed in giving practical demonstrations of their capabilities in the grounds. Of these the most attractive from the popular point of view are undoubtedly the Mekarski compressed-air tramcar and Mr. Holroyd Smith's electric tramway, both of which, by the time these lines are read, will be in full working order on the railroads laid down outside the buildings in what is called the South Promenade. We have described the Mekarski compressed-air tramcar more than once in previous volumes, and we need only say here that it is one of the best of the schemes for propelling tramcars by a store of compressed air. Tolerably full details of its construction will be found in Vol. XXXVI. p. 63, and there is an account of experimental trips on the Caledonian-road in Vol. XXXVII. p. 485, while there are general articles in Vol. XXXIV. p. 245, and Vol. XXXIII. p. 2. This exhibit serves to display the merits of several inventions, for besides the car itself, the "permanent way" illustrates the Denham-Olpherts-Molesworth system, and the air-compressing engines give a practical demonstration of the capabilities of the Northcott devices as made by the General Engine and Boiler Co., of the Hatcham Ironworks, S.E. The steam-engine is fitted with a simple and novel form of governor, consisting of two pieces of chain kept taut by a spring on the governor spindle. As the speed increases, the chains tend to assume curves, and thus actuate the throttle valve. A house has been erected, in which the tramcar receives its store of power, and the line itself being laid with a rather sharp double curve is sufficient to test the running power of the car on the level, though it would have been more satisfactory if a hill or two could have been introduced. However, the exhibitors have done the best they could with the means at their disposal, and they demonstrate in a satisfactory manner that, so far as mechanical considerations are concerned, a tramway can be driven by means of compressed air. In this connection the question is simply one of economy, and admitting the advantage of compressed air in the shape of complete avoidance of smoke and noise, it may be doubted whether it will successfully compete with steam applied direct. The Mekarski system, it will be remembered, has been at work for some years in Nantes, and all the little difficulties have been overcome, the "hot pots" for warming the air effectually checking the tendency to freeze up. Mr. Holroyd Smith's electric tramcar, working on the system which is being put into working order on a considerable length of line at Blackburn, was ready on Saturday last, and will undoubtedly attract much attention; but at present there is no sign of Rammell's pneumatic railway on the impulse system, although Messrs. Walker Bros., of Wigan, are ready with the fine air-compressing machinery, a specimen of which is shown at their stand in the Middle Court. In the grounds forming the South Promenade Messrs. Dick, Kerr, and Co. show their portable railway and rolling stock, the little side-tank locomotive being fitted with Morton's valve-gear. The South-Eastern Railway Co. exhibit a coal truck and a goods waggon specially constructed for express speed—a class of traffic this company is largely developing in connection with the Continent. In the buildings themselves the best exhibit of prime movers is probably that of the gas-engines—at least, they present the greatest novelties. Messrs. Crossley Brothers, of Openshaw, besides the engines on loan and used for various purposes by other exhibitors, show at their stand a 7 h.p. of new design, with the self-starting arrangement; but their principal novelty is the double-cylinder engine of 4 h.p., specially designed for electric-lighting purposes, where steadiness of running is a desideratum. This engine has an impulse at every revolution, and the charge of gas is automatically increased or decreased as required. An incandescent electric lamp is, in fact, an excellent tester of steady running in a gas-engine, as it indicates every impulse by slight changes in the incandescence. A new vertical model is also shown by Messrs. Crossley, which will attract much attention from those who require about 1 h.p. It is ¾ h.p. nominal, and is notable for the small space it needs. Engines of the well-known pattern are to be seen driving printing machines, dynamos for electro-plating, hoisting apparatus, the Aquarium pumps, &c. The British Gas Engine and Engineering Co. exhibit Atkinson's well-known gas-engine, and an entirely new and novel pattern, which it is almost impossible to describe without engravings. Two bent lever arms pivoted in the centre are connected at their upper ends by links to the crank-pin, while the lower ends are attached to plain plunger pistons, working in a horizontal cylinder at the foot of the casting. There is no valve gear and no slide, the pumping piston and the working piston by their peculiar differential action covering and uncovering the passages for the supply, exhaust, and ignition, an impulse being, of course, given at each revolution. The ignited charge is expanded to about double its volume; but a feature of special interest is the rapidity with which the power is developed, thus reducing the loss of heat to the water jacket. Andrew and Co., of Stockport, show the small Bisschop engine, and the more recent Stockport pattern, which runs with much steadiness, as shown at work. Sterne and Co., of Glasgow, exhibit a Clerk engine with self-starting gear, the principle of which was fully described in No. 1011. Amongst other engines the Körting, exhibited by Körting Bros., of Pancras-lane, E.C., is shown running; but although it is without slides, it has too much gear about it to commend it to the mechanic. It, however, occupies but little space. The Withers gas-engine, exhibited by Beynon and Cox, of Torquay, is a simple vertical, actuated by a single piston valve operated by a cam, which instantaneously opens the port and closes it as quickly, thus insuring a full charge. The consumption of gas for a 1 h.p. engine is stated to be 44 cubic feet per hour, an explosion taking place at every revolution. Statements about the consumption of gas per i.h.p. are, however, not of much value, and the jury would do a useful piece of work if before making their awards they tested the relative economy of the different engines. Another simple vertical engine is one shown by Mr. R. Skene, of Wickham-street, S.E. The simplest gas-engine is exhibited by Edwards and Co., of Southampton-buildings, for apparently it has no gear at all; but as it is not shown in motion, it is impossible to form any opinion of its merits. Clarke and Gillespie, of Stevenage, exhibit a small engine of 2-man power called the Syrinx, which is certainly compact, and there are some others of no particular importance, but which help to make a tolerably complete collection, from which the buyer will have some difficulty in making a selection. Hot-air engines are shown by Hayward Tyler and Co.; Bailey and Co., of Salford; and by the Britannia Company. The first-named exhibit the Rider engine, but Messrs. Bailey have a very compact vertical, on Lehmann's patent, the horizontal type of which we illustrated in No. 794. In this engine the expanded air is cooled by water, and immediately returned to the heating chamber. The Britannia Company have two small hot-air engines, one driving a lathe; but those are suitable only for gas, while the Rider and that exhibited by Messrs. Bailey, though working by gas, are adapted for burning any kind of fuel. Of steam-engines the chief novelties are in connection with the valve-gear, though the compound tandem triplex of Goodfellow and Matthews will be new to many visitors. It has three sets of cylinders arranged radially round the crank-shaft, each set consisting of a large and small cylinder, through both of which steam passes in succession. The pistons are in the form of plungers of two diameters, the smaller portion working in the high-pressure cylinders, and all three coupled to one crank. One eccentric and strap, working valves of the piston type, distributes steam to all six cylinders. Three of these engines are at work driving dynamos, work for which they are specially designed. The Willans engine as applied in launches is exhibited at work in the Middle Court, and in the electric lighting shed driving a dynamo. A curiosity amongst these new high-speed engines is the Parson's four-cylinder exhibited by Kitson and Co., of Leeds, for not only does the crank-shaft revolve, but the cylinders rotate around the shaft at half the velocity of the latter. It is impossible to give any idea of this engine without drawings. Mr. Bumsted, of Hednesford, exhibits Chandler's high-speed engine, which is capable of driving dynamos direct up to 1,200 revolutions. The engine is of the type in which the piston is of the hollow plunger pattern, coupled direct to the shaft by one rod, and is thoroughly lubricated by the crank pin itself revolving through oil at each turn. The engine is shown driving a dynamo at 1,500 revolutions by rope gearing, running itself at 750. Heenan and Froude exhibit the Tower spherical engine coupled to a Crompton dynamo. A model in wood will help the visitor to understand this altogether novel and ingenious device, which it is difficult to explain even with the help of diagrams. Amongst the steam engines in the Middle Court which are shown in motion, that exhibited by D. Adamson and Co., of Dukinfield, will attract attention. It is a Wheelock automatic cut-off engine, with 16in. cylinder and 3ft. stroke. The steam passages are at the bottom to insure thorough drainage, and at each end is a bored chamber filled with a partially rotating valve, which acts like an ordinary slide-valve, placing the passage in connection with either the steam or the exhaust. Between the main-valve chambers is a central steam chamber fitted with cut-off valves, which give a free opening with very small movement. No steam can leak into the exhaust without passing both cut-off and main valves. Mr. Ogden, of Ashton-under-Lyne, also has an attractive exhibit in the shape of a "Manchester" automatic expansive engine, which is shown running. The cylinder is simply a pipe with flanges. The valves, steam, exhaust, and cut-off, are independent of each other, and can be adjusted; the grade of cut-off from no steam to three-quarter stroke is under the control of the governor. The Corliss gear is silent and simple. Marshall and Co., of Nottingham, Hornsby and Sons, of Grantham, and Robey and Co., of Lincoln, exhibit splendid specimens of the semi-fixed compound engines, which have found so much favour during recent years. In the case of Robey's engine, it is fitted with Richardson's patent electric regulator for maintaining a constant electric current on a circuit. An electro-magnet acts upon a heavy armature, which is attached to a lever that operates a steam valve, so that in the event of an accident to the lamps, the steam would be shut off, or the speed reduced in proportion to the number of lamps cut out. This engine is shown driving the exhibit of the Kirkstall Forge Company, consisting of their rolled shafting. Specimens are shown in all sizes, from $\frac{5}{16}$in. to 6in., and 20ft. long, and they are rolled so straight, round, and true that no turning is required. Couplings and adjustable bearings are shown in connection. For this shafting an increase of 20 per cent. in torsional strength, and 33 per cent. in flexional strength is claimed. Duncan Brothers, of Queen Victoria-street, exhibit a compound non-condensing launch engine, with Bremme's patent valve-gear for expansion and reversal, a simple arrangement which has replaced the ordinary link-motion in many cases. Howard Lane and Co., of 115, Palmerston Buildings, E.C., exhibit the Lane sectional steam boiler, and a model cylinder boiler with their interior electric lamp fittings for observing the action while at work. The eyepiece is a fitting containing two pieces of glass, and the incandescent lamp is fitted into a bulb of thick glass. A Root sectional boiler is shown close by, and Galloway and Sons, of Manchester, exhibit a boiler similar to those at work, with portions of the sides removed so that the scum troughs and anti-priming pipe can be seen. Durham, Churchill, and Co., of Leadenhall-street, exhibit specimens of their well-known velometers, and a compound spiral piston packing which is so arranged that the rings will expand only to a certain extent, no matter how tightly screwed up. The packing consists of a series of spirals connected together by short lengths of straight wire, instead of a continuous spiral all round the piston. The Venetian Air-valve Furnace Bar Co., of Walbrook, exhibit Galley's movable angled feather furnace bars, and the Rocking Fire Bar Syndicate also exhibit their fire bars with automatic rocking apparatus. Several firms show applications of friction driving gear for working dynamos, and Prof. J. A. Ewing also exhibits a model of his system of gearing by which power is transmitted by rolling friction. Prof. Fleeming also illustrates by a large model his nest gearing, as it is called, which transmits power by rolling friction between drums so arranged as to relieve the bearings of direct pressure. We described this invention on p. 338, Vol. XXXIX. Mr. Hindley, of Queen Victoria-street, shows several examples of his portable steam-engines specially adapted for small power users; and Mr. J. Brady, of Rudgwick, Sussex, shows a light combined traction and stationary engine, weighing 34cwt., which is entirely under the control of one person. It has two cylinders, and is carried on three wheels; but we should like to see it at work on rough roads before expressing an opinion of its merits as a traction engine. Mr. R. M. Marchant, of Fenchurch-street, was, at the time of our visit, erecting the plant to exhibit his system of returning the exhaust to the boiler, and when at work it will doubtless attract some attention as an attempt to use steam in the complete circle, which, it must be confessed, is not considered economically feasible by engineers generally. Mr. Kirkaldy, of West India Dock-road, asks the attention of engineers and mechanics to his remarkably small surface condensers containing spiral coils of cold-water pipes, which are certainly remarkably efficient. Injectors, speed indicators, and recording instruments are shown by several firms, some of them at work in connection with the various boilers and engines, particularly in the electric-lighting shed, and the numerous steam-pipes connected to the various engines are in all cases coated with some of the non-conducting compositions; Leroy and Co., of Gray-street, E., having also at their stand a variety of exhibits showing what can be done with their composition, and a special manufacture, which is sufficient when only one inch thick. Pulleys are shown by several firms, those most noticeable being the light varieties made of steel and wrought iron, and those with perforated faces, which are supposed to enable the belt to take a firmer grip. Belting is shown in great variety, both at the stands of the exhibitors and driving various machines; there are also some belt fasteners, but nothing very novel in character. Boiler feeders are exhibited in model and full size, Fromentin's being on view in the shape of drawings and model at Stand No. 470, while mechanical stokers are represented in full size, but so far as we have been able to discover none of the boilers at work is fitted with one. There is undoubtedly much prejudice against mechanical stokers; but an examination of those exhibited will show that there is no reason why fuel should not be automatically fed to a steam-boiler. Lubricators are exhibited at the stands, and also in great variety on the different engines and machines—Trier Brothers showing a good collection of Stauffer's devices, with Akaiser's mechanism for obtaining step-by-step rotary motion in numerical counters for machinery. Mr. D. Joy exhibits a moving cardboard model of his gear, two sets operating the three valves of a triple engine, and a quadrant block from a L. and N. W. goods engine which has made 48 million revolutions. H. and T. C. Batchelor, West Kensington, show one of their patent "motion drawings" in the shape of the engines of the Atlantic liner *America*. These drawings are on cardboard, cut out and laid over one another, so that the parts can be moved to various positions of the motion. This group embraces so many exhibits of interest, that it is scarcely possible in the available space to do much more than indicate what is to be seen; but it contains exhibits which properly come under other heads.



## WYKE'S SCREW-CUTTING GAUGE.

These gauges are made by J. Wyke and Co., East Boston, Mass. The engravings, with the following description, will explain the uses of the tool:—To get the rake of thread of any pitch whatever, take a piece of sheet metal (or other material) Fig. 8, with one edge A true. Then lay off a line B, the same distance from the edge A, as the diameter of the screw to be cut. Then draw line C at right angle with edge A. Then from line C, on line B, measure off half the pitch D, and draw line E, which will be the angle or rake required for the tool. Set the gauge as shown in in Fig 1. When the gauge is set to the line as shown Fig. 1, it is then set to use when making tool, and is applied to both sides as shown in Figs. 2 and 3. E represents the tool with clearance allowed. When the gauge is set to the rake of any right hand thread, by simply turning it over on the other edge it become set for left hand. When cutting V-threads, the gauge can be used for grinding angle of tool (60°) and setting the tool square on rest; also for depth and for testing accuracy of thread. When testing accuracy of thread, set the gauge down in the thread as shown in Fig. 4. Then reverse the gauge, and if the thread is not correct it will be seen at once. This can be done before the screw is quite finished, thus giving time to finish correctly. When cutting bastard threads, the gauge can be used for depth angle of thread, and setting tool correctly on rest as shown in Figs. 5 and 7. (The line represents the bar in the lathe, and the tool is supposed to be in the rest.) Also, for testing whether the thread be perpendicular to the axis of the screw. When cutting worms to suit gears, set gauge as shown in Fig 5. It is then set for depth of thread, also for testing thread and setting tool correctly on rest. When cutting square threads, set the gauge to half the pitch by scale, and you have the depth required as shown in Fig. 6. The gauge can be used for taking all depths of the Franklin Institute Standard threads, also standard worm threads from the regular standard gauges. It can be used for getting equal clearance when making cutting-off tools, and as a depth gauge when cutting gears, drilling and planing out key seats, &c., as shown in Fig. 9; also as a depth and angle gauge for many purposes. These gauges are made in two sizes. No. 1 has a graduated scale 2in. long, and can be used for all threads up to ¾in. pitch. No. 2 has a graduated scale 3in. long, and can be used for all pitches from ¾in. to 2½in. pitch, or for other purposes, as mentioned.—*American Machinist.*

## THE WAVE THEORY OF LIGHT.

By Prof. Oliver Lodge.

In a recent issue of the *Engineer*, under the head "A Scientific Mistake," is an article asking a question, an answer to which it is easy to give. The writer says he will be gratified by hearing that unsoundness in the wave theory of light has been admitted by teachers or writers of textbooks. To a certain extent I am able to gratify him, then; for, though I cannot answer for all teachers or text-books, I can assure him that the wave theory of light has been felt to be unsatisfactory ever since its inception at the beginning of this century. To call it "unsound" is too strong; to call it "unsatisfactory" is what all good teachers are, I believe, accustomed to do every time they expound it. Let me explain the difference. A wave theory of light is certainly and demonstrably true. That is to say, light does consist of waves. But what does one mean by a wave? A hump on the top of the sea? That is one kind of wave, and by no means a very simple kind, but it is scarcely the kind that constitutes light. But what does one mean by a wave? An oscillation or vibration of some form of matter? Not necessarily. What then? A periodic disturbance? Yes, a disturbance of a medium *periodic both in space and time.* Note the definition. Now light indubitably is periodic in space and time, and hence it is a wave motion. So far all is certain; and from this certainty alone a host of facts, diffraction, &c., &c., are instantly explicable. But now, when we try to go further, and to ask what is moving, and with what sort of motion, we are landed in many difficulties; and progress is impeded, either by want of hypothesis altogether, or by cumbrous and artificial ones. The natural early view was that the wave motion was a material motion just like motions to which we were accustomed in sound and other of the more tangible phenomena, although minute beyond ordinary recognition. This mechanical view of the wave theory, as an actual bodily oscillation of some jelly-like substance seems to me doomed. With great ingenuity it can be made to account for a multitude of the facts, and it apparently numbers among its present adherents the magnificent name of Sir William Thomson. I venture to think, nevertheless, that it will be abandoned; and the periodic disturbance which constitutes light will be sought, not in the mechanical oscillation of ordinary matter, but in the subtle oscillation of the electric medium as conjectured, and more than half-verified, by Clerk-Maxwell. Calling a disturbance "electrical" instead of "mechanical" is rather like calling a phenomenon "chemical" instead of "physical," when we mean to say we do not understand it; but such a statement means more than simply saying we do not understand it—it relegates light to a host of more or less familiar phenomena with which every day we are becoming better acquainted; it marks its relationship and family in the general body of knowledge; and it gives us the assured hope that as soon as the nature of electricity is better and more intimately known, then will the nature of a wave of light also begin to be clearly and definitely intelligible.

## TWO NEW TYPE-WRITERS.

Two new type-writers have recently been introduced to notice. One, the invention of Mr. E. Peacock, a journalist, is a portable type-writer and manifolding machine. The "dial" type-writer consists of a small brass cylinder 4½in. diameter and 2½in. high, the top forming a dial around which are engraved two circles of characters, the outer circle comprising the capital letters of the alphabet and the numerals, and the inner circle the small letters, signs, and quotation and punctuation marks. Corresponding types are carried radially in two horizontal circles within the cylinder, and by pressing a small lever either set can be brought into play. Around the edge of the dial are a series of countersunk holes corresponding to the letters against which they are radially placed. Attached to a spindle in the centre of the dial, and revolving about it like the handle of a domestic coffee-mill, is a short lever, on the under side of the outer end of which is a pin, which fits into the holes formed around the rim of the dial. Upon this lever being depressed over any letter or figure it causes a corresponding type to be smartly projected horizontally through a small aperture in the cylinder. Inking rollers are provided on either side of this opening, and, the types having been inked in passing them, impressions are made on the paper, which is carried on a roller in front of the striking point. This roller is traversed automatically from left to right, and when the end of a line is reached the roller and paper are sent back by touching a small stop, which also causes the roller to turn partially round, thus presenting a fresh surface of the paper for the next line. By depressing another small stop spaces are made between the words. In this way the machine prints a single copy on ordinary paper, but by the use of tissue paper and carbonic sheets placed alternately it is stated that as many as 20 perfectly legible impressions can be produced at once.

Another, the invention of Messrs. T. G. and H. Daw, consists of a series of levers carrying at their outer ends the printing types, both letters and figures. These levers are arranged in a circle about 7in. in diameter, and are actuated by piston-keys or plungers placed above them in two concentric circles. Upon a piston being depressed by the finger the type connected with it is sharply brought from the vertical to the horizontal position, each type striking a point central to the circle formed by the whole; one type only can therefore be in effective operation at one time. The types are similar to those used in printing—that is, they are the reverse of the letter or figure produced, as the impression is formed on the under side of the paper on which they strike. This paper is carried on a cylinder around which carbonic paper is first wrapped. The cylinder is automatically capable of rotation around its axis, and of a horizontal movement under the point where the types strike. The step-by-step rotation takes place as each type is imprinted on the paper, a similar step-by-step horizontal movement taking place at the end of each line. As each sheet of paper becomes covered with writing it is automatically thrown off from the roller, the latter being at the same time returned to its normal position ready for a fresh sheet of paper. On this being placed on the roller the machine is ready for the next start. By using several sheets of paper and placing carbonic sheets between them it is stated that six copies can be produced at the same time. The type requires no cleansing, as the paper is struck on the reverse side to the colouring matter, which latter can be easily renewed from a roll of carbonic paper placed within the cylinder.

## THE COLOURING MATTERS OF FLOWERS AND FRUITS.

A very interesting communication has recently appeared in the *Verhandlungen der Physik Med. Gesellschaft zu Wurzburg* on the subject of the colouring matter in flowers and fruits, contributed by Dr. A. Hansen. It appears that a relatively small number of pigments serves for the production of the seemingly endless variety of colour in flowers and fruits. The white and black shades which we encounter there are not due to any special colouring matter. White is due merely to the reflection of light through colourless tissues containing air. Blacks owe their origin merely to the dense concentration of violet pigments. If we set aside chlorophyll green, which is rarely met with in flowers, we may recognise the three following groups of colours:—(1) Yellows, (2) reds, (3) blues and violets. Hildebrand has previously demonstrated that the yellows are mostly in combination with the plasmic substance, whilst the colours of the second and third group are generally found existing in the cell-sap. The yellow of flowers forms an insoluble compound with fatty matters, as was demonstrated by Krukenberg in the animal kingdom under the name of lipochrome (this may go far to account for the general comparative permanence of the yellow colours both of plants and animals). The yellow pigment, obtained by Hansen in a pure crystalline state by saponification with soda and extraction with petroleum ether, agrees in its behaviour with lipochromes. The spectra of the pigments of different yellow flowers agree with each other so closely as to lead to the conclusion of their mutual identity. Between the F and G lines there occur two absorption bands, which do not, however, always occupy exactly the same position. The solutions are not fluorvescent. Orange is formed by a denser deposit of the yellow pigment. Thus the colour of the rind of an orange is due to the same pigment as is found in the yellow flowers of *Ranunculus repens* (butter-cup, king-cup). The colour of yellow dahlias and of lemon rind is not a lipochrome. It is soluble in water, and behaves differently both chemically and spectroscopically, displaying, for instance, no absorption bands. It is very similar to the pigment of *Æthalium septicum* (the yellow fungus or mould on rotten wood) examined by Krukenberg.

The reds of flowers may be reduced to a single pigment—the rose-dye of roses, carnations, peonies, &c. It is soluble in water, and is decolourised in alcohol, probably in consequence of dehydration. On the addition of an acid the colour is restored. The spectrum displays a broad absorption-band between D and F. The varying intensity of the colours of roses, carnations, and peonies depends probably on the presence of acids. The scarlets and brick-reds of poppies, scarlet lilies, the berries of the dog-rose, &c., are produced by the simultaneous presence of lipochrome.

The blue and violet pigments turn pale also in alcohol. The solution is reddened by the addition of an acid, as was noticed by Fremy and Marquardt. They assumed, therefore, that the red colours were merely blue pigments modified by acids. Hansen, on the other hand, holds that the blue and violet colours are derivatives of the red. In favour of this view is the fact that certain blue and violet flowers (*Boragineæ*) are at first red. The flowers of *Erica cinerea* (pine-leaved heath) are on opening red, but turn more to a violet on fading. On the contrary, the corolla of many fuchsias passes from a bluish violet to a red. Salts of iron turn the red of peony flowers to a violet. It is well known that gardeners can produce blue Hortensias by adding iron to the soil. Peony red is turned to a violet by the addition of sodium phosphate, and larger quantities of the same reagent render it blue. The spectrum of the blue and violet pigments has two absorption bands between D and *b*. These pigments also may be combined with lipochrome yellow, they producing the colour of the berries of *Ampelopsis* (Virginian creeper). Hansen does not refer to the red, blue, and violet colour granules which occur here and there in flowers and fruits. He assumes, therefore, only four fundamental pigments—soluble yellow, lipochrome yellow, flower-red, and chlorophyll green. He opposes the view that all colours are derived from chlorophyll green, since their specia do not agree. The change of colours of green fruits and green leaves in autumn he accounts for by the destruction of the chlorophyll, and either the simultaneous formation of new pigments, or the unmasking of lipochrome which existed previously, but which was concealed by the chlorophyll. Brown decomposition products co-operate in the production of the autumnal colours.

## ELECTROTYPING.

THIS eminently useful application of the art of electrotyping originated with Volt, Cruickshank, and Wollaston about 1800 or 1801. In 1838, Spencer, of London, made casts of coins and cast in intaglio from the matrices thus formed; in the same year Jacobi, of Dorpat, in Russia, made casts by electro deposit, which caused him to be put in charge of the work of gilding the dome of St. Isaac at St. Petersburg. Electrotyping for the purposes of printing originated with Mr. Joseph A. Adams, a wood-engraver of New York, who made casts (1839-41) from woodcuts, some engravings being printed from electrotype plates in the latter year. Many improvements in detail have been added since, in the processes as well as the appliances. Robert Murray introduced graphite as a coating for the forme moulds. He first communicated his discovery to the Royal Institution of London, and afterwards received a silver medal from the Society of Arts.

### Blackleading the Forme.

The process of electrotyping is as follows: The forme is locked up very tightly, and is then coated with a surface of graphite, commonly known as blacklead, but it is a misnomer. This is put on with a brush, and may be done very evenly and speedily by a machine in which the brush is reciprocated over the type by handwheel, crank, and pitman. A soft brush and very finely powdered graphite are used; the superfluous powder being removed, and the face of the type cleaned by the palm of the hand.

### Taking the Mould.

A shallow pan, known as a moulding pan, is then filled with melted yellow wax, making a smooth, even surface, which is blackleaded. The pan is then secured to the head of the press, and the forme placed on the bed, which is then raised, delivering an impression of the type upon the wax. The pan is removed from the head of the press, placed on a table, and then built up, as it is termed. This consists in running wax upon the portions where large spaces occur between type, in order that corresponding portions in the electrotype may not be touched by the inking roller, or touched by the sagging down of the paper in printing.

### Making the Deposit.

The wax mould being built, is ready for blackleading, to give it a conducting surface upon which the metal may be deposited in the bath, superfluous blacklead being removed with a bellows. Blacklead, being nearly pure carbon, is a poor conductor, and a part of the metal of the pan is scraped clean, to form a place for the commencement of the deposit. The back of the moulding is waxed, to prevent deposit of copper thereon, and the face of the matrix is wetted to drive away all films or bubbles of air which may otherwise be attached to the blackleaded surface of the type. The mould is then placed in the bath, containing a solution of sulphate of copper, and is made a part of an electric circuit, in which is also included the zinc element in the sulphuric acid solution in the other bath. A film of copper is deposited on the blacklead surface of the mould, and when this shell is sufficiently thick it is taken from the bath, the wax removed, the shell trimmed, the back tinned, straightened, backed with an alloy of type-metal, then shaved to a thickness, and mounted on a block to make it type-high.

A recent improvement has been introduced, in which there is added finely pulverised tin to the graphite for facing the wax mould: the effect in the sulphate of copper bath is to cause a rapid deposition of copper by the substitution of copper for the tin, the latter being seized by the oxygen, while the copper is deposited upon the graphite. The film is after increased by the usual means. Knight's expeditious process consists in dusting fine iron filings on the wet graphite surface of the wax mould, and then pouring upon it a solution of sulphate of copper. Stirring with a brush expedites the contact, and a decomposition takes place; the acid leaves the copper and forms with the iron sulphate a solution which floats off, while the copper is freed and deposited in a pure metallic form upon the graphite. The black surface takes on a muddy tinge with marvellous rapidity. The electric-connection gripper is designed to hold and sustain the moulding pan and make an electric connection with the prepared conducting pan of the mould only, while the metallic pan itself is out of the current of electricity, and receives no deposit.

### Backing-up.

The thin copper-plate, when removed from the wax mould, is just as minutely correct in the lines and points as was the wax mould and the original page of type. But it is obvious that the copper sheet is no use to get a print from. You must have something as solid as the type itself before it can be reproduced on paper. So a basis of metal is affixed to the copper film, and this again is backed up with wood thick enough to make the whole type-high. To get this, a man melts some tinfoil in a shallow iron tray, which he places on the surface of molten lead, kept to that heat in square tanks over ordinary fires. The tinfoil sticks to the back of the copper, and on the back of this is poured melted type-metal, until a solid plate has been formed, the surface of which is the copper facsimile and the body white metal. The electro metal plate, copper coloured and bright on its surface, has now to go to the finishing-room.

Here are two departments. In one the plates are shaved and trimmed down to fit the wood blocks, which are made in the other department. Some of these operations are done by hand, but it is very interesting to see self-working machines planing the sheets of metal to precisely the required thinness with mathematical exactness. A pointed tool is set to a certain pitch, and the plate of metal is made to revolve in such a way that one continuous curl shaving falls until the whole surface (back) has been planed perfectly true. The wood blocks are treated in the same way, after being sawn into the required sizes by a number of circular saws. Another set of workmen fit and join the metal to the wood, trim the edges, and turn the blocks out type-high and ready for working on the printing press.

### A Wet Blackleading Process.

In Messrs. Harper's establishment in New York, an improved wet process of blackleading is adopted. The wax mould is laid face upward on the floor of an inclosed box, and a torrent of finely pulverised graphite suspended in water is poured upon it by means of a rotary pump, a hose, and a distributing nozzle which dashes the liquid equally over the whole surface of the mould. Superfluous graphite is then removed by copious washing, an extremely fine film of graphite adhering to the wax. This answers a triple purpose; it coats the mould with graphite, wets it ready for the bath, and expels air bubbles from the letters. This process prevents entirely the circulation of blacklead in the air, which has heretofore been so objectionable in the process of electrotyping.

### A New Foreign Process.

The galvanoplastic process of M. Coblence for obtaining electrotypes of wood-engravings is as follows: A frame is laid upon a marble block, and then covered with a solution of wax, colophane, and turpentine. This mixture on the frame, after cooling, becomes hard, and presents a smooth, even surface. An engraved wooden block is then placed upon the surface of the frame and subjected to a strong pressure. The imprint on matrix in cameo, having been coated with graphite, is then placed vertically in a galvanoplastic bath, and a cast, an exact reproduction of the wood-engraving, is obtained. The shell is then backed with type metal and finished in the usual way.—*Printer and Stationer.*

## SCIENTIFIC SOCIETIES.

### ROYAL METEOROLOGICAL SOCIETY.

THE usual monthly meeting of this Society was held on Wednesday evening, the 20th inst., at the Institution of Civil Engineers, 25, Great George-street, Westminster; Mr. R. H. Scott, F.R.S., President, in the chair.

Dr. H. Dobell and Mr. J. N. Longden were elected Fellows of the Society.

The following papers were read:—(1) "The Temperature Zones of the Earth considered in Relation to the Duration of the Hot, Temperate, and Cold Period, and to the Effect of Temperature upon the Organic World," by Dr. W. Koppen, Hon.Mem.R.Met.Soc. (2) "Velocities of Winds and their Measurement," by Lieut.-Col. H. S. Knight, F.R.Met.Soc. The author, after describing the various ways of ascertaining the direction and velocity of the wind, makes several suggestions for the improvement of Robinson's anemometer. (3) "On the Equivalent of Beaufort's Scale in Absolute Velocity of Wind," by Dr. W. Koppen, Hon.Mem.R.Met.Soc. The author refers to Mr. E. Harding's paper read before the Society in December last on the anomalies in the various wind velocities given by different authors as equivalents for the numbers in Beaufort's scale; and, as illustrating the point, calls special attention to the want of agreement between the velocities obtained by Mr. Scott and those subsequently obtained by Dr. Sprung and confirmed by himself. (4) "Note on a Peculiar Form of Auroral Cloud seen in Northamptonshire, March 1st, 1885," by the Rev. James Davis.

**Atmospheric Electricity.**—Professor Palmieri, of the Vesuvian Observatory, has recently published some observations of interest on atmospheric electricity. In clear weather the atmospheric electricity is usually positive, if negative a downfall of rain, &c., may be inferred to be going on at some little distance. There is a maximum of atmospheric electricity at 9 a.m., another soon after sunset, which often continues during a great part of the night. A minimum takes place before daybreak, and another in the afternoon. This periodicity is, however, disturbed by atmospheric movements. When the maxima are very pronounced, cloudy weather often follows. If the sky becomes overcast the electric indications grow stronger, and if at the time of the evening maximum the relative moisture increases with a heavy dew, maxima of special duration and intensity may be expected. The assumption that atmospheric electricity becomes stronger with altitude is not borne out by the Vesuvian observations. Lower potentials are generally observed on hot summer days; in spring and autumn the indications are stronger; in winter they are uncertain. On cloudy days the potential is less intense, but positive; during rain the potential increases. A rain zone is positive but surrounded by a negative zone, which again is surrounded by a zone of positive electricity. According to Palmieri, there is no thunder and lightning without rain.—*Engineering.*

**To Clean Marble.**—Brush the dust off, then apply with a brush a good coat of gum-arabic about the consistency of thick mucilage, and expose it to the sun or wind to dry. In a short time it will peel off. If all the gum should not peel off, wash it with clean water and a clean cloth. If the first application does not have the desired effect it should be tried again. Another method is to rub the marble with the following solution: ¼lb. of soft soap, ¼lb. of whiting, and one oz. of soda, and a piece of stone blue the size of a walnut; rub it over the marble with a piece of flannel, and leave it on for twenty-four hours, then wash it off with clean water, and polish the marble with a piece of flannel or an old piece of felt; or take two parts of common soda, one part of pumice-stone, and one part of fine-powered chalk, sift it through a fine sieve, and mix it with water, then rub it well over the marble, then wash the marble over with soap-and-water.

# SCIENTIFIC NEWS.

AMATEUR astronomers all the world over, and our readers in particular, will regret to hear of the death of the Rev. Thomas William Webb, M.A., which took place last week after a short illness. Mr. Webb graduated at Magdalen Hall, Oxford, taking his bachelor's degree as second class in mathematics in 1829. He was admitted to priest's orders in 1831, and after having held a minor canonry and the precentorship of Gloucester Cathedral with sundry curacies, he was instituted to the vicarage of Hardwick in 1856, and made the name of that place famous as the residence of the author of "Celestial Objects for Common Telescopes." A few years ago Mr. Webb was appointed a prebendary of Hereford Cathedral; but it is as a contributor to the records of observational astronomy that he will be most widely remembered, for we suppose there are few owners of telescopes who, reading the English languago, have not Webb's "Celestial Objects" in their library. Mr. Webb joined the Royal Astronomical Society in 1852, and had, we believe, completed his 78th year.

A portrait-medallion of the late Mr. Peter Squire was last week unveiled in the Pharmaceutical Society's house in Bloomsbury-square by Sir Spencer Wells, Bart., in the presence of a notable gathering of members of the medical profession. To Mr. Squire we are mainly indebted for the British Pharmacopeia, and when anæsthesia was first practised in this country he constructed the apparatus used in the initial operation—apparatus which is now in the Museum of University College. Mr. Squire was one of the founders of the Pharmaceutical Society, three times president, and for 27 years its examiner in botany.

The success achieved by MM. Henry in the production of star-charts by photography with the aid of provisional apparatus, determined Admiral Mouchez, director of the Paris Observatory, to grant the requisite order for a large instrument specially constructed for the work. The results of some preliminary trials with this apparatus have been recently reported to the Academy of Sciences, Admiral Mouchez expressing the opinion that the problem of constructing celestial charts, including all stars down to the 15th magnitude, is now solved. The minimum times of exposure required to secure impressions of stars visible to the naked eye vary from ·01 to ·5 of a second; for 12th magnitude stars, 2m.; and for the faintest stars obtained (15th and 16th magnitude), 1h. 30m. The images are perfectly distinct, about 2,800 stars being discernible on one plate of 0·25m. surface. The report on the observatory for 1884 contains a chart of part of Perseus, reproduced from the photographic plate by heliogravure. MM. Henry have, we believe, obtained the best results with gelatino-bromide plates.

M. Stephan contributes to No. 2661 of the *Astronomische Nachrichten* a catalogue of places of 100 new nebulæ discovered and observed at Marseilles during the last two years. The places are given with great accuracy for the epoch of 1885, and short descriptive notes referring to brightness and form accompany them. This list continues that published in No. 2502, which contains 96 nebulæ discovered in 1879-82.

The dome for the observatory erected by M. Bischoffsheim at Nice is finished, and will presumably be in place shortly. The dome will rest on water carried in a trough round the observatory room, the edge of the dome being shaped so as to form a reservoir for air—a plan said to be so perfect that one person will be able to move the great weight completely round the horizon. There is a risk of the water freezing, but frosts are rare in Nice; still, experiments are to be made shortly, and in view of the effects of corrosion with salted water it is probable that some other floating medium will eventually be adopted. The dome is 22m. diameter—a little more than 72ft.

The subject of the address which Prof. W. Grylls Adams will deliver during the forthcoming meeting of the British Association is the "Electric Light and Atmospheric Absorption."

The statue of Darwin by Mr. Boehm has been placed in the great hall of the Natural History Museum. South Kensington, and will be unveiled early in June by the Prince of Wales.

The Fishmongers' Company have made a grant of £2,000 to the Marine Biological Association—£1,000 to be paid this year, and £200 per annum for the next five years.

Mr. F. O. Bower, the lecturer on botany at South Kensington, has been appointed to succeed Prof. Bayley Balfour in the regius chair of botany at Glasgow.

Dr. Kleiber, of St. Petersburg, has published the results of the investigations made by himself and Dr. Keller as to the augmentation of the earth's mass by meteors reaching it from space. On an average it is said that a single observer will see about 10 meteors per hour. A single observer, however, does not command the whole of the sky above his horizon—actually only about 23 per cent. of it; but combining a series of separate deductions, it would appear that about 450,000 meteors fall on the surface of the whole earth each hour. The average weight of a meteor, it is shown, may be taken at five grammes; whence it follows that the earth receives hourly not less than 4,960lb. of foreign material.

In a congregation held at Cambridge University last week, it was resolved to raise by way of loan the sum of £70,000 for the erection of the proposed new chemical laboratory and the Sidgwick Geological Museum.

The Seventy-first Annual Report of the Council of the Royal Geological Society of Cornwall is issued with part 7, Vol. X. of the Transactions. Amongst the papers there is an interesting description of the raised beaches of Plymouth Hoe, by Mr. R. N. Worth, and an important contribution by Mr. F. W. Millett, on the fossil foraminifera of the St. Erth clay pits. The most noticable feature in this deposit is the complete absence of arenaceous forms of foraminifera; but taken as a whole, such forms as have been recognised indicate a fauna such as might be found in the shallow seas of a subtropical climate. In all probability they belong to the Tertiary period, but that point cannot be settled without further investigation.

Col. Murdoch Smith, R.E., has been appointed director of the Science and Art Museum, Edinburgh.

It is stated that while excavating at the Dumfries Gasworks the workmen came upon a bed of peat in which are imbedded the trunk of a Scotch fir, 6ft. in height, with the bark upon it; pieces of elm, oak, and hazel, with nuts and cones, broken antlers, and various coleopterous remains. In a quantity of the moss placed under glass the cranberry and other plants have begun to germinate after a sleep of centuries. This spot, which is now in the heart of the town, is supposed to have formed part of the bed of a loch in pre-historic times, and three centuries ago a mill-dam was constructed at the place, which was then a morass. The bed of conglomerate on which the peat and other top layers rest has been found to contain large fragments of red granite, a rock which is not known to exist in the immediate vicinity.

At a recent meeting of the Royal United Service Institution, Mr. F. A. Gower delivered a lecture on aërial warfare by means of torpedoes. He proposes to construct aërostats, to fill them from reservoirs of compressed hydrogen, and to send them up when a favourable wind would enable the aëronaut to drop 100lb. shells of guncotton into the midst of an army or into fortified towns.

At the Inventors' Institute last week Mr. Reckenzaun read a paper on "Electrical Tramcars," in which he described a car worked by secondary batteries. For the car there are two motors, each capable of working up to nearly 9-horse power, and weighing 420lb. Each motor is carried separately upon a small bogie, in such a way that each bogie forms a small locomotive engine, upon which the car rests. One axle of each bogie is a driving axle; thus are actuated four small driving wheels. The speed of the motors is high, about 1,000 revolutions per minute when the car is running at seven miles an hour. The gearing employed is a worm on each motor shaft, and worm-wheels on the driving axles, giving a ratio of about 1 to 12. This worm gearing is incased, and the wheels work in oil, the lubrication being perfect. The variation of speed and power is obtained by means of a compound switch, which arranges the motor circuits so that the machines shall work in series, in parallel, or singly; thus the resistance of the circuit being varied, the power and speed vary accordingly. When a greater range of speed is desirable, the motor circuits are still further divided by arranging the field magnet wires apart from the armatures. This obviates cumbersome gearing.

The *Ruapehu*, of the New Zealand Shipping Company's line, has just made the fastest run home on record from New Zealand, having accomplished the distance in 36 days 15 hours. The *Tainui*, of the Shaw-Savill line, left one day before the *Ruapehu*, but was detained 27½ hours longer at Rio, and reached Plymouth two hours after her rival. This is bringing ocean travel to the regularity of the railway.

At the recent meeting of the American National Academy of Sciences, Prof. Rowland stated that the value of the ohm, as corrected by his experiments, came out as equal to 106·2 centimètres of mercury one millimètre square.

The Edison Electric Light Company have commenced several suits in New York against alleged infringers of Edison's patents for incandescent electric lighting. Mr. Edison, it should be stated, claims to be the inventor of the only means for making the incandescent light practical. "Before me, everybody who had experimented in that direction endeavoured to employ conductors of a low resistance. I took exactly the opposite course, working with conductors of high resistance. . . . Subdivision and high resistance are my discoveries, and the great principles upon which my patents are based." Mr. Edison says that the phrase "filament of carbon" was unused until he adopted it, or rather invented it.

M. Fouqué has recently read before the French Academy of Sciences an important paper on the earthquake which occurred in Spain last December. He shows that the epicentre—that is to say, the portion of the surface vertically above the centre of disturbance—was situated between Chorro and Zafarraya, in the Sierra Tejeda. In seeking to determine the depth of the seismic focus, or subterranean centre from which the earthquake shocks were propagated, M. Fouqué rejects the famous method of Mallet, which was applied to the Calabrian earthquake of 1857, and also that of Seebach, applied by Von Lasaulx to the disturbance at Herzogenrath in 1873. In place of these he suggests a new method of extreme simplicity, and requiring for its execution no other instrument than a seconds watch, by which the interval is observed between the subterranean sound and the shock which follows it. In explaining the origin of the Andalusian earthquake, M. Fouqué inclines towards the old volcanic hypothesis, and rejects the supposition that it was connected with any shrinkage consequent on secular cooling of the earth's crust.

THE Natural Gas Company of Bowling Green, Ohio, have struck a wonderful vein of gas in their second well. The pressure of gas threw mud and water out of the well. It is claimed to be the largest flow of gas ever struck, and the amount is estimated at one and a half million feet per day.

**Indelible Stamping Ink.**—For an indelible stamping ink, M. E. Johanson, of St. Petersburg, gives the following for marking textile materials by a stamp: Twenty-two parts of carbonate of soda are dissolved in eighty-five parts of glycerine, and triturated with twenty parts gum arabic; in a small flask are dissolved eleven parts of nitrate of silver in twenty parts of officinal water of ammonia. The two solutions are then mixed and heated to boiling. After the liquid has acquired a dark colour, ten parts Venice turpentine are stirred into it. The quantity of glycerine may be varied to suit the size of the letters. After stamping expose to the sun or apply a hot iron.

**The Largest Steam Engine.**—What is said to be the largest stationary engine in the world is in Lehigh County, Pennsylvania, at the famous zinc works at Friedensville. The engins is known as the President, and as now run, with sixteen boilers, is of 5,000-horse power; with double the number of boilers the capacity of the engine is 10,000 horse power. There is no pumping engine in the world that can be compared with the monster. At every revolution of its ponderous wheels it throws out a little river. The number of gallons of water raised every minute is 17,500; twenty-eight tons of buckwheat coal are consumed by the boilers every day. The driving wheels are thirty-five feet in diameter and weigh forty tons each. The sweep rod is forty feet long, the cylinder 110 inches in diameter, and the pistom rod eighteen inches in diameter, with a ten-foot stroke.

# LETTERS TO THE EDITOR.

*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

*All Cheques and Post-office Orders to be made payable to* J. PASSMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

### ζ HERCULIS—MR. GAUDIBERT'S OBSERVATIONS OF DOUBLE STARS—MR. BURNHAM'S DOUBLE STARS, &c.

[24270.]—THE angle and distance of ζ Herculis in letter 24226, about which "F.R.A.S." inquires in letter 24249, page 256, were given from calculation, not observation. I am surprised at "F.R.A.S.'s" repeated failures to see this object with 4¼in. aperture; but possibly they arise from the reasons set forth on page 157 of the XXXVth volume of the *Memoirs* of the R.A.S., though I should have thought that, with the aperture used, the small star would have been clear of the diffraction ring. The late Mr. Fletcher measured the angle of ζ Herculis on six evenings in 1851, when the *comes* was in exactly the same position as at the present time, with a telescope of precisely the same size as that employed by "F.R.A.S." Dawes saw it clearly divided with his 3·8in. refractor, when the distance was considerably smaller than it is now, and measured it at noonday with 6⅓in.; while I see, on glancing over Vol. XXVI. of the *Notices*, which happens to be bound up with my copy of Vol. XXXV. of the *Memoirs*, that Mr. Burr saw the pair well separated on the 19th of May, 1853, with only 3⅜in. aperture. The distance, according to Dawes, was then 1·66″, and the angle 80·1°. The same position angle will be reached about the spring of 1887. I received a day or two ago the following unpublished measures of this pair in a letter from the distinguished Italian astronomer, Prof. Schiaparelli.

96·05° : 1·515″ : $15^n$ : 1883·57
90·72 : 1·636 : $9^n$ : 1884·58

The results of the separate night's measures of distance in 1884 are as follows:—

1·492″ : 1884·553
1·707 : ·558
1·761 : ·567
1·725 : ·578
1·642 : ·583
1·648 : ·586
1·558 : ·589
1·642 : ·591
1·552 : ·605

The air was not good when the first measure was made. Prof. Schiaparelli has not commenced his measures of this star during the present year as yet, but I have received the following measure on one night from Mr. Tarrant:

90·0° : 1·7″ : 1885·37

This measure is marked "very good." Probably the distance given by me in letter 24226 is slightly too small. Mr. Burnham notes that it was "well seen" with 3¼in. aperture of his 6in. refractor in August, 1879 (Schiaparelli gave 1·380″ for the distance that year from eight nights' observations, and β 1·52″ from three nights), and I just saw it double two years later with 3·2in., and I notice that Mr. Gaudibert split this pair in 1882 with 3½in. side aperture of his 8½in. reflector; and that Mr. Gardiner divided it in June, 1880, with 3¼in. of a 3½in. refractor ("E.M.," Vol. XXXII. p. 378; Vol. XXXV. p. 546). I do not think, therefore, that "Beta" is labouring under any mistake as to his having seen the *comes* with a 4in. Wray this year.

The first portion of Mr. Gaudibert's letter (24224, p. 233) has, I think, already appeared on p. 261 of Vol. XL., and I replied to it on p. 298 of the same volume. I presume that the angle of δ Equulei was about 200° in December last; what is the star S. of it to which he sees a distant *comes?* I think he must be mistaken in the supposed elongation of 85 Pegasi. The *comes* is very small, not brighter than 18 mag. in Herschel's scale according to the mean of 9 estimations by its discoverer (who, with the exception of Prof. Hall with the 26in. at Washington, is the only observer who has measured it), and the distance being less than 0·6″, it could hardly be perceptible as an *elongation* of a sixth-magnitude star with only 8½in. aperture. Moreover, the angle was certainly not 310° at the end of last year. I am surprised that while Mr. Gaudibert appears to see such excessively difficult pairs as 64 Pegasi, 126 Tauri, B.A.C. 6762, β Delphini, δ Equulei, &c., without much trouble, though such objects might be supposed to be theoretically far beyond the grasp of a 8½in. mirror, yet he fails to see such comparatively easy pairs as 7 Tauri, Σ. 3121, and 25 Canum distinctly double. Sch. found 25·8°: 0·45″ for Σ. 3121 in 1882·31, the stars being in contact or divided at times with the 8 6in. refractor, power 690; the angle should now be about 35°, and the distance 0·55″. Of 25 Can. Ven. Schiaparelli writes:—"Questa stella, esaminata da me più volte nel 1875, mi era sembrata semplice. Soltanto il 5 Giugno 1876 vidi il satellite uscire fuori dalla luce della stella principale, da cui posteriormente si venne poco a poco allontanando." Ds. found 151·77° : 0·748″ : $4^n$ : 1878·41; Sch. 151·28° : 0·70″ : $8^n$ : 1882·45, the stars being "ben separate" in only moderate air in 1881 and the following year. The angle should now be about 148°, and the distance is not under 0·70″. Mr. Perry's distances are frequently much too small; but Mr. Gaudibert has overlooked Mr. Perry's measure (0·6″) in 1883·42. The angle of 42 Comæ can never be 130°; it is now about 5°, and the distance is certainly under 0·25″. The angle of 32 Orionis is probably nearer 195° than 165°, that which Mr. Gaudibert gives for ω Leonis is about correct; the position and distance calculated from Do.'s first elements are 93·5° : 0·66″; but this angle is probably too small, and the true one is nearer 103°. I do not know the quoted measures of 64 Pegasi in 1880; Mr. Burnham's measures of O.Σ. 234 are the latest I have seen. De. found only a doubtful elongation on two nights in the spring of 1877 in 139° and 116°; while Sch. found it single many times in 1875 and 1877. He suspected a prolongation of the disc in the direction of 133° on April 26th, 1879; but he writes that the observation was a *very* doubtful one.

A careful examination of the following pairs during this or next year would at once show whether they are physically or only optically double. Ceti 82 (β 395), ω Andromedæ (β 999), B.A.C. 525 (β 870), 58 Ceti (β 7), 48 Cassiopeiæ (β 513), 66 Arietis (β 878), $p^3$ 65 Leonis (β 599), 46 Virginis (A. G. C. 5); 48 Virginis (β 929), B.A.C. 3992 (β 603), Corvi 26 (Hvd. 131 = β 605), 6 Serpentis (β 32), 90 Herculis (β 130), B.A.C. 6480 (β 648), 14 Aquarii (De.), 34 Pegasi (β 290), 78 Pegasi (A.G.C. 14), 27 Piscium (β 730). I should be glad to know whether Mr. Gaudibert noted the angle of B.A.C. 3992 (β 603), when he examined that pair last year. β gives for this 7·0, 11·0; 337·7° : 1·52″ : 1878·2, and it seemed unchanged in 1880. I find with the p.m. which I have adopted that the angle should have been 22·5°, and the distance 1·73″ at the date of Mr. G.'s observation, if the stars were *not* physically connected. He mentions in letter 22820 in the "E. M." for June 6th, 1884, that he saw the *comes* separated from the large star"; but he does not give any estimate of the angle.

I would draw particular attention to the close pair, Ceti 82 (β 395). In the case of this star the p.m. is no less than 1·355″ annually, about the same as that of 85 Pegasi; and as the pair was discovered by β on November 5th, 1875, the change should be very evident if the stars were not physically related. I have no doubt about their connection, however, as the pair would otherwise have been seen widely separated by Piazzi and Taylor. β estimated P. = 135°, D. = 0·5″, mags. 6·0, 6·0 at the time of discovery; but I am not aware that it has ever been measured. It is perfectly visible to the unaided eye, and its place for 1885·0 is 0h. 31m. 26s. South Decl. 25° 24·0′. 9 Argûs (β 101) is another close pair with considerable proper motion (0·37″ annually); but here the binarity has also been shown from the measures. The proper motions of β 999 and 599 are about the same as that of β 101, and those of β 290 and 648 rather less.

"Garrison Gunner's" letter (24225, p. 233) admirably explains Mr. Nelson's difficulty. It would be interesting to learn with what apertures Mr. Nelson can see the following pairs: ξ Boötis (Σ. 1888), δ Serpentis, α Herculis, μ Draconis, λ, τ, and 70 Ophiuchi. During the transit of Venus in 1874, the planet, which subtended an angle of about 64·0″, was distinctly seen by some observers on the sun's disc with the naked eye. I may remark that Dawes sometimes divided pairs at a distance considerably closer than that indicated by his own formula—*e g.*, he saw η Coronæ completely divided with his 3⅞in. Dollond in May, 1831, the distance then being only 0 88″.

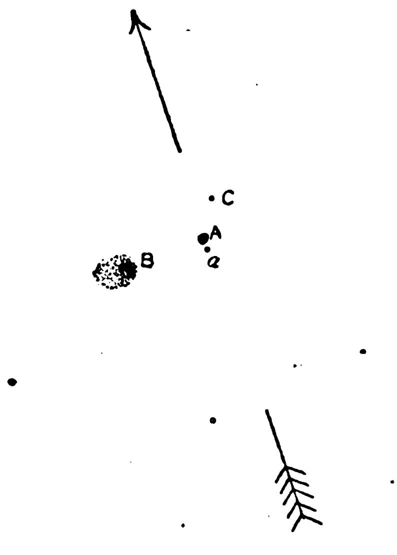
May 22nd. **H. Sadler.**

P.S.—Dr. Eugelmann gives the following measures of 25 Can. Ven. with the 8in. Alvan Clark, at Leipsic:—

149·30° : 0·748″ : 5 – $4^n$ : 1882·33
151·37° : 0·802″ : $6^n$ : 1883 43

### H (G C) 2091. (H 2529).

[24271.]—I SEND a rough sketch of this interesting object, which, thanks to a tracing from *Peters'* Chart most kindly supplied by Mr. Sadler, was found without difficulty on the night of April the 15th, and has been systematically observed since. The weather of late has been most unfavourable for delicate work, only three nights—viz., 21st April and 1st and 2nd May yielding any really satisfactory results. With regard to the close pair, A *a*, I have never been able to obtain any definite evidence of its duplicity, partly from want of light, and also that it is a most difficult object to focus; still, there has always been a peculiar appearance about it, *p.* and *f.*, and I have little doubt a larger aperture would show the P.A. of the small star to be about 90°. The star B is very nebulous; in fact, immersed in the S. edge of the nebula, giving it the appearance on some occasions of a telescopic comet. On this account any estimate of its magnitude must be most uncertain. The star C, although noted as "excessively faint" by Burnham with the 18½in. at Chicago in 1879, was most obvious on the 21st April and 2nd May, and was estimated at about 12 of Σ.'s scale; the P.A. from A 235° ± dist. 9″ ±. The nebula itself bears magnifying fairly well, and has been well seen in strong moonlight; it seems elliptical, the direction of the longest diameter being N. and S., and is now quite 20″ from the close pair, at 360°. There seems little reason to doubt very considerable proper motion in distance on the part of this nebula, for, by comparison of the data given by Mr. Sadler (letter 23999), we find that when discovered by H in 1830 the pair A *a* formed the nucleus of the nebula; the Parsonstown observation in 1851 seems to show that the nebula was then midway between A and B. In 1865 the star B formed the nucleus, and it now is quite at the S. edge, if not altogether clear of it. The outlying stars, several of which are in the field with a moderately low power would afford an excellent means of measuring the motion micrometrically, as the angle seems unaltered. The full aperture of my 10¼in. Calver has been used; powers 60 to 320. Allow me to thank Mr. Gaudibert for his interesting letter, but I would point out that the elements of 42 Comæ give for this year P.A. 5°, dist. 0·13″. I have obtained a doubtful elongation with 850 on one occasion, but it, like 8 Sextantis, is generally far beyond the reach of my instrument, fine mirror though it is.



**Kenneth J. Tarrant.**
Letchford House, Pinner, May 15.

### THE SEPARATION OF DOUBLE STARS.

[24272.]—MANY thanks to "A Fellow of the Royal Astronomical Society" for his reply, and for the table of measurements of star discs. From it I conclude that the diameter of a star disc varies directly as the aperture, the power being constant. I presume that those measurements were made with the same object-glass stopped down. Would "F.R.A.S." kindly say if a different result would have been obtained if object-glasses of various focal lengths had been used; also, if the passage, "press deep eyepiecing as we may, we shall always have our stars in contact," means that the aperture being constant, the diameter of the star discs varies directly as the power? I mention this because I have been under the impression, owing to my limited experience (288 on a 4in. being my highest power), that star discs were amplified in a ratio wholly incommensurate with the increase of magnifying power. The impression has been strengthened by Sir W. Herschel's measurement of α Lyræ—viz., 7ft. Newtonian, 6¼ ap., power 460. ⅒in. diam.; power 2,010, ⅛in. diam.

There is a seeming contradiction here. Is it caused by the different performance of reflectors and refractors, an error on H.'s part from want of instruments of precision for measuring, or what?

This morning I was truly grieved to learn, from the obituary notice in the *Times*, the loss we have all sustained by the death of the Rev. T. W. Webb. Though most of us were probably unacquainted with him, even by sight, I am sure we shall all miss him as a personal friend, so well did we know him by his work.

May 25th. **Edward M. Nelson.**

## ASTRONOMICAL.

[24273.]—You will remember that I announced the discovery last year of two new *comites* to 39 Draconis. I beg to announce the discovery on April 23rd of a third *comes* still nearer to the primary. This one is about 35″ distant and 260° or 270°. It is thus less than half as distant as the old well-known *comes*. It seems remarkable this star should have escaped notice so long, as it was visible in moonlight both on the 23rd and 24th with 9in. mirror. **Edwin Holmes.**

## ORIGIN OF COMETS.

[24274.]—In your summary of the proceedings of the Liverpool Astronomical Society, Mr. Denning is represented as giving reasons why a cloud of meteors ejected from a planet, so as to move in a cometic orbit round the sun, might ultimately be expected to form a ring of meteors. No possible objection can be raised to Mr. Denning's argument so far; but whether the total mass of meteors, say, in Tempel's meteor-comet, might not be so great as to render its planetary origin improbable, as Mr. Sutton supposes, it is not easy to say.

But I fail to understand why any comets, or comet-systems, are supposed to arise from planetary eruptions. It is impossible, of course, to prove the negative; but I presume the only reason for such an assumption is the close contiguity of many cometic orbits at some points to those of the planets.

Now, it can easily be shown that if a comet move in an orbit whose aphelion distance is greater than the distance of Neptune from the sun, such an orbit, owing to its perihelion and node-movement, more particularly the latter, will sooner or later come successively into a position of contiguity with all the planetary orbits, and will remain a considerable time in such a position, above all when the planet is Jupiter. Taking this latter circumstance into account, the orbit of any comet taken at random, with a sufficiently large aphelion distance, would very probably be found to be either contiguous to Jupiter's, or that of one of the superior planets.

I have, however, omitted to consider what may be considered by some as the strongest argument in favour of the planetary origin of most of the comets. That is, that all the comets that do not proceed into unknown regions, with the sole exception of Denning's comet, have their aphelion distance nearly equal to the distances from the sun of the four major planets; but if we suppose eruptive discharges with a sufficient velocity to proceed from a planet in all directions, but a very small percentage of the cometary orbits supposed to arise therefrom would fulfil the above-mentioned condition of the aphelion distances, and we should expect that such cases as Denning's comet would be the rule, and not the exception.

Whence we must conclude that the law of aphelion distances has some other cause than the origin of comets from planetary eruption.

**W. C. B.**

## THE ECLIPSE OF THE MOON, MARCH 3, 1885.

[24275.]—The moon had already risen nearly 6° above horizon, when an opportunity was offered me to go to my observatory. Detached clouds floated about, and much interfered with observation. On turning the telescope on the moon, the bluish twilight was readily seen extending some distance round the dark limb each side of the light cusps.

The dark shadow was just outside of Plato, and rendered the interior of this ring plain, of a dark colour, contrasting strangely with the surrounding bright regions.

The highlands, or hill country, bordering the Mares, and just inside the dark shadow, were of a light bluish green, while the Mares remained dark right up to their boundaries. About ten minutes later on this illumination of the highlands, especially southward of the Mares Crisium, Serenitatis, and Iridium, and the long neck of highlands stretching down on to Herodotus and Aristarchus, seemed to become much more brilliant, and formed a considerably wide belt all along the shadow. This contrasted very strangely with the darker Mares, as these plains did not seem to be similarly affected. Nor did this illumination last long; in about five minutes it had decidedly become less bright. Aristarchus and Herodotus were very conspicuous, while yet the dark shadow lay close to Plato.

The preceding half of the plain, inside of Plato, was very noticeably darker than the following. The latter half had a stifled appearance. When the shadow line had reached to midway between Plato and Aristarchus, I could plainly trace the limbs of the obscured part all round.

Finally, the shadow left the edge of the moon in the Mare Australe, somewhere behind Mounts Oken or Vega.

The broad greenish-blue band bordering the shadow, and only seen on the highlands of the moon, seems to me worthy of notice. Is it the more varied angular inclination of the surface which thus causes a greater amount of reflection of earth-light received *through* the ring of our atmosphere? Or have the constituents of our atmosphere to account for part of the colour?—while the greater slopes and varied surfaces of the moon's hilly regions collected more of this light and colour to return to us. **John Ballot.**

Rolfontein, Transvaal, S. Africa.

## ζ HERCULIS.

[24276.]—I am exceedingly obliged to Mr. Sadler for the kind trouble he has taken in examining the above star for me, and gratified to find that my conviction is correct as to the distance between its components, being at present greater than any quoted in Webb.

Bearing in mind the suggestions of "F.R.A.S." as to diffraction rings, and even as to having mistaken the star, I examined it carefully this evening, definition being excellent, and unquestionably saw it distinctly double for the third time, both with 255 and 400. Of course, I do not mean that I clearly *separated* it; but that it was sufficiently divided to render its duplicity a matter of certainty and instant remark. The position of the *comes* exactly corresponds with the angle given by Mr. Sadler.

How it is that "F.R.A.S." cannot see it otherwise than as a single star, I fail to understand; his o.g., however, is probably no larger than mine; for although I called my telescope a 4in. for brevity, it has a *clear aperture* of that diameter, and the o.g. must, therefore, be about 4⅛in.

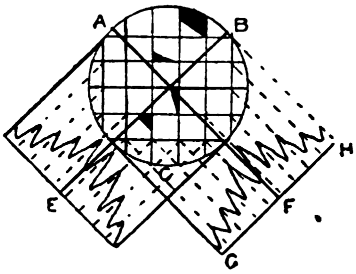
London, May 23. **Beta.**

## GRINDING AND POLISHING GLASS SPECULA.

[24277.]—I think now is the best place to introduce the amateur to the study of the side motion, as it will be fresh in his mind what I taught him in my last letter—that the parts of most resistance, and therefore most cut, are the centres of the facets; therefore we have to do with parts that cut much and with other parts that cut but little, and also the grooves, where there is no cut: it follows that at each straight stroke only parts of the face of the speculum are being worn, and these practically straight lines; but by the revolution of the speculum, combined with the revolution of the polisher, these lines are crossed over one another, so that all parts of the speculum are equally worn. Now, let the amateur suppose one set of grooves of the polisher to be parallel to the straight stroke during that straight stroke. Of course the grooves not cutting would leave the face of the speculum where they passed over elevated, while where the lines of facets passed over would be worn into grooves on the face of the speculum, the lowest parts being where the line of the centres of the facets passed over. All this would be true from side to side of the speculum. Now, let the amateur suppose the polisher turned round one quarter of a revolution: we now get another set of grooves and lines of centres of facets brought into action, but not in the same places as the former ones, thus tending to equalise the action of the cutting surfaces from side to side of the speculum. Now, let the amateur again suppose the polisher turned round one quarter of a revolution: he will now have the first set of grooves and lines of facets brought into use again, under the same conditions as at the first, except that they are not over the same places on the speculum as either the first or second cases; again, let the amateur suppose the polisher turned round one quarter more, when the same grooves and lines of facets will be brought into action as in the second supposed case, but not in the same places as in the first, second, or third cases, so that the inequality of cut caused by the grooving is reduced to one quarter by the arrangement of the grooves I have explained in a former letter. So far for when each set of grooves is parallel to the straight stroke; but we must take into account when the grooves are at an angle of 45° to the straight stroke, and as there are four places where this can occur, we shall have, with the four places where the grooves are parallel to the straight stroke, studied the action of the polisher over eight of its diameters, which is certainly for all practical purposes pushing our researches far enough. I give the reasoning on these points, so that anyone coming after me in this study may have the advantage of knowing how far others have gone, and the laws that have already been discovered, and thus start in their researches from where others have left off. I will give also the practical directions so that any amateur who wants simply to work a speculum may do so at once, so as to conform to the laws I explain without the necessity of mastering them, though this latter I strongly advise. We will now examine the lines of most and least cut when the grooves are at an angle of 45° to the straight stroke.

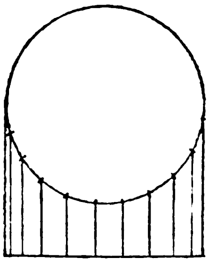
Fig. 1 represents all these four conditions of the straight stroke, A B C is the polisher with lines to represent the place of the grooves; no great accuracy of representation is aimed at, as my object is only to describe the principles brought into play. I suppose (though not represented) the facets are graduated so as to produce the parabola, as I have fully described in my former letters, but not obliterated. Now let the line A F represent the direction of the straight stroke along which the polisher is moved; if parallel lines were ruled to this (I rule them ⅛in. apart) and the length of cut measured upon these from the base line G H, it would be found that the cut would be represented by the zig-zag line from G to H. Now it will be observed that the hill of most cut to the right of the diameter line A F, is ¼ the distance from this diameter line, that is between the centre of one hill to the centre of the next hill, so that when the polisher has revolved half-way round, the centre of the one hill of most cut would be put over the centre of the valley of least cut, and so with all the other hills and valleys; thus this whole set of hills and valleys will be practically obliterated. Now let us take the other diagonal straight strokes represented by the diameter line B E. Here it will be seen that the hills or lines of most cut, on both sides of the centre line, occur at equal distances from that line, and therefore the effect of these hills or lines of most cut, on one side of the diameter line, will be when the polisher has turned half-way round, to increase the effect of the hills or lines of most cut on the other side, and thus to produce rings of hollows on the face of the speculum corresponding to the distances the hills or lines of most cut are apart. Now, it is interesting to discover that these hills occur exactly at the same distance from the centre line B E, as the very faint rings for which I have directed the amateur to make certain obliterations in the facets in parts where these rings occur (see Vol. XL. p. 322). So that out of the eight diameters that we have divided the polisher into to study the effects of the grooving and straight strokes, it is the straight strokes that are parallel to the diameter line B E, of the graduated but not obliterated polisher that produce the last crop of faint rings, the cure of which is the obliterations. I have marked where they occur in black on Fig. 1.

FIG. 1



Now, it might be naturally asked if the above polisher with properly graduated and obliterated facets will produce the parabola without rings, what use is there in the side motion, for it seems to have come into use because it removes many irregularities, and further, it is evident that the only place where one parabola can fit on another is where they are central to one another. Now the polisher by the side motion is kept much off this central point by the straight stroke being carried from side to side. And with a circular wheel on the side motion axis, the straight strokes over the centre of the speculum are only about one quarter those on either side, but more of this further on. Now, these conditions led me to abandon the side motion at one time, for I have with care easily produced the regular parabola without it, but with all my care I found occasionally rings would occur from accidental causes. Thus, perhaps, some of the facets would alter during a night from the general level, and after the first half-hour's polishing in the morning, I should find upon testing that I had very faint rings, and that it would take the whole of the day of six or eight half-hours' polishing to get these rings out, they only very slowly disappearing without the side motion, for I found that the speculum with rings had the power to form a polisher with rings, and the polisher and speculum acted and reacted on one another, so that the rings were perpetuated for a long time, and while the tendency of the polisher properly faceted and obliterated was to gradually remove the rings, it took sometimes seven or eight half-hours'. polishing to remove a crop of accidental rings, while if I applied the side motion, they were nearly removed in one half-hour's polishing, and completely removed by the end of the second half-hour's polishing; or by displacing the faceplate on which the speculum was fixed to such a distance on one side as to throw the hills into the hollows in one complete revolution of the speculum, I could get rid of the rings. But I must explain that one amount of side motion or displacement of faceplate only suited one width of hollow or hill, so that the side motion or displacement of faceplate is not perfectly effective when there are different widths of rings on the same speculum. Now, speaking generally, the tendencies to rings of elevation and depression were blended together into one general level surface on the speculum, which, acting on the polisher, produced a generally level surface on it, which generally level surface had no tendency to produce rings, provided it was properly obliterated. Now, as I have before stated, these accidental rings only very occasionally occurred to me; but I thought, to the amateur who has not had the experience I have, they would certainly occur much more frequently, and therefore it will be safer for him to be recommended to use the side motion; and so I have described it in its simplest form—viz., with a circular wheel to produce it. But we are now in a position to study the side motion more fully, and to find out the best form and quantity of side motion. The amateur will easily understand that with a circular wheel to produce the side motion, the polisher will be kept more at the extremes of the side motion than at the middle. This I illustrate in Fig. 2, where I suppose there are twenty-two straight strokes to one revolution of the side motion wheel. I have only traced the straight strokes for half the revolution, because, of course, the other half would only be a repetition of that shown. It will be seen that the straight strokes are much closer together towards the extremes right and left, about one-quarter as far apart as those over the middle. Therefore, there will be about four times as many straight strokes in the worst position as there are in the best position or over the centre of the speculum. Now, to correct this, I use an oval side motion wheel instead of the circular wheel O, shown in Fig. 3, p. 113, Vol. XXXVI. This oval wheel is driven by the circular small wheel M by means of a guttapercha round band or gut. The long diameter of the oval is seven times the short diameter. This I find produces an equal rate of side motion from side to side. The proportion 7 to 1 refers to the bottom of the groove round the oval wheel, which groove is very deep, about ¾in., the gut is about $\frac{3}{16}$in. diameter, the wheel M is, in diameter, a mean of the larger and smaller diamers of the oval wheel; actually my oval wheel is 7in. long and 1in. broad (at the bottom of the groove), the wheel M is 4in. diameter. This arrangement causes the motion to be equal from side to side, and not as shown in Fig. 2, *i.e.*, it causes the straight strokes to be as numerous over the centre of the speculum as at the extremes of the side motion. I give a drawing of the oval wheel arrangement in Figs. 3 and 4. In Fig. 3 the oval wheel is shown in the position, when the straight stroke is over the centre of the speculum, it will be there seen that, as the longer diameter of the oval wheel is in action, the side motion will be caused to be slower while passing over the centre of the speculum, while in Fig. 4 the shorter diameter of the oval wheel being in action, the side motion will be greatly accelerated, while, at the extreme of each side, by these two actions the unequal rate of the circular wheel side motion is reduced to an equal rate from side to side. This oval-wheel arrangement takes more room than the circular-wheel arrangement, because the distances between the wheel M and the oval wheel O has to be more, to allow the gut to be nearer parallel, and thus not slack and tight alternately as when these wheels are closer together, and, again, the oval wheel itself takes more room than the circular wheel it is substituted for, therefore the machine will not take in a 12in. speculum; but this is remedied by simply making the foundation plank 8in. longer—viz., 3ft. 8in., and then putting the upright shaft on which the oval wheel revolves 3in. further from the faceplate axis, and putting the wheel M 5in. further from the oval wheel axis.

FIG 2



Having now decided which is the best form of side motion, we have to decide what is the proper theoretical amount of side motion. I say theoretical because with a properly grooved and graduated and obliterated polisher there is no tendency to produce rings; therefore any amount of side motion that is not excessive may be used; but it will be well to understand what theoretically is the proper side motion, and upon what laws its use depends. I may just observe in passing that, for a 6in. speculum and 1in. between the grooves of the polisher, and the circular wheel side motion, I have ascertained both practically and theoretically that ¾in. is the best amount of side motion, and very good work can be done with this, but I shall not explain the theoretical part of the circular wheel side motion, because the oval wheel is in every way superior, except that it is a little more difficult to make. Now a very different and a very much simpler set of laws govern the oval wheel side motion. Now to study these laws let us put ourselves in the very best position to produce rings, and then by the regular side motion let us obliterate these rings; this in passing, I may just observe, cannot be done by the irregular (*i.e.*, the circular wheel) side motion, under the unfavourable circumstances I am about to suppose. I, therefore, strongly recommend the adoption of the regular (oval wheel) side motion for all sizes of specula above 7in. diameter. Now let us suppose we are working with a polisher that has its middle groove right across its centre, and that the next grooves on either side are 1in. from the centre, and the next 1in. further, and so on to the outside, and further let us suppose the polisher is kept from revolving, and that one set of grooves are parallel to the straight stroke, and, lastly, that no side motion is used, but that the centre of the polisher passes over the centre of the speculum at each straight stroke. Now it will be evident to the amateur at once, who has read my previous letter attentively, that the centre of the speculum will get no wear, and therefore a central mound will be left, and further that at 1in. on either side a ring mound will be left as the speculum revolves, and another ring mound outside this 1in. from it, and thus on to the edge; in other words, there will be annular mounds corresponding to the position of the grooves on the polisher, and annular valleys corresponding to the position of the lines of facets. Now let us suppose a small amount of regular side motion put on, say ¼in.; this small amount would be an advantage, for it would broaden out the valleys, and thus reduce the hills, but it would not obliterate them. To illustrate this, let the top wave-line of Fig. 5 represent two adjacent hills or mounds on the speculum over which the grooves happen to come, with the hollow A produced by a row of facets; we will consider the effect of a point A in a facet. Of course the same reasoning will apply to all other points; and now let us suppose a regular side motion of ¼in. In this case the point A will be carried regularly ¼in. on either side—*i.e.*, from A to B and from A to C (see the second wave line). Now let this wave line be carried from A to B and from A to C, which I have represented by the dotted wave lines. Now the point A being carried regularly over the space from B to C, while the straight stroke carries it backwards and forwards, it will, of course, regularly wear this space, but will leave the spaces from C to D and from B to E untouched; therefore there will be still left the mounds represented by the dark parts on C D and B E, smaller than the original mounds. Now let us suppose a ½in. regular side motion, this is represented by the third wave line, where the point A is carried regularly ½in. on either side of A to B and C, leaving the spaces C D and B E untouched. Now here the remaining mounds over these spaces are seen to be much smaller than for a ¼in. side motion, while in the fourth wave line, which is to represent a ¾in. regular side motion, the mounds on C D and B E are seen to be very much reduced; the last wave line represents a 1in. side motion, that is, the same as the width of the grooves apart, where it will be seen the points C D coalesce, as also do the points B E, thus obliterating the previous mounds; in other words, the point A (and this is true of all other points) is carried regularly over the face of the speculum to the places where the corresponding points in the adjoining facets on either side are also carried, and if we study them in like manner we shall find that they, and all other points, would have their effect equally distributed over the face of the speculum from facet to facet, proving that the proper amount of side motion is the distance any particular point in a facet, say its centre, is from the corresponding point or centre of the next facet, or a multiple of this distance. The above rule applies to the four diameters parallel to the grooves; but in Fig. 1 of this letter I have represented the wave line produced by the more and less cut of the four diagonal diameters, and these waves are not 1in. apart, but about ·7in., therefore the regular side motion for these ought to be ·7in., or multiple of this, and by finding those multiples that nearest approach to multiples of 1in. we could choose the very best reguler side motions, and if we could not find among these multiples a quantity we wanted for any particular sized speculum, we could make our grooves wider apart, say 1¼in., or 1½in., or 1¾in., when we should get a fresh set of multiples to choose from, *i.e.*, if we wished to be theoretically correct in our regular side motion. The above reasoning applies to a polisher in the very worst conditions, and yet with these unfavourable conditions, with a properly calculated regular side motion, a speculum free from rings may be produced, but not with an irregular, *i.e.*, circular wheel side motion can this be accomplished; and I give the above explanations to show the amateur the superiority of the regular side motion. But I must futher explain to the amateur that, with a properly grooved polisher and proper obliteration, the causes of rings at their sources are removed (and this we should always aim at), and therefore any particular quantity of regular side motion may be used, its use being reduced to the prevention of the perpetuation of accidental rings, and for this I find from the ⅙ to the ⅛ of the diameter of the speculum is enough, and this is all the amateur need attend to if he be careful to have a properly formed polisher, combined with a regular side motion, one of the great advantages of the latter being that it keeps the polisher longer over the centre of the speculum than the irregular, *i.e.*, circular wheel side motion does, and this I have proved practically, as well as theoretically, to be an important element of regularity of figure.

W. A. Wassell.

Addenbrook Villa, Love-lane, Stourbridge.

FIG 3

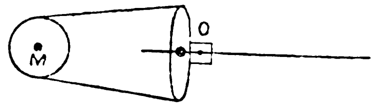


FIG. 4.

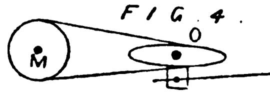
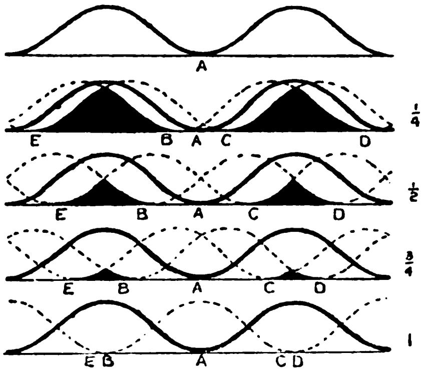


FIG 5.



## CURVES FOR SPECULA—TO MATHEMATICIANS.

[24278.]—If the great mirror is a parabola the convex mirror of the Cassegrain should be an hyperbola, and the concave of a Gregorian should be an ellipse. So much for (well known) theory, but in practice the small mirror is worked to a spherical curve, and the curve of the great requires modification.

In testing mirrors by the method used, and so clearly described, by Mr. Wassell, the aberration of the parabola at centre of curvature is calculated, and the actual aberration compared with it.

Is it not possible to calculate what should be the aberration of the great mirror of a Gregorian or Cassegrain when similarly tested, so that it should work with the spherical small mirror?

At present a tedious process of trial and error has to be gone through till an approximately correct result is obtained, more by chance than by knowledge.

Dr. Royston-Pigott's articles on the Cassegrain (unfortunately suspended when incomplete) have recalled attention to this question, which is surely within the grasp of some of our mathematical friends.

A. S. L.

## EVOLUTION.

[24279.]—"Pre-Adamite" says:—"Surely if a fish's surroundings were changed, the fish would die instead of accommodating itself to them?" First, it depends on the extent of change. Second, does "P." think to reduce evolution to the life of "a fish?" I thought in my last I had at least shown him that the "change" which takes place in the creature is not confined to an individual but many generations, and that this change is chiefly that of difference between parents and children. "P." will be disappointed if he thinks that *he* can bring about *any amount* of evolution *in any direction* during his lifetime ("the drying up of a pond"), or that of a fish! Does he really think that a man could dry up a pond of sticklebacks and leave it, when he dies, a patch of dry ground and the sticklebacks metamorphosed into lizards? And if he extends the drying up (though why he should think that simple drying up of the pond—taking away of the very life-element—should be the means of evolution, I don't know) over many generations, I should like to ask him how he knows that Nature does "yield up the struggle," as he cannot see both ends of the process. With regard to the evolution of the seal, I don't think it is known in what direction it is tending; but, of course, it may be in either direction, or neither, or both (*i.e.*, some tribes may be becoming more aquatic, others the reverse). In saying fish were the ancestors of mammals, I spoke generally, meaning that fish existed on the earth before mammals. Of course, mammals may, in some cases, be changing and becoming aquatic, and may have done so before now.

I think if "P." studies the "chain" of existing and fossil creatures known, he will find that there are no very great gaps; some gaps must be greater than others, but I don't think that is any reason for rejecting the theory for them, even if they are inexplicable from an anatomical point of view.

If three different forms were specially created (fish, bird, and mammal), why do those three forms run as much into each other as they do? I think it more likely that they would be *totally* different. I think you must either wholly accept or wholly reject evolution (and you cannot very well do the latter). If you strike a medium which seems to me very unreasonable and unnecessary, you cannot tell where to draw the line, as far as I can see (not at gills, I think), and you embrace the difficulties of both theories while you lose the advantages, so to speak, of the theory of evolution.

Those who take a medium theory must settle "P.'s" question about the "half-lizard and half-fish" among themselves, for the question has meaning for them only, and it matters little what the answer be, as long as it satisfies them.

But I don't think they *will* find an answer, and I think that the more "Pre-Adamite" studies evolution the more he will be inclined to accept it. I do not think, with "H. B. F.," that this controversy leaves all, if any, of the disputants where it finds them. **Crumby.**

## EVOLUTION.

[24280.]—IF the theory of evolution has any truth, *life* must have been a process of evolution. May I ask some who know so well, what were the conditions of habit, custom, or necessity which produced that evolution? Why was the inert atom of calcium, or the floating bubble of oxygen, compelled to other conditions than those in which they were?

Spontaneous generation, the prime apostles of evolution themselves declare an impossibility. How was the first life evolved? Again, how were the *first organs of reproduction perfected* for their first use? By what habit, custom, or necessity did the first life (Mr. Darwin's "protoplasm") evolve *a prescience of its future* requirements, what need even for sexual arrangements? Evolution of life from elements is certainly more simple than reproduction by complex processes. Fifty other such questions must be answered before a pebble to stand on can be found as a *foundation* to the scheme; even Mr. Darwin, with his great ability, and with his extraordinary honesty, commences his admittedly great work in the middle of the subject.

The truth is, this theory of evolution is thoroughly unscientific; it is a scheme of suppositions, to explain facts by a novel method. Many of its evidences are begged, and much of its argument about rudimentary organs has been amputated by physiologists at least as thoughtful as any of its supporters.

In this strong point of rudimentary organs we have plenty of evidence. How readily we see what we wish in the random assertions of many who should know better, such as the rudimentary tail, and the gill slits in the human embryo, and the "young whale's teeth"!

There is just as much evidence that "rudimentary" organs are, as the term properly implies, in process of *perfecting*, as in process of degrading, and that is no *real evidence* either way.

I fear the disciples of the theory mistake the marvellous *unity* of an undoubtedly direct creation, distinctly exemplified in all the obvious *facts* around us, by which facts I am told the most distant star my telescope reveals to me is of the same elements as the bodily structure my soul inhabits, as the rock on which I stand, as the water with which I quench my thirst.

The speciousness of the theory had for some time a strong influence on myself, but having read all the best writers for and against; unless I can get some common-sense answers to such questions as I have asked, shall now sign myself

**A Convert from the Theory of Evolution.**

[24281.]—As to the point raised by "W. G. P.," there may be sometimes, although I think but rarely, a difficulty in deciding whether a structure now apparently without use, was once effective, or whether after certain changes it is about to become so.

The swim-bladder of fishes is perhaps a case in point. We have at present fishes without any, also bladders without any outlet, as well as those opening into the esophagus, but non-cellulated, and others also with an opening, but cellulated, acting as rudimentary lungs.

The received opinion is, I believe, that all these proceed from a non-cellular bladder with an outlet acting functionally, in the first instance merely as a swim-bladder which has developed in two directions. But the non-cellular swim-bladder, even in its best form, appears to me as most probably an abortive organ whose first function was to aërate the blood, and its first form a vascular indentation of the anterior portion of the esophagus.

I am inclined to think that the wholly inclosed swim-bladder is upon the whole a decided disadvantage to the animal possessing it.

The whole course of the embryological development of the higher animals is a continued development of organs which become aborted. Take in man the aortic arches, same in number with those of fishes, and which afterwards are almost entirely obliterated, and out of the scraps left our more simple system is formed in a somewhat awkward manner. In fact, however we may admire in many respects the operations of nature in the formation of organisms, she cannot be congratulated upon doing her work in the shortest possible manner, or upon not frequently using the feminine privilege of changing her mind.

We may conceive something like such a style of workmanship if we suppose a manufacturer of chairs, tables, and ladders always beginning with chairs; then, if tables are required, destroying some of the chair and making additions to form the table, leaving portions of the chair legs sticking out from the surface. Then, again, if ladders are wanted, the chair as usual is begun with, then obliterations and additions till a table is almost formed; and then more obliterations and alterations until finally a ladder is arrived at, in which, however, the remains of the chairs and tables can be detected impairing the utility of the ladder.

**W. C. E.**

[24282.]—IN letter 24256 "H. B. F." gives us a definition of evolution and creation. I should like to ask him how can any man know that a "quality" is not previously existent even in a latent state? Again, he says, "It cannot be admitted that the simplest organic form could possibly have held latent within it the diversified organic characteristics," &c. I should like "H. B. F." to study "embryology." Why, there we have "evolving" from an infinitely small speck of protoplasmic matter within the short space of 20 years a perfect adult man. Or is "creation" constantly at work producing fresh "special," previously non-existing qualities, in each individual man? The same everywhere in the works of Nature: from the "seed" springs in time the mighty oak, &c.

I sincerely believed "creation" simple—*i.e.*, something out of nothing, was at this time of day gone with other ancient ideas, such as mythology records among all nations, from Minerva springing fully armed out of the head of Zeus, down to the "perfect man created" on the sixth day of this planet's existence.

The thing is irreconcilable. If "creation out of nothing" is reasonable, Evolution must go. The same *vice versâ*. **F. W. H.**

## WHEATSTONE'S BRIDGE.

[24283.]—HAVING had some experience with the bridge, I can give a few hints as to the use of it.

The bridge described by Mr. Bottone, though very useful for measuring low resistances, is not suitable for measuring high ones. Even if it were, a resistance of some hundred ohms, measured as described from a 1 ohm coil as a basis, would be inaccurate. I have a bridge with a thick and thin wire, either of which can be used at will. The range of the bridge is thus much increased.

The following are useful tests to ascertain whether the bridge is in good order. To test the sensitiveness of the arrangement, shift the key after balance has been obtained. A very small movement of the key should affect the galvanometer. To test the accuracy of the bridge, balance the standard and tested ohms, then reverse their positions. On again pressing the key, there should be no motion of the galvanometer needle, if there is, the bridge is faulty. The fault lies either in the stretched wire, which is uneven, or in the connections. The wires and terminals should be clean and in good contact with the copper strips. The stretched wire should be soldered to the copper strips. Dirty and insufficient connections are the chief sources of error in measuring small resistances.

A low resistance battery is best. I prefer a bichromate, with lifting arrangement for the plates. A constant battery is unnecessary, as only momentary currents are used.

I will next week give directions for making a sensitive astatic galvanometer. I shall be glad to show a bridge at work during the first four days of the week to anyone who may care to call on me.

97, Crawford-street, W. **G. Bouron.**

## AGAIN DISAPPOINTED.

[24284.]—I AM sorry to trouble you again; but I wrote once more, inclosing cash, and using the number "Montmartre" kindly gave in letter 24217. The result was receiving back my P.O O. and the inclosed letter, stating that the "tickets of the Society are not transferable, and that the orders should emanate from the members themselves." I am again much disappointed.

9, India-street, Edinburgh. **G. Dickson.**

[It is a pity that red tape has again defeated "Montmartre's" kind intentions. Can he not arrange with some respectable optician to supply, and not trouble the Stores?—ED.]

## HIGH POWERS IN OPERA-GLASSES.

[24285.]—"MONTMARTRE'S" letters about opera-glasses seem to be developing into advertisements in favour of a certain co-operative store. His notions on the subject are at the least peculiar, and liable to mislead. Very high power in an opera-glass can be obtained only by sacrificing light and field to such an extent as to render the instrument (in the opinion of most persons) totally unfit for use as an opera-glass. No wonder that "Montmartre" tried in vain to find such a thing in the shops of certain London opticians, the reason being that the said opticians were not such fools as to stock unsaleable articles. No doubt they could make high power opera-glasses fully equal to those "Montmartre" writes about, and would do so if there were any demand for them; but even supposing a power of, say, 12 diameters, were desirable for indoor use, it is probable that it could be obtained more satisfactorily by means of a binocular telescope. If any of my fellow-readers want a good opera-glass they will not be likely to do better than by getting one, at a fair price, from some respectable English optician. At any rate, let me advise them to see these wonderful glasses recommended by "Montmartre" before paying for them. **Experience.**

## EGG PRESERVING.

[24286.]—THINKING that perhaps some of your subscribers may feel interested in preserving eggs by a new and cheap process just given to the public by an American farmer of Coos County, Oregon, I inclose a copy of article taken from the *Prairie Farmer*, of Chicago, Ill., U.S. I am of opinion that sulphur alone would have answered the purpose, as it would seem that the acid fumes of the burning mixture effectually sealed the pores of the egg-shells. Can any of your scientific correspondents explain the action of mixture used upon the lime forming the shells? You can, if you care to print the article, make use of the queries in this, but please do not print the letter itself. **Saml. Haigh.**

Coquillam, British Columbia, April 28.

"A NEW EGG-PRESERVING PROCESS.

"After many experiments I think I have hit upon the right way to preserve eggs. It is inexpensive. I got my idea by seeing sea captains burn charcoal and sulphur to disinfect ships, kill rats, &c., with, carbonic acid and other gases, set free by combusbustion. Free carbon and sulphur fumes are death to living things, septic germs not excepted. Graphite and lampblack are carbon, and I chose lampblack for my experiment. Sulphur with lampblack sufficient to hide it were mixed together. I took a churn 20in. square, having a circular hole in one side, and on the 1st day of February, 1883, placed in it two dozen fresh laid hen's eggs and two goose eggs, filled a saucer about two-thirds full of the sulphur and lampblack compound and placed it on the eggs; set on fire with a match (it burns slowly and without endangering anything); put on the churn cover, pasting a paper over it to keep in all the smoke, and left it over night. On opening the churn I removed the eggs to an open paper box, and set them in the store-room. After four weeks they were examined, and found all right; the last of them were tested on the following 4th of July, and were as fresh as when laid. I broke one into a saucer, and placed it in the sun, and it dried out perfectly sweet. Two of the eggs were placed under a hen with other eggs. The fresh eggs hatched out, but she could not spoil the two which which had undergone the process; they came out as good as new. Use perfectly fresh eggs, and a dry, air-tight box. I don't pretend to say how long they will keep, but do know the result of my own test. J. HODSON.

"Coos Co., Oregon, March 14th."

## THE EDMUNDS THREAD, &c.

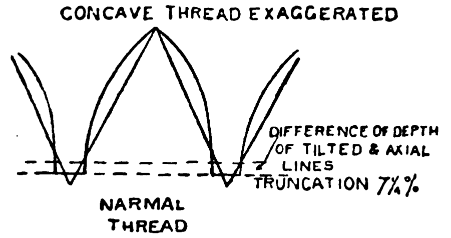
[24287.]—THE third-last par. of my last (24241, p. 235) refers to fitting by the slide-rest processes I have before mentioned, and not by hand-turning or special tools of other kinds. Curved tools, as mentioned by others, have their action limited to one screw, to one rake, and one diameter alone, and are not practically worth considering, unless we have the magical ability of "J. K. P." to convert an annular cutter into a spiral one by the simple process of reducing its diameter.

Last week I examined specimens of the actual "Edmunds" thread. The thread is as described, "beautiful," its clean, sharp appearance being enhanced by the very slight, almost infinitesimal, concavity of the thread-faces on the axial section. Two screws, with their axes parallel and teeth engaged, just show this curve with a light behind and a lens in front.

Practically, this minute concavity is the sum total of the case against it. The thread is non-reversible, only in that the reverse of the groove and thread sections are not the same; but in the sense Mr. Wenham sets it forth ("lopsided," and that a chuck could not go on either way) it happens that it is reversible—faultlessly so.

Mr. Wenham has treated us to no little circumlocution and false reasoning, one good specimen occurring in 24225, where he demonstrates conclusively what "Tubal-Kain" stated previously, that a point alone can trace the lines of a screw-thread, and that therefore it is not possible to cut a screw-thread at all.

The "Edmunds" thread is abnormal, even the sections on the zigzag line—called the *normal* lines by the Dr. and by myself to distinguish from *axial* one—are not of the depth of the named isosceles, though their sides are, as far as they go, true to name and a V point. The deviations are in all cases so very slight that it is no easy matter to deal with them at all by observation. I add a sketch of the thread upon the isosceles; qualitatively correct only, and to my best belief.


CONCAVE THREAD EXAGGERATED
DIFFERENCE OF DEPTH OF TILTED & AXIAL LINES
TRUNCATION 7¼%
NARMAL THREAD

The thread is too fine, in my judgment, for a lathe nose. I prefer eight turns only and a stouter thread; if the clearance at bottom was reduced by a 5 per cent. truncation of V, and 8 per inch adopted, it would be about right; but though threads similarly cut and abnormal, and apparatus to produce them are common, I do not think it is true practice to incorporate them with scientific work. With an increased rake, too, the factors would be increased in amount, and the thread would hardly be as strong as the normal; the gripping during "on" or "off" being also rendered greater by the more acute angle at the top of the curve, causing wear.

The thickening of top is at most an infinitesimal quantity, nothing to compensate for the concavity. I am not absolutely sure of its existence in the specimens I examined, though as the point penetrates less on the tilted than on the axial section, it looks a certainty as on the diagram, though again it is reduced in quantity by the obliquity of the axial section.

What Mr. Wenham's intentions are with regard to the impression to be left on the minds of inquiring members I cannot make out at all in the matter of hard and soft noses. We are to begin by softening them, then to avoid maker's lathes whose noses will not stand the test of a file corner. Then we see a particular maker animadverted because of spring temper noses, and alien makers advertised because their noses are hard; but finally (?) we are landed thusly. A hard cylinder is not to be used for centring, but a nose cut with a chaser (that must have warped in the hardening) under the guidance of a screw that has at least too much "back lash" to guide another tool truly, and this at a very slow speed and good genuine back-gear in, as well as all the jarring train of leading-screw wheels, &c., with slack bearings, spring, and so on—a ten-ton sort of process, seemingly.

All this to end in the much-decried and regretted soft nose!

Anyone who supposes there are no direct-acting high-class scientific methods of truly guiding revolving tools freely backwards and forwards supposes wrongly; and without any gear whatever in the guiding action, there is no difficulty in doing it. Mr. Wenham has raised several "bogeys," including that more or less one of "foreign competition"; but there is about as much "bogus" as "bogey" in the matters, each and all.

**Vulcan.**

## CAN A V-THREAD BE FORMED BY A LAP?

[24288.]—ON a spindle running in a lathe let a disc of paraffin wax be mounted to represent the lap. Take a finished V-threaded screw and press it on the lap so as to form an edge, each part of which is touched by the screw thread. The lap so formed will give the shape of one which, if made of proper material, would produce a similar thread to the one used to make the wax one. The lap will have an angle more acute than the groove of the screw. It is shown in Figs. 1 and 2. In them it will be seen that the bottom of thread is touched only at a point on a line joining the centres of screw and lap, and that from this point to A the lap cuts *a* side of groove, and from this same point to B the lap cuts *b* side of groove only. It will also be clear that the section of the lap cannot be that of the groove it cuts, and this, I think, is what misled Mr. Wenham.

**Glatton.**

FIG. 1.

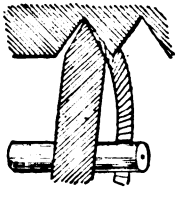
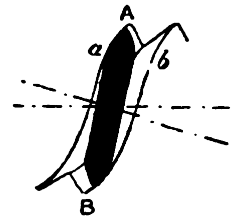


FIG. 2.



## INTERCHANGEABLE MANDRELS.

[24289.]—WHILE thanking "E. J. S." for his polite reference to my letter, I must again apologise if I have mistaken his meaning. I believe it was in connection with the front slide lathe that I last expressed in the ENGLISH MECHANIC my views upon the value of large bearing surfaces, and in practical work I have never failed to carry out this principle in every possible form. "E. J. S." perfectly understands the mechanical principles involved; but I would point out that there is a difference between two surfaces rubbing continually upon each other, and two surfaces which only partially cover each other at intervals. Take, for example, the cylinder of a steam-engine having a 2ft. stroke, and, although the motion of the piston is regular and constant, it will be found upon investigation that for a distance of about 5in. at either end of the stroke, the wear gradually decreases to *nil*. A further example in our more immediate vocation may be seen in the poppet cylinder of a lathe used continuously for boring or drilling, and which will inevitably show signs of unequal wear, the front portion of the head and the back portion of the cylinder being the most worn.

But what decided me against the long-cylindered mandrel-nose was the sacrifice of screw-thread unless increased length was given to the nose. A long mandrel-nose in the workshop is bad; it is more liable to injury, more time is taken in screwing chucks on and off, and the result is greater wear, without any adequate increase of stability or endurance. I would much rather have a short nose with a large shoulder-face, than a long one having but a small face for the chucks to abut against. In the *travel* which chucks would have to make over a long cylinder the abrasion is multiplied. So far as mere pressure goes after the chuck has arrived at its seat, the abrasion, though not lessened in its total amount, is divided up and distributed over a larger area; but the abrasion of pressure upon the Edmunds cylindrical "stop-surfaces" is infinitesimal. The value of the cylinder as a "stop-surface" to eliminate "eccentric variation" is not increased by any length beyond the thickness of a florin for small lathes; therefore the increased length of the long-cylindered nose, the conicity which would soon result from the abrasion of long travel of the cylinders upon each other, and the time wasted in putting chucks on and off were my reasons for objecting to this form of mandrel-nose. At the same time I endorse all that "Vulcan" has said (page 236, col. 2) in favour of the Edmunds cylindered mandrel-head, and I recommend all my customers to adopt it, as better, simpler, and cheaper. The mandrel itself may cost a little more than the old form; but, then, it gets rid of the costly, cumbrous, and ricketty transfer-chucks, while it will do anything, from the finest ornamental ivory turning to the manufacture of a small steam-engine.

Screws are the most important parts of mechanism, and the principles of all sound workshop fitting are involved in the questions now being discussed. No subject of greater importance than this has ever been discussed in the ENGLISH MECHANIC, and these letters are being read with great interest by practical mechanicians as well as by scientific amateurs. I wish some of our contributors would peruse over again Dr. Edmunds's last letter (page 189).

"Canmore" gives a clear and excellent drawing, Fig. 1 and Fig. 2, but I do not understand how he gets the rounded sides of thread, as shown in Fig. 3; nor do I see how it is that he draws conclusions which are different to the Doctor's. I am not sure that I always understand what "Vulcan" means, and his diagram seems wrong to me. Dr. Edmunds's tilting of the cutter-wheel to the rake of the thread does not mean that the cutter-axis is to make a horizontal angle with the lathe-axis, but only that the cutter-axis should be tilted in a vertical plane parallel to that containing the lathe-axis.

Those who read Mr. Wenham's recent letters side by side with mine will see which is the "angry" one. Mr. Wenham's ten-ton 18in. centre lathe with "a hardened mandrel" ought to be sent to the exhibition. I don't wonder at his objecting to the finest cast steel. Lathes of this calibre usually had their mandrels (I quote from the catalogue) "of best Yorkshire iron." I have known them to be case-hardened, but not always, and these were usually fitted into conical gun-metal bushes or parallel split bearings.

After stating that "some of our best lathe makers now true up their hardened steel mandrels with a diamond tool," we are told that there are two unknown makers in Berlin who do it. I cannot pursue this phantom any further, but no doubt some of our contributors will examine and report upon these lathes if there are any good points in them due to diamond tools.

Mr. Wenham puts this climax to his assertions: "at one time I should have made no hesitation in taking the contract for a gross of mandrels, every one of which when screwed into a test chuck finished in the lathe, should have the free or tail end running absolutely true, and, as I have said before, there are plenty of light turners who could be trusted with the job."

In the catalogue issued by the firm whom Mr. Wenham cites as the greatest authorities on these points (page 36), there is the following:—

"*Although all lathes of the same size, say 5in. centre, have their screws exactly alike, as to the diameter of thread, it is only by mere accident that the same chuck runs truly upon two different lathes.*"

This remark about such centring by means of the screw-nose will be endorsed by all mechanical experts who know their business. It was to overcome this difficulty that Dr. Edmunds has devised the cylindered and wide-faced mandrel-head. Mr. Wenham asserts that the present screw-nose will answer perfectly. Can contradiction further go?

**Edward Hines.**

Griffin Works, Norwich.

## LATHE MATTERS.

[24290.]—PERHAPS "Faber" will acknowledge that I am now a little further than I was on p. 237. What appears on p. 259 was intended for the previous week, but being very busy, I could not forward it in time. I have read "Hadah's" on p. 235, and at present hold the opinion that his last paragraph is erroneous. I do not know whence come the words in inverted commas beginning with "providing" down to "blank." They are all wrong, anyhow, as "Hadah" says, but his own correction is wrong. I find a 55° cutter making an eight-threaded screw produce about 60° angle of screw thread measured on the plane in which the axis of screw lies. The statement that a cutter of 50° will cut a counterpart V-thread is, as far as I have experimented, entirely wrong, too.

I am also at present absolutely sure in my inner consciousness that the italics beginning "there is no," &c., at bottom of middle column, p. 259, are wrong; inasmuch as the cutter cannot clear itself except on the *Faugh-a-ballagh* principle—that is, by clearing out a way for itself, which means something very different.

Also, at the top of third column, as far as I have gone, I do not agree with line 6. My threads come out rounded, not hollow, on the sides, and U-shaped at bottom, about ¼ of a circle, using a sharp V-edged cutter of 55°. I hope I have not misspelt the Irish motto of one of our most splendid regiments. Although descended from Brian Boroimhe, I do not include that tongue amongst my useful knowledge.

If there is any plagiarism at all about different numbers of threads requiring different cutters, Mr. Wenham certainly made the assertion before I did, and it is beginning to be received as true—at least in the sense in which I used the expression, and as I understood him to use it. J. K. P.

### LATHE MATTERS.

[24291.]—I have now seen the drawing and description of the lathe in the *Amateur Machinist* of March 7, referred to by Mr. Myall; it was kindly sent by Messrs. Barlow, of Manchester. I have written for a copy from America, and if you, Sir, will engrave it, I shall be glad to send it to you. It is most cheering to me to see several of the points we have been contending for so well carried out in practice. We have the front slide, vertical slide for milling, bored mandrel, with front apparently formed into a kind of Essex chuck, and the nose appears to be coned outside, not threaded, and the chucks, I suppose, held from within.

One word about the nose and screw question. Mr. Wenham says, on page 238, "With a good screw-cutting lathe they (screws) can be made quite as true as any cylinder work." Now, I thought we started with the supposition that that amount of truth was not sufficient; that is, that the degree of truth obtainable by the fixed tool is not sufficient for the production of screwed or plain fittings on which the interchangeability of a mandrel is to depend (see page 367 of last vol., and top of middle column); but that the surfaces required to be left with the finish of ring and plug gauges, and I never heard that these could be finished by the fixed tool. F. A. M.

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[24292.]—Mr. S. Beeching (letter 24260, p. 258) has given two shaped tool holders for iron and other metals. These forms I have had in use for many years for wood turning; but of course the shape of the tools, especially the gouge, has to be altered. The gouge is made of a tube of steel, and has the merit of being capable of being sharpened all round at once, and a simple turn of the tube brings a fresh cutting edge. The tool B with me carries many shaped cutting tools. To enable different thicknesses of steel tools, and to enable the tools to be held more firmly, I have a thickish piece of hardened steel (tempered), a little hollow underneath, or rather bowed a little from end to end, and it is on this that the screw acts, and so the tool is held at both ends of the arched or bowed piece, and the screw does not mark, or what is more important, bend the tool. I have omitted to state that the gouge is held in a bar split at the end, and turned down like A, and the screw brings the two sides together and holds the tube (which fits the hole) very tightly. R. S. T.

### CUTTING SCREWS, &c.

[24293.]—My terminology is no doubt faulty; but I found a good deal of newly-coined terms in some letters, and used them as ready-made and to hand. I have used the word "normal" in its mathematical sense as well as in its "nominal" or contra-abnormal sense; but I do not think confusingly to anyone reading all letters from the beginning.

If I had been writing a treatise instead of discussing a non-momentous current question, I should have settled my terms more carefully, and at commencement.

I have spent some time over Dr. Edmunds's letters, and regret that all I have learned is how error clothed in much and semi-neo-technical language can be iterated and persisted in, plus the limit of my capacity to pursue a tortuous and not profitable reading without wearying.

The commencement of the discussion afresh "with clear and distinctive terms," &c., I am not prepared to undertake, and it will be some time before those terms are forthcoming—at our present rate or proportion of progress, a long time.

My case against the thread and its nomenclature is summed up in letter 24098, p. 129: "Whereas the thread is spoken of as 50°, neither section, axial or normal, is truly so; but the section of the groove or nut-thread, has a true 50° normal section. If nut and nose are to be alike, it is necessary to have the 50°, or other angle, axial." Dr. Edmunds says (24172, p. 189): "The object at which we are aiming is the formation of an angular thread derived from an isosceles triangle;" also see Fig. C, p. 562, No. 1040. If that is the object, and the lap wheel is as often described V-edged and tilted to mean angle of threads in the groove, then those remarks of mine and that letter were sufficient, if practically looked into, though I did not "demonstrate" much.

Mr. Wenham has not only stated and shown enough; but something too much. "Canmore's" diagram—a similar one was begun by myself, but thought unnecessary—is a very plain demonstration, though the angular rake-line should be a tangent to mean angle of mean diameter of thread, not to outer diameter and least rake, and it is not clear why the normal cross section on such minimum's vertical plane should be diagonally set on the page; but it is next door to "stereotomo-metrising" a wooden bench screw.

What occult property of the traverse is to produce spiroidal lines on the V-side along the serrated line, or series of short diagonals across the groove, I cannot divine; but unless we are prepared to measure threads for their nominal section on these diagonals and in the groove (as "Hadah" suggests), a thread cut by straight-edged V-wheels, as described will be unnameable. If we do so, we get in return an unsymmetrical and too deeply-cut screw, and an inferior one that breaks all the mechanical unities.

Dr. Edmunds's case seems to me to be thus: (1) He has cut fine screws that have hardly any apparent distortion, it not being discoverable by himself or others who have examined them, but the which distortion (concave axial lines) I found myself with the watchmaker's lens I often use as surely as I have eyesight, and that over and over again; this looking along the lines tangent to the contacts in axial plane, not *point blank*; (2) he is not familiar with large screws where the defects would be visible, and has involved himself very much indeed as regards the principles of accurate screws and screw-cutting by a "persistence of vision" for the helixoidal lines "turned in air"; (3) has been deceived by the angular set or tilt of the point tools often used to cut screws, by regarding such tilt as necessary, and a finishing process, whereas the tilt is given to get equal cutting-edges on the tool for quickness, without the trouble of hollow-grinding the top in an axial plane; (4) has not had to depend on his acumen in these matters, and as a total, is in the matter of his lapse "an untransformable geometric entity."

The workaday theory of screws and screw-cutting is simple enough. The factors "given" are the length, diameter, and axial section; with these, all else is ascertainable easily. For physical purposes, the attachment surface to shear altitude and angle to get surface and stress on it; longitudinal motion of a revolution to get power required for any given work and distance. A quantity of such work will follow from the above.

The shape, position, traverse rate, &c., of the tool all follow from the axial section. The screw to be cut requires to turn round so much faster or slower than the leading screw, as there are more or less turns in the same length to be cut in it, one revolution making each thread. This, with an example or two, will generally penetrate the average intellect, and once it has done so, he will work out his change-wheels like an automaton, and have a fair idea of what he is about.

Why we should be called upon to consider an impossible helicoidal trigonometry (24038) p. 103, as "the normal cross section to which regard should be paid in calculating the strength of the thread" I fail to see; nor why (24172), p. 190, "the curved line forming the base of the normal thread section would be one of the spiral lines of the normal rectangular helixoid"; ordinarily, the diagonal on a cylinder is elliptic.

It is beyond our mathematics to deal with a diagonal normal section cut by a plane as the sides are spiroidal and the base elliptic, save by the consideration of the plane triangle in the axial plane; in an unsymmetrical screw the triangles of neither section nor the thread itself would be considerable at all.

My last diagram reconsiders as both very correct and very necessary. My text referring to it, though parenthetical where it occurs, seems to me to be extremely clear, and very relevant to that calling it forth.

Primarily, we read Mr. Wenham's case of the "cedar pencil" or spiral on a cylinder with disc applied to show difficulty of lining latter to centre-line. Next (24172, p. 190), "If anyone will draw two circles touching each other, say, of the sizes, &c., and will then draw a straight line joining their centres, he will see that it is not possible to get the revolving cutter off the line of centres. Whether the axis of the revolving cutter is above or below (note) that of the screw to be cut, makes no difference whatever to the angle of the groove, inasmuch as the cut finishes on the line of centres." Then the axial inclination is easily given, and guidance got by the slide-rest.

My text is (24241) p. 236, "I send a diagram of such a cutter set for a quick screw, but at a maximum off centre—*below screw*. The angular set goes entirely to deform the thread, and its original purpose is gone, as the cutter has no inclination left to the pitch of the thread, but is at right angles to axis of screw in plan." Moreover, my diagram shows a cutter finishing on the line of centres.

It is the plainest complete disproof of Dr. Edmunds's proposition. If he has a slide-rest on links, one end swivelling on line of centres and others on line of the axis of the divided head, and that automatically adjust themselves before the inclination is given, the fact should be stated, for in no other case is his proposition true.

There is no difference, theoretical or actual, as to difficulty or necessity of aligning revolving tilted tools or fixed tools, provided the latter are ground on the sides alone and properly held and fitted on the slide-rest, as in the case of cutter bars in use.

If my text has been read as well as my diagram glanced at, I am more deficient in capacity to explain than I thought, or somewhere that factor is wanting.

That a square or even undercut thread could be trimmed by wheels coupled horizontally, "by cutting one side at a time .... with suitably sized cutters," I stated in 23945, p. 35, and I regard it as an easy-to-be-seen fact, Mr. Wenham's drill-cutter being only one set at the mean angle so as to act on both sides at once, but which can only be of small diameter.

It is *not* essential "in order that the tool clear itself, its plane of revolution must be tilted, &c." As I have (24241) stated, an upright parallel disc—one that runs on an axis parallel all ways to the screws, and cannot be set off line of centres—can be turned to such curves as its sides come in contact with till it bottoms and cuts a true thread, though rounded at bottom, and by sizing it, it can cut on the normal section. Moreover, I have found a tool that cuts true screws, and that inclines on its cutting edge to the exact duplicate of the screw being cut, *but in the opposite direction*, and that has specific advantages of its own.

When Dr. Edmunds has done writing upon remotely relevant pennies, screws, planes, &c., and has a terminology pretty well considered, and has also got on a sound elementary basis by sectioning some real screws of visible dimensions, I shall then be ready to look into his results. I cannot afford either time or labour for no or retrograde results.

The model mandrel and its de-modelling by the lapsus in its thread formation have been very long in hand already, and the element of error has been frequently well pointed out. When it is out of hand—as it is now, so far as I am concerned—I am willing to assist with "terminology," or any subject of interest (sufficient) as I can spare time.

The definition bisected by "a rectangular helixoid" reads well, but my own "axial section on apex or centre of its summit," was framed for simple language, and to show in diagrams where the "helixoid" is not comprehensible.

As for the "lady's fan," I do not use one; and from what I have seen I should say represented wave motion rather than anything in a screw; and I also think that the majority who cut screws will be more familiar with the screw-propeller, and understand it better as an instance that a screw-thread winds from lengthwise to across as its depth increases upwards and *vice versâ*.

Why the tangent line that "Canmore" shows should be called a "hypothenusal line," or where the right-angled triangle gets to or comes from when that line mysteriously winds into "helixicoidity," I cannot understand.

The grooves on cylinders cut by a wrongly-tilted V-cutter do not seem to me to be U-like particularly: they seem to me to begin in a decided Gothic arch (perfect when tilt is to bottom angle of groove), running then to elliptic and circular arcs. This U is taken from "J. K. P.'s" diagram, Fig. 3, page 237, "on the flat," which diagram is misleading, inasmuch as one side (the left) is shown with the straight line of the V in it, and the other, especially at the top, with an elliptical curve alone, and the sides should be alike.

I fancy our "G. O. Mechanic" has been hurried, if not worried, over this discussion, and a good deal of time and space all round might have been better employed. I agree with him as to clearance, but cannot get my annulus to split its edge and wind spirally by turning it smaller; it begins to cut off the thread at the other side.

The last two paragraphs of letter 24263 that once more "settle the case out of which this discussion arose," and "refer to the general proposition," if written by a responsible pen, would be the acme of folly in practice and the climax of that quasi-deduction that has befooled mechanics so often in the past and still does so. That anyone whose knowledge of screws is based on plane trigonometry should by simple assertion thrust aside a tool I have spent some valuable hours in ascertaining the efficiency of—in fact, this discussion has trespassed no little on time that belonged to more important work—seems to me to be a case calling for the use of space, if space were only valuable for such purposes as above. "As I have before shown" is not the case; "as before stated" is more to the point, and error cannot be converted into truth by reiteration, even when the latter process is an encyclopædic neo-technological one.

No helical line whatever is the shortest across any number of thread turns if taken separately, and the "therefore" does not follow, as curved lines cannot be as short as straight ones. The radial altitude remaining constant, "the normal section will have the smallest angle, the shortest sides, and the least area, as well as the shortest base line," has no reference or truth with regard to screws.

The real case stands thus: when the diameter of the screw is infinite and the depth of thread 0, the above is true enough, but when the thread has depth to the axial line and width, then the so-called "normal section" cannot be cut, but we get a spiro-elliptic lozenge. The critical point where the "normal section" passes into this lozenge is about where the thread's base-length and cylinder's or shank's diameter are the same, the former being measured in an axial plane. In this screw the base of the "normal" section is a diagonal or longer of the square of which the axial section's base is only a side approximately, and apart from the curvature of its sides, the normal section has the longer ones —in a thread the height equal to the base, about half as long again,—and the area may be many times that of the axial section, and the greatest, with height equalling base about twice and a half.

The critical point at which the "normal" begins to approximate to the plane goniometry cannot be found, but exists somewhere on the road to infinity.

If our attention is confined to the groove, we get into an equally absurd predicament, for the "base line" is somewhere or other beyond the nearer bottom of the groove.

That "to cut a screw that approaches the last limits of theoretical accuracy is impracticable" is undoubtedly true with reference to a model mandrel; but for other purposes, such as physical and micrometrical apparatus, such screws are cut; and in revolving tools, Mr. Wenham's drill, the bevelled disc, and the oblique-edged cutter I have several times named, will all do it on any material.

What I have stated with regard to this oblique tool "on the flat" is quite true: that it would not work on such an infinite diameter and clear unless itself of 0 diameter, or having extra motions on its teeth, I did not state, and it is beside the principle at issue to do so.

But that it will work correctly on screws other than plane trigonomo ones, I have ascertained, that, provided that it be sufficiently small to clear and set to rake at bottom of threads, this rake is somewhat of a matter of indifference when both screw and itself are small and there is plenty of clearance, as it will come, if made as described on page 125, No. 1,046 (24075) rightly up to the most projecting section—the axial one. It may be used as either cutter or lap with fixed abradant, and when set to mean angle of threads, made of same diameter as screw, and the two revolve at same velocity in opposite directions, the theoretical action is almost perfect. I send sketches this time. It would lap a smoother surface than a drill, and could be run much faster on periphery.

The best finishing process, and about the only theoretically accurate one, is by facet grinding and a floating abradant. For a screw, segments of a nut, duly to area and edge angles, held together by springs, and with guide to give due increase of pressure towards ends and away from centre, to prevent hollow grinding, these nut facets would have to revolve at same velocity and in opposite direction to screw, to prevent centrifugal action, heaping up the abradant unevenly and on one summit.

Lastly, one of these discs with oblique edges will cut symmetrical screws, all scale models of one another, or systematised, through a very large range of diameters and numbers per inch.

As to "men may come, and men may go," &c., I am now one of the going description, and I leave the field to those of the other kinds.

May 25th. **Vulcan.**

## THE NEW TIME.

[24294.]—Even after reading opinions adverse to the change from our present method of reckoning to the 24-hour system, I fail to see any difficulty in the way of the change which cannot be surmounted. The question of counting 23 and 24 strokes is, I consider, fully answered by "F.R.A.S." and "A. S. L." ("E.M.," Feb. 6). That of the difficulty in recognising the figures on dials could easily be remedied by the use of a revolving dial which, through an opening, would show the hour. To business men and others the new reckoning would, in my opinion, be a great boon, and the adoption of a "universal time" for international communications still greater.

When we come to the astronomical change, I am, however, at variance with "F.R.A.S." I have read that the Astronomer Royal has adopted the new reckoning, and that "the change was easily made from January of this year." Now, Sir, I would ask any astronomer whether, in a case where constant reference must be made to the *Nautical Almanac*, as must be the case at an observatory like Greenwich, some confusion must not arise occasionally? Even Prof. Oppolzer, whose expression in favour of the change Mr. Christie gladly welcomed, considered the change should be deferred till the new time is adopted in almanacs. The head of English astronomy advocated the change at Rome, and it would have been much better had he, before inaugurating so radical a change, taken some means to ascertain the opinion of astronomers on such a question. His colleague at Washington issued an order directing the change in astronomical reckoning to be made, but has had to withdraw it in consequence of the opposition of the superintendent of the "American Ephemeris." Heron, Forster, and Tietjen have declared themselves against the change; so that the heads of American and German almanacs agree in resisting adopting in haste and repenting at leisure. The director of our national association has not been heard on the subject; but the hydrographer (who knows how a change will be felt by seamen who use the almanacs), is against it. So much for those in high places; and now for one or two remarks on the arguments.

A prominent advocate of the change considers it essential that the civil day should change when most civilians are asleep; how this is consistent with changing the astronomical day when astronomers are in the midst of their work, I cannot imagine. Another difficulty I have been unable to surmount (even when almanacs are changed), is on which day would an observation be put down when it was taken partly before and partly after midnight; say, for example, an observation of Jupiter's satellite at transit; and again, a star observed at 11.59 p.m., would be a day different, for reduction, to one at 12.1 a.m. To my mind, the official organ of the Greenwich Observatory was about right in saying "It is impossible for the change to be made in observatories until it has been previously made in the great ephemerides . . . until the chiefs of the principal nautical almanac offices have agreed to introduce the change, no forward step can be taken." And again: "The change should not be made until astronomers are unanimous upon the subject, or at least, until those favouring the change are so greatly in the majority as to render the dissent of the minority a matter of no consequence. The change should then be made at some common fundamental epoch adopted by arrangement among the astronomers of the world."

**Conservative.**

[24295.]—I am sure you will allow me to point out that the "advocate of change" (letter 24249) contents himself with very little more than a mere verbal criticism of my letter 24247—hardly even defends his own case; certainly advances no new argument, as I had hoped he might do, of advantage. The change may give immunity from confusion to him and such as he is; but to the men, women, and children less learned than himself, there will be constant confusion for somewhere between ten days and the end of time.

I expect to find ere long the idea relegated to the limbo of forgotten fancies, even in spite of the difficulties of astronomers and professors of mathematics who find their *route* in the pages of Bradshaw a more bewildering task than the search for the train of a comet through the labyrinths of most mysterious and complicated calculations.

**Civicus Olim.**

## ACHROMATISM, &c.—VIOLINS.

[24296.]—It will interest our optical readers to know that I have recently received from Mr. W. A. Haren four numbers of the *American Journal of Science*, containing important papers upon object glasses. These papers deal exclusively with achromatism and the secondary spectrum; spheric aberration is not touched upon. They are, of course, entirely mathematical; but the analysis is new, and the method of treatment interesting. The first paper is by Prof. Harkness, and it will appear as soon as possible.

Every reader of this paper will be glad to learn that the health of our friend, Mr. J. A. Brashear, is much improved; and ere long we may hope to see his appearance in these correspondence columns again.

With reference to the subject of violins I may remark that since my last letter I have been enabled, through the kindness of "Country Parson," to examine the curves of a Strad. and of a Guarnerius model, and I shall have more to say upon them in the course of a week or two; but it may be as well to state, for the information of Mr. J. Towns (query 56665), that if he is working on the Strad. model, Mr. Heron-Allen's book on "Violin-making" is the very thing for him. It contains full-size drawings of a Strad. and of a Guarnerius violin, together with instructions for properly dimensioning the various parts. If these two full-size drawings, together with two small diagrams showing the proper finished thicknesses of back and belly could be had separately from the book, they would be a boon which numbers of amateurs would not be slow to appreciate; and if these few words of mine should chance to meet the eye of the talented author, I am sure many would rejoice if they induced him to offer the drawings separately.

**Orderic Vital.**

## A NOVEL CLOCK.

[24297.]—I should like to describe for the benefit of the readers of the English Mechanic a novel form of clock, for which I took out provisional protection some time since; but, of course, have not the slightest objection to anyone making a model for himself, if not for sale.

The idea admits of endless variations; but I shall only describe the original model which I made myself, as any ingenious person can develop and improve upon it.

The case of the clock is a 9in. cubical box of wood, which is ornamented by staining the wood, painting in water-colours on the stain suitable designs and mottoes, and varnishing over all. The top of the box has a 6in. hole in the centre to admit of a china bowl, resting in it as a basin in a wash-stand, but with its edge flush with the wood. Round the inner edge of the bowl two rows of Roman figures from I to XII are painted in gold, one row near the edge of the bowl and another about half-way down. I found the easiest method of spacing these figures correctly to be to paste paper over the interior of the bowl, divide off by compasses, and mark the figures on the paper with sulphuric acid, which, on exposure to heat, eats the paper away, and forms a rough stencil plate, easy to remove by warm water when the gold is painted in.

A wooden or indiarubber image of a duck, swan, or other swimming bird must now be procured, and a small bar magnet, such as those used in toy boxes with fish, inserted in its head with (say) the N. pole to the front. A toy fish with a similar magnet with S. pole in front may now be gilt, and weighted with snipe shot until it floats comfortably below the surface of water, in a natural manner.

Next take a cheap American clock, such as one may readily obtain for 4s. 9d. Remove the face and the hands, and attach to the hour and minute axles respectively horizontal bars of wood. At the extremity of the bar attached to the hour axle fix a light bar magnet vertically with S. pole uppermost, and to the bar of the minute axle a shorter magnet with N. pole uppermost. The minute bar must of course be shorter than the hour bar, in order to go round freely inside the latter.

Now cut away a little of the bottom of the wooden case, so as to admit of the clock lying flat on its back thereon. If it be thought worth while to rigidly attach the clock to the case, of course a hole must be cut for the winding screw; but I prefer to simply lay the clock down and withdraw it for winding when required.

The clock being now in position, and a bowl inserted and filled with water, it will be seen that the magnet on the hour axle will draw round with it the duck or swan, and that on the minute axle the fish, thus presenting the pleasing appearance of a bowl of water with two moving figures showing the time with no visible attachment to machinery. My own model is a very handsome ornament to a drawing-room, and cost me about 10s. A most beautiful object could be made in the same way by carving and decorating the case so as to make the bowl appear an artificial lake, with overshadowing trees and devices of roots, ferns, &c., for the figures.

I may add that my model was made in January last, and has gone well ever since. Very feeble magnetic power is sufficient, and if light bars and magnets be used the clock will keep excellent time. I hope I have made myself intelligible, as I have no time to draw a diagram. I hope also that if any amateurs construct a like clock they will let me know their experience, and I trust to the good fellowship of the English Mechanic contributors and readers not to infringe the patent by making clocks of this kind for sale.

**Garrison Gunner.**

## VOSS'S ELECTRICAL MACHINE.

[24298.]—I send a short description of the principle of Voss's (more correctly Töpler's) electrical machine, in which I have tried to avoid the old misleading "two-fluid" nomenclature, basing the explanation on the following facts:—

1. That round every conducting mass charged with electricity there is a region or "field" of force which diminishes in intensity with distance from the centres of electricity.

2. That electrical energy tends to move from points at high potential to points at lower potential in the field.

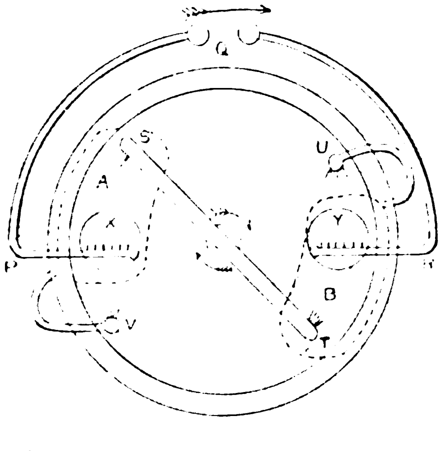
In the annexed diagram, A B are the paper inductors at the back of the fixed plate; X Y are two of the series of tinfoil carriers on the moving plate; P Q R is the main conductor, the rods being carried above the plates, as in Wimshurst's machine, for clearness; S T is the cross conducting arm; U V are the bent arms connected with the inductors, and furnished with metallic brushes which touch the carriers as they pass.

Let one of the inductors, A, be raised to high potential by any method.

Then the system of conductors P, Q, R, lies in a field of uneven potential, falling off towards R, and takes, as usual, the average or mean potential of the field. Therefore P is in a region of higher potential than itself, and electricity is transferred from X to P (by the row of points), and R is in a region of lower potential than itself, and electricity is transferred from R to Y. Hence X is reduced to a state of low potential, and Y is raised to a state of high potential. And the portion P Q of the main conductor having received electricity is at high potential relatively to Q R, which has given up electricity. Hence a gradient of potential is established between the two parts, P Q and Q R, and electricity tends to transfer itself in the direction of the arrow across the interval at Q.

Now let X be moved round until it reaches the cross-arm S T at S, Y will at the same moment come in contact with T; and since the carriers are still in the field of A, a second transfer of energy will take place similar to that just explained, so that X will be reduced to still lower potential, and Y raised to higher potential.

Next, let the rotation of the plate be continued until X touches the bent arm U connected with the inductor B. Then, since it is at low potential, electricity will be transferred from B to it, and B itself will be reduced to low potential. Similarly, when Y touches V, electricity will be transferred from Y to A, and the potential of this inductor will thus be raised above that due to its original charge.



Then the conditions are the same in character as at first, but intensified, A being at higher potential than before; B being at lower potential than before. Thus, there is now a steeper gradient of potential between P and R, so that the tendency of electricity to pass across Q is increased.

Lastly, when the plate has made just half a complete turn, X comes where Y was at first, and the cycle of changes begins again; X now gaining electricity owing to the low-potential field of B, and Y losing electricity (as X did) owing to the high potential field of A.

What is said above of X and Y is true of all the other pairs of carriers on the moving plate as they come in succession opposite A and B. Hence, as the plate rotates, there is a continual transfer of electrical energy from one side to the other, and the difference of potential between the inductors A and B soon becomes very great, and thus a very steep gradient of potential is maintained between P and R, so that discharge takes place at Q through some distance of air.

The function of the cross-arm, S T, appears to be to cause the change in the electrical condition of the carriers, under the influence of the fields of the inductors A and B, more decidedly and effectively than can be done by the main conductor, P Q R (as in the Holtz machine), in which there is high resistance whenever there is an interval of air at Q. The main conductor system, then, serves for external work, while the cross-arm does the internal work of maintaining and increasing the difference of potential of the inductors.

The whole action may be roughly compared to the work of setting up and maintaining a current of water in a pipe connecting two cisterns by laddling water from one of the cisterns to the other, so as to keep up a constant difference of level. **E. R. P.**

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### MAGNETIC MOMENT.

[24299.]—QUERY 56546 has given rise to answers so numerous and so contradictory that a few observations on the subject of the moment of a magnet or "magnetic moment" may be useful.

There exists a good deal of confusion in terms of misunderstanding on this subject. The magnetic moment of a magnet is a quantity dependent on the magnet itself, and quite independent of the intensity of that field of magnetic force which is due to the magnetism of the earth or other cause. The moment of the couple, or, more shortly, the "couple" exerted on a magnet when displaced from the magnetic meridian is a quantity perfectly distinct from the magnetic moment. This couple tends to bring the magnet, when displaced, back again into the magnetic meridian, and it is in confounding this couple with the "magnetic moment" that some of the answers to the question have gone wrong.

Suppose an ideal magnet of pole strength $m$ and distance between poles or length of axis $l$. Then the magnetic moment is $m\,l = M$ (say). Now, the unit strength of magnetic pole is that strength of pole which repels a similar pole at unit distance with a force of one dyne. The dyne is the unit of force on the centimetre-gramme-second system of units, and all magnetic and electrical units are now based on this system: we therefore measure $l$ in centimetres. It must be noted that "pole strength" is not measured in dynes. Pole strength is a derived unit, and is got from the equation

$$\frac{m\ m'}{d^2} = F$$

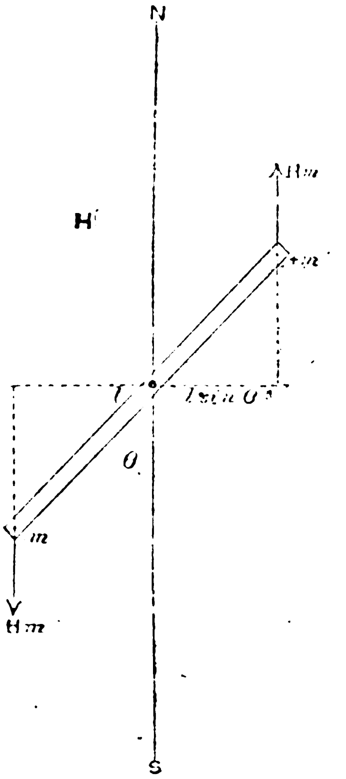
Where $m$ and $m'$ are two poles, $d$ is the distance apart, and F is the force in dynes with which they repel each other. In fact, the "dimensions" of pole strength are $L^{\frac{3}{2}} M^{\frac{1}{2}} T^{-1}$, whereas those of force are $L M T^{-2}$.

It cannot be too strongly emphasised that, in experiment, the quantity which we always deal with in a magnet is its magnetic moment. In an ordinary bar-magnet it is impossible to locate the position of the poles with accuracy, or to determine the length of the axis. It is the product of these two quantities or M—*i.e.*, the magnetic, moment that we always deal with in practice.

Suppose, now, that we have the above magnet, of pole strength $m$, and length of axis $l$ displaced through an angle $\theta$ from the magnetic meridian, which we call N S, and suppose, also, that it moves only in the horizontal plane. Then the couple, G, tending to bring it back to the meridian is—

$$\begin{aligned} G &= H\,.\,m\,l\,.\,\sin.\ \theta \\ &= H\,.\,M\,.\,\sin.\ \theta \end{aligned}$$

where H is the horizontal intensity of the earth's force (H = 0·179, nearly, in London).



Now in the query (56546) $m = 3$ units of pole strength, and $l = 10$ centimetres, so that $M = 30$. The strength of field is here 10, so that $H = 10$, and we have

$$G = 10 \times 30 \times \sin.\ \theta.$$

When $\theta = 90°$, or the magnet is at right angles to the direction of the force,

$$G = 10 \times 30 \times 1 = 300.$$

I do not wonder at many readers being in some confusion on this subject, as the complete understanding of the units employed is a matter that needs close attention.

**Lewis Edmunds, D.Sc., LL.B.**
10, King's Bench-walk.

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### A NEW DEMONSTRATION OF THE PARALLELOGRAM OF FORCES.

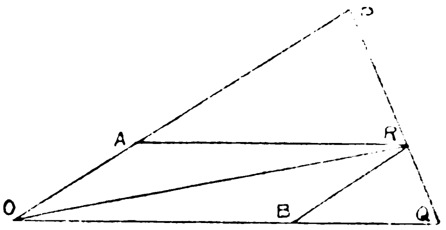
[24300.]—I BEG to submit for insertion in "Ours" what I venture to think is an original and simple demonstration of that important and interesting problem known as the "Parallelogram of Forces." I hope that you will insert it, and that it will elicit an expression of opinion from some of your talented correspondents.

Lemma 1. The spaces passed over by moving bodies are (*cæteris paribus*) inversely as the masses.

Lemma 2. The impelling forces of moving bodies are (*cæteris paribus*) directly as the spaces.

Lemma 3. The centre of gravity of two bodies divides the line joining them, so that the ratio of the segments is inversely as the adjacent masses.

Proposition.—If the adjacent sides of a parallelogram represent the direction and space which would be passed over by a body when two given forces act upon it separately, the diagonal will represent the direction and space which would be passed over when the forces act conjointly.



Let O be the initial position of a mass, M, and O A the direction and space which it would pass over in a given time when acted upon by a force C; also O B the direction and space which it would pass over in the given time when acted upon by a force D. Then, if the parallelogram, O A R B, be constructed, its diagonal, O R, will represent the direction and space passed over by M in the given time when the forces C and D act conjointly.

Now, since M cannot contemporaneously pursue two directions, let it be supposed, when acted upon by C and D, to divide (without resistance) into two portions, G and H; and let O P, O Q be the spaces passed over in the given time by G and H respectively. Then (Lemma 1)—

$G : M = OA : OP$ ..............................(1)
And $H : M = OB : OQ$ ......................(2)

Therefore, from (1)—

$$G = \frac{M\,.\,OA}{OP}, \text{ and } OP = \frac{M\,.\,OA}{G}.$$

Therefore, from (2)—

$$H = \frac{M\,.\,OB}{OQ}, \text{ and } OQ = \frac{M\,.\,OB}{H}.$$

Join P to Q. Then the equation to P Q when put into the form

$$\frac{x}{a} + \frac{y}{\beta} = 1, \text{ is } \frac{H\,.\,X}{M\,.\,OB} + \frac{G\,.\,Y}{M\,.\,OA} = 1.$$

Now this equation is always satisfied, irrespectively of the values of G and H, by $x = OB$, $y = OA$. Hence, G and H being the only variables, P Q always passes through a fixed point; which, obviously, is R, the other extremity of the diagonal O R.

Further, because at the end of the given time, G and H are found at P and Q respectively, and that

$$\begin{aligned} G : H = \frac{M\,.\,OA}{OP} : \frac{M\,.\,OB}{OQ} &= \frac{OA}{OP} : \frac{OB}{OQ} \\ &= \frac{QR}{QP} : \frac{PR}{QP} = QR : PR, \end{aligned}$$

the point R is (Lem. 3) the centre of gravity of G and H.

Hence it is manifest that the effect of the simultaneous action of the forces C D upon the mass M is equivalent to the translation of M from O to R.

Moreover, the locus of R (the centre of gravity of G and H) is the straight line O R. For the direction of O R depends upon the angle A O B and the ratio O A : O B, which depend upon the direction and magnitude of the forces C and D; but C and D are invariable, consequently O R represents the path of M when C and D act conjointly.—*Q. E. D.*

Corollary.—Since O A, O B, O R represent the spaces passed over by M in equal times, these same lines will also represent the magnitude of the impelling forces (Lemma 2); hence, if the adjacent sides of a parallelogram represent the directions and magnitudes of two forces which act upon a body, the diagonal will represent the direction and magnitude of the force which is their equivalent.

**S. Stokes.**

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### TO E. M. NELSON.

[24301.]—IF the condenser mentioned by "Amateur" is the one I have in my mind, the top lens is nearly a hemisphere, the other is a plano-concave of flint and biconvex of crown. I should say that if you silvered the convex surface and ground off the apex, you would spoil it, and gain nothing.

The amount of flint in an object-glass depends entirely on the formula by which it is made, i.e., the idiosyncrasy of the maker. **E. M. Nelson.**

### MINERAL-OIL LAMPS.

[24302.]—J. HUGHES has claimed to be a "practical man," and on that claim sets all other persons at defiance. He says, in fact, that he has worked at his subject for 40 years, that we know nothing about it; but that he, having proved all by test and experience, can give us a lesson or two.

Well, then, why does he not enlighten us? To my advocacy of metal reservoirs, he insinuates that I am a mere theorist, and calls upon me to test the cooling influence of glass against the heating of metal, and while suggesting that my understanding may be enlarged by so doing, almost dares me to publish the result.

My reply was short, and to the effect that I had long since proved that the maximum heat of mineral oil during 10 hours in a copper reservoir was 69·2 Fahr.

Here was a complete answer to J. Hughes, for that temperature is not even the heat of a summer's day, and is from 30° to 60° below evaporation point. Now, will J. Hughes be kind enough to give to the public his knowledge of the heating of mineral oil in a copper reservoir.

23rd May. **J. D. Shakespear.**

### CRANK AXLES OF LOCOMOTIVES.

[24303.]—YOUR correspondent is quite right in stating that the grain of the iron in the web of the crank is in the wrong direction, and this will account for the fact that fractures usually occur where the inside web joins the crank pin.

I think no greater recommendation of the suggestion made by the Board of Trade upon the Penistone accident, that all big ends should be taken down weekly, can be given than by the fact that the number of flaws detected in running sheds last year exceeded half the total of axles broken in running.

I have also good authority for attributing the great breakage both of cranks and of truck and carriage-axles on the M.S. and L. Railway, to the frequency and severity of the curves existing on that line.

Mr. W. Stroudley, in a paper on the Construction of Locomotives, stated that by allowing more breadth in the four blocks, the engine would be prevented from leaving the rails, even if the axle broke, except in crossing points. Now by the use of the Joy valve-gear, space is given for 9in. of bearing, and also 5½in. for the crank-pin, together with ample room for inspection, in the case of Mr. Webb's new L. and N.W. three-couples.

Another solution of the question is the compound passenger engine of the L. and N.W., which has its single inside crank formed by the metal being bent into shape, an arrangement which keeps the grain in the right direction, while the application of force directly in the centre reduces side-play to a minimum.

Lastly, the strains on the crank-axle seem to be caused as follows:—

(1.) *By the reciprocating motion of the pistons.*—Hence it is more likely that the axles of the express engines should break than those of goods engines, as the extra leverage obtained over the smaller wheels gives an earlier cut-off, and lessens the strain.

(2.) *By side-play.*—This is proved by the large proportion (1·5 : 1·9) of straight axles broken last year as compared with that of cranked axles, it being well known that engines with straight axles and outside cylinders are most liable to oscillation.

(3.) *By curves, and possibly tightness of points.*—This is not sufficiently relieved by the bogie, or radial box, but is now allowed for in some "single" engines.

Surely the resolution of these into tensile and crushing strains would give an answer to the question whether steel or iron should be used, since the tensile strength of iron is 60,000lb. per square inch of section, while that of steel is 130,000. (Bourne).

Is it possible that inclined cylinders may, by their direction, obviate a certain amount of side-play? **Beginner.**

[24304.]—"WILFRED," p. 260, refers to what has been said by the Railway Servants' Society—that the fibres of iron run in the wrong direction in the crank webs; but he further goes on to say that there is an invention by a firm he names, to get the fibres in the proper direction. If this can be done it is a grand thing, so I anxiously wait for full details or a sketch of this way of making cranks. In consequence of the Railway Servants preferring "iron axles," Messrs. Vickers and Co. have just issued a statement to show the good work of some of their *steel* axles, and as the figures refer in a great degree to Midland engines, perhaps it will be considered in the "E.M." by our friend "Midland."

**Crank-Axle.**

### COMMUNICATION CORDS ON RAILWAYS.

[24305.]—THERE can be no question that as a matter of safety that Scotch express train *should* have been stopped and the brake-blocks removed from the step board of the carriage; but I think a "Carlisle Passenger" did quite right in not using the cord. The Company would doubtless argue that it was "not sufficient reason," and he would therefore have found himself removed from the train at the next station and charged before the magistrates. What is "a sufficient reason for using the cord"? This has never been defined by law. Perhaps Mr. Stretton will give his opinion upon the matter?

**Lex.**

### THE AFTERGLOW.

[24306.]—SINCE 30th March the glow, after a period of inactivity, suddenly returned to nearly its former splendour; though, strange to say, subjected to marked variability from day to day—being bright one evening, but almost nil the next.

On the 7th and 8th inst the light was very strong, and huge ribs or streams stretched right across the sky to the eastern horizon, terminating there over a sort of dark circle. These streamers are seen after the arc of light in the east has faded.

The first, or rather red glow, lasts for about 25 minutes, when, as before, it settles on to horizon in a deep orange band; the sky now again brightens up, and a *third glow* goes through the same stages, lasting for another 30 minutes. On the 7th the sky seemed clear and the stars bright; but, on using the 6in. on Jupiter, the planet presented, most of the time, just a luminous blurr, with spurious images flapping on its sides, the same as I have before noted of Venus, and which seemed to me caused by the glow-producing medium.

Transvaal, 10th April. **John Ballot.**

## REPLIES TO QUERIES.

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the tit e and number of the query asked.*

[54825.]—**Salt, &c.**—"Dens" agrees with me that nature's law is uniform; but why this should be his reason to begin with a civilised man, instead of a lower type of man, I fail to understand. If they are found, when found at all in "older formations," and only with the most primitive stone implements accompanying them, it seems to me most natural to begin with "Palæolithic man." The whole of "Dens's" reply confirms me in doing so. Naturally the most remote ancestors of our race would show the fewest remains, and those imperfect, left undestroyed by the tooth of time and incessant agencies at work to destroy and recreate, only under quite exceptional conditions. I cannot agree with "Dens," "if man had lived for a thousand centuries, &c., we should not be able to find a rood of ground without a skeleton in it." As is well known in geology, the older the strata the fewer the fossils, until we come to those which contain none at all; hence it follows, the older, the lower the type of fossil, whether of beast or plant; the less is also their number, regardless how numerous they may have been when covering the earth in life. In short, "Dens" rather mixes things when he says, "I begin with civilised man," and, in conclusion, says, "It won't do to speak of these men as being primitive." Again, if "Neanderthal skulls" have been found, it is beyond my scepticism to conclude, with "Dens," that "it is as yet only supposition if such men ever lived."—F. W. H.

[55879.]—**Cutting Iron (U.Q.)**—If "Younker" has cut his circle of 1-50th of an inch thick, I hope he will tell us how. I should turn a wooden faceplate and fix the iron ring on it truly central. Then take a piece of wood about 2⅞in. wide by ½in. thick and fold a piece of emery cloth over the end. Use this as a turning tool to grind the groove out. The edges will not be sharp, and must be finished with a scraper held so that the edge is well below the part held in the hand. I think I should try to do without a rest for the latter part of the operation, many using an upright piece of wood to prevent side motion of the scraper, and nipping this between the scraper and the thumb of the hand holding it.—GLATTON.

[55952.]—**Sheet Iron.**—Cut out one piece and use it as a template to mark off the others. Lay it on a plate, and, with a steel scriber trace the outline. Then cut the plate to this line.—GLATTON.

[56243.]—**Fuses for Projectiles.**—To "GARRISON GUNNER."—Having been away for the last few weeks, I have only now seen your answer to my query. I thank you very much for the information you have so kindly given. I shall not trouble you to look up the "Changes in War Stores," for I know what trouble that would entail, and, besides, you have told me all I wanted to know. I have been so much interested in your description of the new fuses, particularly of the "time and concussion," that I am about to write to the D. A. for permission to procure the chromo-lithographs of them from the R. L., Woolwich.—EX-GARRISON GUNNER.

[56318.]—**Owls.**—If "Agricola" will put caustic soda into the holes and runs of the rats, they will go away at once, and never come back. Should a new lot come in, repeat the dose. It is a most thoroughly effectual and safe way of getting rid of such vermin.—DENS.

[56358.]—**Chronic Cold.**—In answer to "Ora et Labora," the following prescription for a lotion to be snuffed up the nose into the mouth and spat out will be of infinite value:—Sodæ bicarb.; sodæ biborat.; sodii chorid., aa. grn. vii.; sacch. alb., gr. xv. Mix; dissolve in breakfast cup of tepid water.—Q. A.

[56335.]—**Wheel Gearing** (53635, Vol. XL. p. 181).—The inner pitch line will not be at the same distance as the outer one. Its position relatively to the point and root of the tooth will be the same as the outer one is to its point and root; but the distance between the lines representing the pitch circle, the point, and the root on the small side will be so much less, because the length of the tooth is less. In the sectional drawing of the wheel, the lines representing the pitch, the point, and the root upon the large diameter are laid down. They are then severally prolonged to the centre of the wheel, or to that point where the line of bevel cuts the centre of the shaft, or, speaking more correctly, to the apex of the cone. The breadth of the teeth is then marked upon these lines; and where the intersection occurs the relative distances of the pitch line, point, and root for the small side are pricked off with compasses. The top and bottom dotted lines are those on which the centres of the radii for striking the flanks and faces of the teeth are placed, for the obvious reason of obtaining uniformity of shape all round. The distance of these lines from the pitch line is not a constant distance, but will vary with the diameter of the wheels and the shape of tooth adopted. If you look on p. 250 of the number in which your query occurred you will see a case in point. Three sets of wheel teeth are there figured, struck with Willis's Odontograph; and in the case of the smallest wheel of the three the striking line for the roots is a long distance without the circle of the teeth. This can only occur with the smallest pinions of a set; but in every case it is necessary, in order to attain certain results, to fix upon the shape of the teeth, and then to adopt the striking lines to them. The thickness of wheel teeth from ½in. to 4in. pitch, advancing by quarter inches, and expressed in nearest fractions of an inch, should be as follows:—

| in. | in. | in. | in. | in. | in. | in. | in. |
|---|---|---|---|---|---|---|---|
| ½ | ¾ | 1 | 1¼ | 1½ | 1¾ | 2 | |
| $\frac{7}{32}$ | $\frac{11}{32}$ | $\frac{7}{16}$ | $\frac{9}{16}$ | $\frac{11}{16}$ | $\frac{13}{16}$ | $\frac{15}{16}$ | |
| 2¼ | 2½ | 2¾ | 3 | 3¼ | 3½ | 3¾ | 4 |
| $1\frac{1}{16}$ | $1\frac{3}{16}$ | $1\frac{9}{32}$ | $1\frac{13}{32}$ | $1\frac{17}{32}$ | $1\frac{11}{16}$ | 1¾ | 1⅞ |

A third and fourth is not quite correct for the relative lengths above and below the pitch line. A better proportion is 3 above, 3½ below; or, to be more accurate, 5½ above, 6½ below, and this gives quite enough for bottom clearance.—J. H.

[56360.]—**Tandem Bicycle.**—"Bike" does not give sufficient particulars; but it is not a matter for surprise that he does not get on well "with different riders." The tandem bike is a rare goer when you get two riders to run together; but it takes a good deal of practice even when the two are fairly matched. There are not many tandem bicycles in use.—ESSAR.

[56364.]—**Wire Blinds.**—This query is rather a puzzle, for the difficulty seems to be in the want of sharp edges to the gilt letters. If the querist cannot do without, he should paint his letters first, and when dry lay on the gold size, taking care that its edges are sharp. Gild when tacky, and the edges of the letters will be sharp also.—ESSAR.

[56367.]—**Cocoa-Nut Oil.**—I thought it was the odour that was objected to, not the colour, for cocoa butter is white. Sturtevant's process is as good as any, and consists in steaming the oil in a wooden vat, and adding to each ton 6lb. of sulphuric acid, and 12lb. of hydrochloric acid. Time is allowed for settling, and the oil is drawn off.—NUN. DOR.

[56374.]—**Globe Telephones.**—One wire is for the bell circuit, I suppose; the other two for the telephone.—E. G.

[56377.]—**Electrical.**—No. 24 wire is quite fine enough for electro-magnetic machines.—NORMAN.

[56397.]—**Feeder for Organ Bellows.**—Why not make two feeders worked by one handle, so that the opening stroke of one feeder is the closing stroke of the other?—J. W.

[56398.]—**Boiling White.**—The proportions are 3lb. of cream of tartar to 4lb. of grain tin or shavings. About two gallons of water will be sufficient. Boil, say, for half an hour, and then put in the brass, previously cleaned. Does that last word throw any light on the failure? This question has been answered many times.—Nun. Dor.

[56484.]—**Varnished Wall Paper.**—"C. D. R." says, "You might as well clean dirty windows with paraffin as dirty wall-paper." He will be surprised to hear that the best thing to clean either dirty or dull windows, or any other glass, is paraffin oil.—R. C. N.

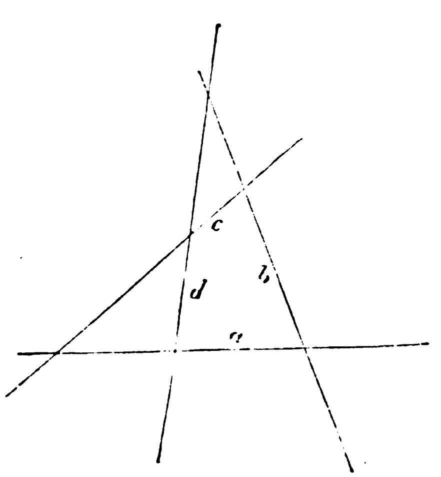
[56518.]—**Organ Building.**—The questions asked under this heading could be better answered by a correspondent more thoroughly acquainted with pipe-organ construction than what I profess to be. My experience is chiefly in connection with reed organs, and beyond the matter of simple repairs and tuning, I do not profess any great knowledge of pipe-organ construction. I have never attempted to make organ-pipes of any kind, and have never had any desire to attain to that art. Perhaps some of our organ-building correspondents will kindly reply to the questions put forth on p. 222. The information required will doubtless be of interest to many readers. If the querist had any intention of building a reed organ, I should be pleased to help him in any way I possibly could. I will, however, offer a few hints to the querist on the subject of organ-building. He is no doubt aware that a small pipe-organ will take up as much room (if not more) as a large reed-organ. Though the volume and quality of tone obtained from good organ-pipes is superior to that obtained from reeds under any conditions, a large reed-organ is preferable to a small pipe-organ, for the following reasons:—1. The former can be made to a convenient size, suitable for any private dwelling, and yet to contain as much variety of tone as may be found in a large instrument of the latter class. 2. In a reed-organ we can have from two to four manuals, each of which may contain reeds, voiced to imitate effects similar to that found in the larger class of pipe-organs. Other advantages of a large reed-organ over that of a small pipe-organ could be explained if necessary. One set of good organ-pipes would cost as much, if not more, than four or five rows of vibrators. My remarks refer to the American organ-reeds and cavity-boards. The American organ is the nearest approach to the pipe-organ in quality of tone, and I think that the majority of persons will admit that a large, well-constructed American organ, with two or more manuals and pedals, is superior to a small pipe-organ—that is, if a variety of tone effects are required.—G. Fryer.

[56531.]—**Gramme Dynamo.**—On p. 223 read: "Armature consists of 16 segments of No. 18 S.W.G., and total wire weight of 2lb. 2oz.—usual Gramme core (solid). Wire on field magnets, No. 16 S.W.G., and total weight 14lb. 4oz."—Vandu.

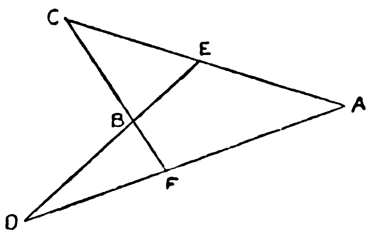
[56530.]—**Harmonium, &c.**—To "Harmonica" (p. 223).—I offer the following advice, if he likes to take it: You say that you are about to add two rows of reeds to your harmonium. Are you sure that your bellows is large enough for two extra rows? If not, I should advise you to first ascertain this. If you can obtain the required amount of wind, buy a complete pan suitable for the entire number of rows of vibrators required, you will then have no need to trouble about the sizes of pallet holes, or yet to ask whether the reeds would "sound right if simply screwed on top of holes." A soundboard, or pan, for one row of reeds, consists of a series of 61 channels or tubes made to a certain scale. The use of these channels or tubes is to give body of tone from the reeds, and also to subdue some of the harshness or reediness of tone which would result, if the reeds were merely screwed on a piece of wood with holes for the reeds to vibrate through. You cannot actuate the reeds on the suction principle with a pressure bellows, like that found in harmoniums; you must use a suction bellows, which has a contrary action to that of the harmonium pressure bellows. As I can partly guess what you require, I will advise you to dispose of your harmonium, and either make or purchase an American organ containing the required number of rows of reeds. If you want the harmonium and American organ principle combined, I should advise you to make a two-manual affair, the lower manual on harmonium principle, and the upper manual on suction principle with American organ reeds. I will send all necessary particulars for accomplishing this, if requested. As the query now stands, to accomplish what is suggested in it is an impossibility, for obvious reasons. I will, however, answer one question with regard to the matter as to "how the valves [pallets] are opened in the American exhaust principle?" The valves, or pallets, are situated immediately under the reeds, and cover a series of longitudinal apertures which are cut out of the mortise board on which the tubes containing the reeds are secured. Each pallet is provided with a spring of sufficient power to keep each pallet firmly closed. The pallets are actuated by plungers, which are small pieces of wood. The plungers pass through a portion of the wood forming the tubes. They are made steady in action by the employment of a guide-strip or guide-board. You will see this illustrated more than once in very recent numbers of the English Mechanic. When the plungers are pushed down by the keys, they actuate the pallets.—G. Fryer.

[56547.]—**Geometrical.**—I find that this problem, which has attracted some attention in these columns, is capable of further development. If we join the centres of the four circles, and thus form a quadrilateral figure, it will be found that a circle can be described passing through the four corners of this figure, and also through the point where the four circles intersect, and thus we have five circles intersecting in one point. Also, if we draw the diagonals of the quadrilateral, each of the angles made by the diagonals and the sides will be equal to one or other of the angles to be found in the original figure. The proof of this is somewhat difficult. I wonder if "Hemisus" or "T. H. L." could put this in as neat a form as they have succeeded in doing with the first part of the problem. In this complete form, the problem becomes one of considerable elegance.—M.I.C.E., Bath.

[56547.]—**Geometrical.**—"J. C." and Mr. Dwyer see difficulties in my answer to the first part of this query. In the figure *a b c d* are the four lines, and *a b c*, *a c d*, *a b d*, *b c d*, are the four triangles. Their difficulties are of their own making. There is no question of "twelve lines" or of "equal lines." The proposition deals with the four triangles always and necessarily formed by drawing any four straight lines (not limited in length) in a plane. "Hemisus" has given a good proof of the property enunciated.—L. Edmunds.



[56547.]—**Geometrical.**—In the two replies to this query (p. 242), the conditions of the problem appear to be lost sight of. We are required to draw a figure with four straight lines of given length in which figure there are to be four triangles, and then to prove that if we draw circles circumscribing each of these four triangles, the four circles will intersect each other at a certain point. In the first reply we are shown how to describe four separate triangles with four straight lines, which is nothing to do with the problem, and in the second we are introduced to a figure made up of eight straight lines, and as many triangles. Evidently the figure that Todhunter had in view was something like the one in the annexed diagram, where we have the four straight lines A C, A D, D E, and C F, and the four triangles A C F, A D E, C B E, and D B F. I have not drawn the circumscribing circles, to avoid confusion in the diagram; but this can easily be done, and it will be found that the four circles will cut each other at a certain point, whatever the length of the lines may be or whatever shape the figure may be, provided it fulfils the required conditions. I have not worked out the geometrical proof, but the drawing of the figure alone (which will comply with the conditions), makes a good puzzle, and is rather a curiosity.—M. I. C. E., Bath.



[56550.]—**Sawing.**—To J. M., a Sawyer.—I have been sawing some elm and ash into plank; my saw is 6ft. 6in. long, 10½in. at the top, and 2in. at bottom; teeth ⅝in. apart. I intend doing the sawing myself, and I do not mind spoiling some to learn, for it cost me about four times as much to buy the plank than to buy the tree and sawing included. I have done two pieces of ash into eight planks well since I sent the query, but the third piece very bad; it seemed to get worse all the way to the end of the 12ft. length, and then it was ¼in. or more hollow. I somehow thought it was because the saw was getting blunt, so I sharpened it, and the next cut went very much better. Perhaps you will give full particulars how to set and sharpen it; and if you write giving all particulars how to begin on a tree, and so on all the way through into planks, all the tools, &c., what are used, and what sort of saw is used to cut curved pieces over the pit, such as felleys, &c., with drawings, if possible, I think it would be a great help to many as well as myself, for it is a subject I have not seen treated on in the English Mechanic, and I have them all from No. 1.—Alabama.

[56558.]—**Lincoln Cathedral** contains no "stone beam." The remarkable arch of 23 stones, so miscalled, was apparently built as a strut, to keep apart the west towers, when the 13th-century masons, who were finishing them and planning the vaulting, apprehended some settlement of the towers toward each other. Their west corners were well separated by the great arch of the front; but their eastern must have shown some symptoms that this clever device has effectually stopped. The 23 arch stones are of uniform section, only 11in. deep, 21in. wide, and so chamfered below as to reduce it to about 195in. super. The clear span is 28ft., and the form a pointed arch extremely obtuse, the middle being but 20in. higher than the north springing, and but 8in. higher than the southern. Thus the whole suspended rib contains not quite 38 cubic feet. The radius of the southern half is about 100ft., but of the northern 112ft., and that end is loaded for about 8ft. with some 9 cubic feet of rough masonry; but the south or higher end, for a less distance, with about half as much. Nearly 14ft. of the middle are the bare arch-rib. These particulars are from W. A. Nicholson's accurate engraving in *Transactions* R.I.B. Architects, 1841. The 22 joints are normals to the two curves, and are thought not to contain any joggles. Of course, the structure creates a thrust, readily calculated, of many times its weight, or certainly many tons; but does not transmit any from any other arch. According to S. Ware's "Tracts on Vaults, &c.," 1822, Tract ii., p. 21, there is a very similar arch, but heavier and still bolder, in the Jesuits' Church at Nismes, constructed by one Cubisol, of which I would gladly hear anything more.—Harrisian.

[56563.]—**Medical Coil.**—My reply to this query seems to have been a cause of offence to our enlightened correspondent, "C. D. R." I congratulate "C. D. R." on his own reply to this query (p. 242), and on his discovery that mine is nonsense. It seems to me that "C. D. R.," admitting that he himself could not answer the query, is deeply offended if anyone else should answer it. We are reminded of the fox who had lost his tail, and who went about trying to persuade the other foxes that it was the correct thing to have no tails. The quotation from Montaigne which "C. D. R." advises me to lay to heart might sometimes be effectively remembered by himself, especially that part of it which refers to "clutter" and "little pittance" of knowledge. It may interest "C. D. R." to know that "Bobadil's" authority for his information is Angell's textbook, which, of course, may be entirely wrong. Will "C. D. R." be good enough to "enlighten" us on this matter by proving his statements, and showing where this well-known book is at fault? Nothing whatever was said about four electricities. Two were mentioned—positive and negative; and if "C. D. R." wishes enlightenment on the alphabet of the science he professes to teach, I shall be delighted to describe an experiment which proves the separation of the two kinds of electricity by an ordinary voltaic cell.—Bobadil.

[56564.]—**Dynamos.**—To Mr. Lancaster or Mr. Bottone.—I do not care to advise as to the winding of such a Pacinotti ring as that described, as it would surely be a failure. The cogs are much too thick and the spaces too narrow and too deep to be of any use. The field magnet cores must be much heavier, at least 3½in. in diameter. I will give another plan if you desire.—Selimo Bottone.

[56569.]—**Boiler Query.**—To "Boswell."—In answer to your reply, the boiler was made at Bowling in the year 1870. So, therefore, it is 15 years of age, and the plate is Bowling brand. It is all single riveted, the rivets are ¾in. dia., the joints are lap joints, and the first cone tube is 10ft. 2in. from the front of boiler, and there are ten tubes in the boiler, five in each box; the boiler pressure was 75lb. up to 1880, when it was lowered to 70lb., at which pressure it is working. There are no stays at the bottom of boiler, but there are four at each end at top. There are no longitudinal stays in. Could you be so kind as to tell me what alterations to make, so that we could raise the pressure up to 75lb. again with safety, or if it is impossible to work at 75lb. any more? Say what pressure it would be safe at if we got it altered. The plates seem to be good and sound. Of course it has had pretty hard work, and has yet. I am much obliged to "Ex-Blacksmith," and will try to follow his advice.—SAMMY.

[56573.] — **Chronic Rheumatism.** — To "B. Sc.," PLYMOUTH.—Many thanks to "B. Sc., Plymouth," for his kind and prompt reply to above, I now wish to ask him (and others who may reply) for further information, as I wish to try electricity. Should it be what is known as a coil worked by a battery or a magneto machine? If a coil, what battery should be used?—should it be a broken or continuous current? Could I have some arrangement, to apply while in bed, as I am extremely susceptible to cold; am afraid of exposing any part of the body to the air for more than a few moments together. Please give full particulars for the application of electricity. Have taken many medicines with but little benefit.—A MANY YEARS' SUBSCRIBER.

[56578.]—**Electric Bells.**—To H. S. BEACH.—I readily accept your kind help. I do not quite see how you make the line resistance 200 ohms, since the connections are all made parallel with the stations and not all in simple circuit or series. The bells are not large at all—small 4in. single-stroke bells I intend fixing. One of the stations being a long way from the others I thought a relay would be advantageous there, and also by having a relay at each station I could do with a fewer number of cells (Fuller), five or six at most. I may at once mention that they are telephonic stations between different places of business, each place having its own number of beats. I will gladly avail myself of "H. S. B.'s" diagram of connections also.—ELECTRA.

[56580.]—**Tricycle Pedals.**—I am not a mechanic, but as a cyclist think there ought not to be much difficulty in curing the fault in this correspondent's machine. Why not try a neat iron washer filed to a proper thickness, so as just to allow sufficient play to the pedal? In my own machine I stop all rattling by using thin leather washers lubricated with tallow, though probably these would not do for pedals, the friction being too great. As for spring washers, I know nothing about them, and fancy that, if procurable, they would not be near so efficacious as a pair of plain iron ones.—LITHIUM.

[56587.]—**Telephone System.**—If "T. J." is familiar with incandescent lighting on the multiple arc system, he will find, if he joins up a few telephones according to diagram shown in issue of 24th ult., that each telephone receives a portion of the current in the same manner as incandescent lamps do. The following diagrams may enlighten him a little:—

FIG. 1

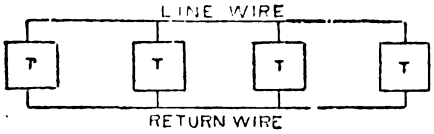
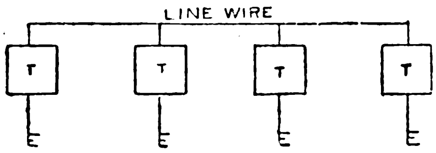


FIG. 2.



In diagram No. 1 a return wire is shown, and, of course, two leading-in wires are necessary in this arrangement. In diagram No. 2 earth is substituted for the return wire. If a telephone circuit is short, a return wire might be run; but if the circuit is a long one, it will save expense by only running one wire, and putting earth on at each telephone, as shown in No. 2, only one leading-in wire being necessary, this being soldered on to the line wire, which may be continuous (without break) from beginning to end. The success of working a circuit in this manner will depend on the earth being good at each station. With this arrangement I find that induction from other wires (such as telegraph circuits) is somewhat diminished. Also when electric tremulous bells are used in connection, no relays are required, as would be the case if joined up in series; and if a telephone gets out of order, or the line wire breaks, it will not stop the whole circuit, so that faults are readily localised.—R. F. S.

[56580.]—**Tricycle Pedals.**—"C. D. R." says, "Why not put in ordinary iron washers?" Well done, "C. D. R." You are certainly getting on. Could "C. D. R." put a washer on a tree without cutting off either the top branches or the roots or splitting the washer into two semicircles and then putting it round. Just in the same way, perhaps, he could possibly get the washer on to the crank in the right position. "C. D. R." does not forget to pounce on Mr. "Bobadil" this week, for that gentleman kindly volunteering information. If "Bobadil" was paid for his advice, it would be a different thing altogether. Wherever did you obtain your information? Dear me! Extraordinary! Could you illustrate with a few diagrams, for the benefit of engineers and amateurs alike, this method of yours? You know it is a tricycle with a crank and not a bicycle in question. Now, do you see, dear ("C. D. R."), I have found "Invicta's" method to answer properly. I ride a front steerer myself, and it was on going down hill with legs on rest that the shaking of pedals became most annoying. Now, "C. D. R.," try and discover a few more methods by next week, and for the future do not try to answer questions about which you know nothing at all. If, instead of waiting for someone else to answer "Medical Coil," you had done so yourself, it would have been better.—U. C. S. W., Cardiff.

[56604.]—**Differential Equation.**—In looking again at this query (supposing it to be given in good faith, and that the first term is a misprint), I think the equation must be meant for—

$$\frac{d^2y}{dx^2} - a\frac{dy}{dx} = 0.$$

This is a "partial differential equation" with three variables, $x$, $y$, and $z$, the solution of which will be—

$$y = m(2z + ax^2 + nx) + c,$$

where $m$, $n$, and $c$ are arbitrary constants. This may be proved as follows: First consider $z$ as constant, and differentiate twice; then $\frac{d^2y}{dx^2} = 2ma$. Now consider $x$ as constant, then $\frac{dy}{dz} = 2m$. Multiply this by $a$, and subtract one result from the other, and we get the original equation. I am rather curious to know how such an equation can have arisen. Perhaps "H. H." would say whether it is from some geometrical construction.—M.I.C.E., Bath.

[56611.]—**Junket.**—Obtain one quart of new warm milk, a small piece of rennet (juice of calves' maw), allow to stand and get cool. Then add two tablespoonfuls of brandy, a little nutmeg, a layer of white sugar; lastly, a layer of Devonshire cream. For teetotallers the brandy need not be added.—A DEVONSHIRE GIRL.

[56617.]—**Stained Skin from Wearing Black Stockings.**—Try a little vinegar or a weak solution of oxalic acid about the strength of vinegar. Rinse afterwards with hard water. Should there be any roughness of the skin, use vaseline.—VERAX.

[56620.]—**Steam-Carriages.**—About four or five years ago a steam tricycle was made by a gentleman named Parkyns (of Woolwich, I believe), and exhibited at the Stanley Show at Holborn Town Hall, London. The cost was to be £40 each machine. The fire was fed with methylated spirit, which was turned into gas and burned in the furnace. The machine seemed to answer every expectation. But before any orders were taken, a friendly test case was tried before Mr. Partridge at the Court of Woolwich or Greenwich, and it was decided that the machine came within the Acts relating to road locomotives, one clause of which, in addition to those enumerated by other correspondents, is that the tires must not be of a less width than 12in. Since the above decision nothing has been heard of the machine, and it would be foolish to attempt to build one with the intention of running it on the public road to any advantage. Since writing the above, I see that a description of the above tricycle is published in the "E. M.," Vol. XXXVI. page 153.—F. SMITH.

[56620.]—**Steam-Carriage.**—This question of a steam-propelled vehicle seems to be perennial; but it is, so far as the public roads are concerned, happily answered by legislation. No doubt any English Mechanic might safely be trusted with a steam velocipede or a steam carriage, but the experience of the frequenters of the river in connection with steam launches is not conducive to expressions of joy and welcome as regards steam carriages on public roads. The replies on p. 266 are amusing—they are so very innocent. One gentleman says that weight, heat, and smoke are all against steam-engines for common roads, which is true enough; but he proceeds to say that a better motor could be had to work with gas, air, electricity, or "even hydraulics." The "even hydraulics" is rich. The Parkyns steam tricycle, which you illustrated on p. 153, Vol. XXXVI., is about the best thing of the kind, but I will venture the opinion that if that were driven along the road at the speed of a fair average tricyclist, it would be "heavy on repairs"; and I have not yet had the pleasure of seeing a practical design for driving by gas, air, or "hydraulics," even on paper, though I have seen Prof. Ayrton's electric tricycle, which I fancy was not altogether economical. "C. D. R." must be a very young man, for he delivers the opinion that "steam carriages would have been an institution years back were it not for the restrictions placed upon them," with an evident belief that he knows all about it. Let me ask him, then, how it came about that all the early inventors of steam carriages gave it up as a bad job, for the "institution" is coeval with the century, and Capt. Dick Trevithick was at least as much of a genius as can be found nowadays. I mention Trevithick because there is indisputable evidence that he and Vivian constructed a steam carriage which actually did some good work (it is illustrated in Vol. XXXII., page 507); but Cugnot, in France, and Oliver Evans, in America, were before him by about thirty years. James, Gordon, Gurney, all built steam carriages or coaches (the last-named ran his on the Cheltenham and Gloucester road), while there are plenty of people still living who remember Hancock's steam coaches which ran between the City and Islington, and the City and Stratford. Some of the steam coaches accomplished as much as 128 miles in a day, and a steam drag made for Sir C. Dance did run from London to Brighton in about 6½ hours. That was in 1833. The Editor of the *Mechanics' Magazine*, writing in his number for Nov. 3, 1832, said: "We do not expect to see steam power ever applied with economy to quick travelling on common roads." The following year saw a great development of steam coaches, which really did in their way work very well; but as to economy—ah! that is just it. Reuleaux, in his "Kinematics of Machinery" (Kennedy's translation, p. 235) says: "We have the problem of steam locomotion on common roads, which has been so feverishly taken up again within the last few years, but the solutions of which seem doomed to eternal incompleteness, for they are self-contradictory. It is desired to make something which shall be a machine, but in which at the same time the special characteristic of the machine, the pairing of elements, may be disregarded." No steam carriage can be successful on a common road unless it has thick rubber tires or elastic wheels, which, so to speak, lay down the other "element" in the shape of a rail. The cost of those rubber tires and their excessive wear made the steam coaches altogether too expensive. Trevithick, Gurney, Hancock, Heaton, and the others all tried hard during the first third of the present century, and gave up the steam carriage as a bad job. We have their experience and our, of course, superior intelligence, superior tools, superior materials, &c., and we really ought by this time to make a steam carriage for use on the common roads—even on those just coated with broken granite or flints. I thought, however, it might be as well to call attention to the fact that steam carriages are not exactly new ideas, and that, as a matter of fact, nearly every conceivable scheme in connection with them was thrashed out half a century ago. There are plenty of good designs for steam carriages in early volumes of the ENGLISH MECHANIC; but, whether or not the "restrictions" upon their use are unfair and unjust, I seem to have a scintilla of an idea that they will never become an "institution" unless they run on rails. Those are the only "efficient and satisfactory steam carriages" we are likely to see.—NUN. DOR.

[56622.] — **Lightning Conductors.** — The essential points to be attended to in erecting a lightning conductor are—(1) to obtain good earth contact; (2) to see that the sectional area of the rod is sufficiently large; (3) to have the leads and all metalwork about the roof, &c., in metallic connection with the rod, and (4), to let the apex of the same consist of one or more sharp points, elevated well above the highest point of the building. The first and third of these essentials are of the utmost importance. With respect to the first, the rod should be joined to a good-sized earth plate, and sunk in damp soil; or, if a stream is available, capital "earth" may be made by carrying about 10ft. or so of the conductor along the bottom, and burying it in the mud or clay. In cases where there is neither marshy ground nor stream, some engineers recommend digging a trench—say, 10ft. long and 4ft. deep, and laying the end of the conductor along the bottom, well bedded in gas-coke, that substance affording a large surface contact with the soil. Too much care cannot be given to obtaining good ground contact, and yet it is a point frequently neglected when the erection of conductors is in the hands of non-scientific persons. In many cases the end of the rod is merely thrust a foot or so into the accumulation of soil, brick-ends, &c., at the foot of a chimney or other erection—an arrangement far worse than useless. The shape of the conductor is immaterial, its efficiency depending on the sectional (solid) area which, in the case of copper, should not be less than one square centimètre: the area of other materials being in proportion to their conductivity. Conductors are frequently passed through glass insulators when near the ground; but this is a matter of little importance. They may be joined directly to the holdfasts without any detriment. As to the amount of space protected, Prof. S. P. Thompson says that Preece has calculated "that a lightning conductor of a given height above the surface of the ground will protect from the external action of electricity a conical space, the radius of whose base is equal to the height of the rod; but whose side is hollowed in the form of a quadrantal arc." It is well to have a conductor tested on completion, with a view to ascertain its resistance (the French Minister of Posts and Telegraphs recommends 25 ohms as the maximum), and, more particularly, to prove the soundness of the earth contact. If this were done generally, there would be some curious results obtained with many so-called lightning conductors.—LITHIUM.

[56622.]—**Lightning Conductors.**—The things to be guarded against are—(1) leaving any strikable point conductorless; (2) leaving a gap, or a fusibly slender neck, anywhere in the conductor's length; and (3) leaving the foot too far from permanently moist earth. The question, "What area does a conductor protect?" involves a total fallacy, as Sir W. S. Harris long ago proved to the Admiralty. No strikable point is protected by another point. Thus, no ship's mainmast is found to protect another mast, or even the jibboom. Nay, where all these four had conductors, a mainyard has been struck. In short, every point that might be touched by the middle of a plane disc, say, of 100 yards diameter, without touching aught else, is a strikable point; but whatever could not be so touched is unstrikable. Having gone to see every point struck within a few miles of London during some 30 years, I found no exception to this. Of course, it follows that no isolated country building can have less than three points needing protection, and most have half a dozen, while the majority of town houses have none in danger. Again, as our buildings all have metal gutters, and rain-pipes to the ground, any bit of special conductor lower than the eaves is a blundering superfluity. But as the successive pieces of descending pipe cannot be electrically connected, as by solder, a short copper band should connect each with the next. The smallest gap in conducting-line is dangerous, as the spark leaping it will fuse the nearest points, as it also will if they alone touch, for they then form a fusibly slender neck. Any neck must be considered fusible whose section is less than ·3 of a square inch of wrought iron, or probably twice as much of cast, or a seventh as much of the purest commercial copper. If this could be had as inelastic as lead, it might be the cheapest material; but any that we find is elastic, the more so the more impure, and probably the amount needed for safety costs more than what is needed of iron. The most economic form will always be that having most cooling surface to a given weight; therefore riband, the wider the better. Insulation is of no use whatever, nor yet making conductors rise above the point protected, nor elaborate sharpening. Slightly ragged ends, naturally left, are just as effective in lightning prevention as needle-points. Any proper conductor prevents many flashes that, in its absence, would occur.—HARRISIAN.

[56624.]—**Newmarket Direct Railway.**—ERRATUM.—For "1878" read 1873.—W. B. P.

[56634.]—**Piccolo.**—In reply to "S. R. P." the Boehm piccolo in D measures 30 centimètres long; 25 centimètres from mouthhole to the lower end, the lower joint being 19 centimètres long. The bore at the cork is 11 millimètres; at joint, 11 millimètres; at lowest key, 7·5 millimètres; and at end, 9 millimètres. The hole diameters, beginning at the lowest, are in millimètres. 8, 8, 8, 7·8, 6, 6, 6, 5·8, 4·8, 4·8, 4·8, 4, 4—13 in all. As to the mechanism and positions, that would take some trouble to explain, and I think there are not a sufficient number of our readers interested; but if "S. R. P." advertises his addressI will try to give him the information he desires.—VULCANITE.

[56636.]—**Australia.**—In last week's "E. M." "books had better be taken" appears. I intended to write "boots," &c., as all English leather goods are better than colonial.—ROSICRUCIAN.

[56640.]—**Detachable Stock for Revolver.**—It entirely depends on the class and make of revolver. If it is, as many are, fitted with a ring screwed into the end of the stock, then the matter is easy enough. Because all you have to do is to fit the shoulder stock with a projection to slip over the lump just behind the hammer, and a set-screw taking into the thread where the eye of the sling ring holds all firmly. Supposing the weapon has no sling ring, then it means fitting the stock to embrace the butt of the revolver, and holding it firm by means of a set-screw and covered clip. If one saw the weapon, it would be easy to quickly devise a plan. For lightness I had a stock fitted to a revolver made from stout steel wire, and for all practical purposes it answered admirably.—INVICTA.

[56642.]—**Petroleum.**—There is hardly likely to be any water in petroleum; the water is perhaps in the cans or bottles in which the oil is stored or obtained. I have never noticed anything of the kind. Dry the inside of the lamp with a piece of blotting-paper or cotton waste, and see that all cans and bottles are perfectly dry before use.—OS.

[56644.]—**Resistance Coils.**—To MR. BOTTONE.—I quote from Mr. Sprague's work, p. 162. The following sizes are suitable: Single ohms, No. 18 to 21; 10 ohms, 20 to 29; 100 ohms, 25 to 34; 1,000 ohms, 32 to 40. The following are about the lengths of 1 ohm: No. 18, 18ft. $2\frac{1}{2}$in.; 20, 9ft. $3\frac{7}{10}$in.; 24, 3ft. $1\frac{6}{10}$in.; 26, 1ft. $11\frac{8}{10}$in.; 29, 1ft. $1\frac{3}{10}$in.; 34, $6\frac{6}{10}$in.—S. BOTTONE.

[56645.]—**Small Gas-Engine.**—I must apologise to "J. H." for interposing in a matter addressed to him personally; but my interposition is intended to be in the interests of the general reader, so that I feel sure he will not feel, as he would otherwise be justified in doing, that I was, in dealing with a personal question, committing a grave discourtesy. The suggestion I would make is this: Gas-engines seem to occupy the minds of more than a few of the readers of this journal. That any amateur runs a very great and double risk in designing and making himself is equally sure, because gas-engines *cannot* be designed like steam-engines, and the money sunk in fruitless experiments has been simply immense. Not only this, but the patent rights are now so many, that it is hardly possible to get to work without treading on the toes of someone, and one patent agent I have had mentioned to me is doing a good business in looking up all infringements, &c., he can discover, and assisting the patentees to mulct the (in many instances) unwitting infringers. Now, there is a way out of the difficulty with safety and ease; and having this in mind, I mentioned, in conversation with a well-known gas-engine patentee, the difficulties. After some discussion, at length he stated his willingness to advise his company to grant a free license to bonâ fide amateurs only, who are, from the extent of their means, unable to buy a gas-engine, and who are not themselves engineers. To such he would be prepared to advise the company to issue a special free license to make one engine only. And this must also be backed up by a legal undertaking to that effect. On my remarking that the clause to make but one engine would be very hard in the case of an amateur who had, for instance, underrated his demand for power, I was told that in such cases, on the facts of the case being laid before him, he would, to prevent as far as possible any hardship, advise his company to take over the smaller engine at a reasonable price as a second-hand motor, and grant the person in question an enlargement of the license to enable him to make a second engine under the circumstances. Under these conditions, and that the engines so made would be at all reasonable times available for exhibition to intending customers, who would be properly introduced by the company's local agent, he would furnish tracings of either a vertical or horizontal engine, and either of the compressing or non-compressing type, and any infringement of patent right would lie with the company, and as no experiments would be needed to get the engine perfect it seems to me a good proposal. At any rate, I throw it out for any remarks on the scheme, which looks to me both feasible and good.—INVICTA.

[56648.]—**Bichromate Battery.**—If you connect up for quantity the different sizes of the batteries will not matter, but if connected in series of course it will. You must then have about the same surface exposed (to the action of excitant) in each cell, and surely you can compare the sizes of the two zincs better than anyone at a distance can do it for you. The internal resistance is the R. offered to the passage of the current through the battery; for instance, if you place the plates at a distance from each other you would have a greater R. than if you place them close together.—OS.

[56648.]—**Bichromate Battery.**—You can connect up your cells either in parallel or series. If you connect them up for intensity or series, the E.M.F. will be double that of one cell, because the E.M.F. only depends on the material used, and not on the size of the cell; but if you connect them up in parallel or quantity, you will get more than double the current the small cell would give, because Ohm's law tells us that the current equals the E.M.F. divided by the resistance. The E.M.F. is the same in the large one as in the small one; but the resistance is less, and therefore the current is stronger. So that if you wish to get the same effect from both cells, you must put in the large cell only enough liquid to cover the same amount of surface that you have covered in the small cell. The internal resistance of a battery is the resistance of the plates and the liquids in the cell; it is the resistance between the terminals of the battery.—WATT.

[56648.]—**Bichromate Battery.**—If you arrange your cells for quantity the difference in their size does not matter; but they must be of equal E.M.F. If the E.M.F. is different in the cells, less current will be got than if the weaker cell were off altogether, and a more rapid exhaustion of the stronger cell will ensue. If you arrange for intensity, have the negative elements of equal size. When they are of different sizes the power of the series is reduced to what it would be were all the negative elements the size of the smallest one. Other things being equal, the power of a battery depends on the area of the negative surface. By the electrical resistance of a substance is meant the tendency which the substance has to obstruct the passage of electricity. In a cell the current is limited by the resistance of the fluid, and this (called the internal resistance) is diminished in proportion to the distance between the plates being decreased, and in proportion to their size being increased.—BOBADIL.

[56648.]—**Bichromate Battery.**—The difference in size is of no importance when all the zincs are joined together to form one negative pole and all the carbons for the positive terminal. They are then said to be connected for quantity, or, as it is at present called, "in multiple arc," and act as one large cell. If you connect the cells in series the electromotive force increases with the number of cells, but the resistance of a small cell is greater than that of a large one, and as the same amount of electric action takes place in all parts of the circuit the small cells having the most resistance will grow hot, because the heat developed by galvanic action is in proportion to the resistance. When the small cells become heated the liquid becomes a better conductor, and in consequence a stronger current passes, so that a battery composed of a number of larger and smaller cells will give more current force than the same number of cells the size of the smallest of the series. Much of the electric force, however, is lost in heating the smallest cells when the series is unequal in size, and it is best to have the zinc surface of each element of a battery the same amount; thus a battery with a zinc 2in. square is equal to one with a zinc 4in. by 1in.—J. SUTCLIFFE.

[56650.]—**Lead Burning.**—It is too much to ask our worthy Editor for more space on upright lead burning, as the subject was exhaustively treated upon through the columns of this journal, and if the instruction had been thoroughly carried out the machine must work satisfactorily, as I have scores of letters from young plumbers who have made machines and are delighted with the results. If your machine is made right and you have plenty of zinc in the machine, say 8 to 10lb. of bar zinc, this will give you a surface of at least 3ft. super., and 5 of water to 1 of acid, or, say, 20 pints of water to 4 pints of acid should last you for an hour's good burning, and another pint of acid added after the hour or so's work, should carry you on for another hour; but, of course, you require the very best sulphuric acid, and not such as is generally sold at oilshops, which I have been particular to speak about. Perhaps you have only added 5 pints of water to 1 pint of sulphuric acid to your zinc, and have not sufficient in quantity, or not sufficient zinc, perhaps too little of both. Have you seen Vol. I. of my work, which treats very exhaustively upon the subject? The exhausted acid must on no account be used a second time. The flame being of a yellow cast, at once tells me that you are using it without wind. The sluggishness is owing to the fact that you have no pressure of gas in your machine owing to insufficient quantity of acid and water, or that the area of the zinc is insufficient for the quality of the acid. If "Young Beginner" will make an appointment, I will show him a small machine made exactly as the one I illustrated in the "E. M." which will run on for two hours without further acid or trouble, or I will send him one if he will communicate with me, as I make them.—P. J. DAVIES, 78, Earl's-court-road, Kensington, May 21.

[56651.]—**Boiler.**—This accident, or rather explosion, would, from the information given, appear to be due to the explosion of gas in the flues. After banking up the fires and closing the dampers, each furnace would be a huge gas retort, and the gas, probably (CO) carbon monoxide, would be generated and held in the flues, and immediately the doors were opened it would take up oxygen to form ($CO_2$), carbonic acid gas, and probably become lighted, and thus cause the explosion. Time, place, and extent of damage would be very valuable to me at the present time, as it would probably confirm a strong argument I have recently used, and would no doubt enable me to give "A. S." some reliable information as to how to prevent similar explosions, and I shall be glad if he will publish full particulars or write me direct, which shall have immediate attention and a reply through the post or these columns.—BOSWELL, 6, Cass-street, Salford.

[56651.]—**Boiler.**—There is nothing at all extraordinary in the facts as stated by you. The gas from the banked-up fire had accumulated in the flues during the Sunday, and as soon as the damper was raised on Monday the fire at once began to brighten, and possibly an accidental spark might have fired the gas. In this case, it was no doubt the result of gas forming in some pocket or hollow in the setting not thoroughly swept by the draught. As to a remedy, that is hardly possible to say offhand—except that on breaking up the fire on a future Monday morning I would advise the damper to be opened wide for a few minutes before the fire is knocked about, and drawn forwards, thus sending a volume of air through the flues, which would disperse and dilute the stagnant gas. In a boiler-flue the conditions are very favourable to forming an explosive mixture. At a large Lancashire boiler, where much sawdust was burnt, minor explosions, were frequent; sufficient to reverse the draught for a second, and blow out flame freely on the fireman, if he was in the way. As with coaldust and flourdust in a flourmill, if the particles be in a state of division only fine enough, an explosion is easily producible.—Invicta.

[56652.]—**American Organ.**—If your instrument is an ordinary American organ, containing one row of 8ft. reeds (not 4ft. diapason, as stated in query), the bellows is probably too small to supply sufficient wind for an additional set of reeds and sub-bass. A sub-bass would require extra pressure of air to make the reeds sound properly. My advice to you is this:—If convenient, sell your present instrument, and build one of a size to your liking, and not waste time and money in trying to accomplish what would result in apparent failures. I may add that you can attach a vox humana without much difficulty. That is reasonable enough. The diapason set is of 8ft. pitch, and not 4ft., as you have specified.—G. Fryer.

[56653.]—**Electric Bell.**—The rule which is usually followed in winding electro-magnets is to wind as much wire as will triple the diameter of the core. No. 28 might do with an increase of the battery power mentioned; but it might be safer to use a thicker size—say, 24 or 26—and your two cells will have a better chance, provided they are not too small.—Bobadil.

[56653.]—**Electric Bell.**—You can use No. 28 if you have it by you; but No. 24 is about the size generally used. There is a rule for getting the best effect from a given diameter of iron, which is: Make the diameter of the magnet, when wound, three times the diameter of the iron core, which in your case is ½in., so that your magnets when wound should be 1½in. in diameter. You would require about 2oz. or 3oz. to each leg of the magnet. —Watt.

[56654.]—**Portraiture.**—In the first place, you don't give long enough exposures in the room, and consequently your negatives are under-exposed; that is to say, you get the details of the dress, if a dark one, all right; but you get the faces, which are lighter, too dark in the negative, which makes them print without sufficient detail in the print. In an ordinary room it is almost impossible to take people without special lighting arrangements; it requires at least an hour's exposure to take a decent picture; the inside of a church takes *five hours*, even with quick plates. Out of doors your mistake is just the reverse: you expose too long without the stop; it might be the right exposure with a very small stop, but without a stop it is far too much, unless the lens is extremely slow. You should never take pictures without a stop to begin with: you won't get clear pictures under any circumstances if you do that; generally the smallest stop is not at all too small. Your remark that you get the groups tolerably (Why only "tolerably"?) well, exposing eight to ten seconds with the stop, shows that *that* is somewhere about the right exposure. It is not very easy to get good portraits with a *view* lens; if you had a *portrait* lens, a good many of your difficulties would be removed. I have not tried the "Uranium" plates. I would advise you to try Marion's, which I can answer for, and a perusal of his book would help you enormously.—R. A. R. Bennett, Walton Manor Lodge, Oxford.

[56654.] — **Portraiture.** — As I have gone through the same annoyance as "Camera," I can sympathise with him. To get a good portrait in an ordinary room with a ¼-plate landscape lens he will require to get a sitter possessed of extraordinary steadiness and patience. According to Burton's table of comparative exposures a lens and stop $\left(\frac{f}{64}\right)$ which takes five seconds exposure for an open landscape requires 16 minutes in an ordinary room. I also observe that his ratio between portraits out of doors and in an ordinary room is as 1 to 30; so if "Camera" gets a good portrait out of doors with 30 seconds exposure he will require 15 minutes inside. My own experience, however, is that good portraits cannot be taken with a landscape lens in the house; but, learning that Mr. Armstrong and Mr. Millar had succeeded remarkably well with a portrait lens of 4in. aperture, I procured one and get fine results with 25 seconds exposure, which is the same as given by Mr. Millar to the portrait which took the medal at the late exhibition. "Camera" asks if a near object takes longer to impress itself upon the plate than a more distant one. I answer not in the sense of distance, but because there is a smaller surface throwing in light on the plate. Take the difference between a portrait and a landscape—the one reflects light from, say, 36 square feet of surface, and the other from 3,600 square feet.—B.Sc., Plymouth.

[56655.] — **Cork Frames.** — I should have thought the simple plan of boiling the corks a little while before using would have answered your purpose. Have you tried this?—R. A. R. Bennett.

[56658.]—**Boiler Enamel.**—There are boilers and pans coated inside with white enamel. You will see them at any ironmonger's shop, but you will hardly be able to do them yourself.—Os.

[56659.]—**Cutting Ebonite.**—When turning or working ebonite, in all shops I know of, the ordinary tools for brass are used for ebonite; but a slow speed is used for turning.—Watt.

[56659.]—**Cutting Ebonite.**—It is just possible that your ebonite is adulterated with some hard silicious material, and that takes the edge off the tools. Pure ebonite (vulcanite) should contain little else but rubber and sulphur, and is very easily turned and cut with tools ground as for hard wood turning.—Os.

[56659.]—**Cutting Ebonite.**—If the ebonite were pure—*i.e.*, only made of rubber and sulphur subjected to heat, there would be nothing to take off the edge of the tool; but as it is, ebonite, like vulcanised rubber, is seldom made without the addition of earthy matter to reduce the cost. I heard this many years ago as to the vulcanised rubber trade; but do not know for a fact that it is so with regard to vulcanite or ebonite. Nothing but regrinding or sharpening the tools will do. Just the same as with ebony, you want a harder steel tool, and frequent applications of the stone. In this case (ebony) it is because Nature has sucked up silicious matter into the pores of the wood.—R. S. T.

[56660.]—**Eclipses of Small Hand of 24h. Clock.**—Starting at 24h. or zero, where the fingers are only in conjunction at the exact hour, we find that the minute finger, in overtaking the hour finger between the hours 1 and 2 makes $1\frac{1}{23}$ circuits; therefore the fingers are in conjunction between the hours 1 and 2 at the time of $1\frac{1}{23}$ of the clock; between the hours 2 and 3 the time would be $2\frac{2}{23}$, and so on, gaining $\frac{1}{23}$ each hour round the dial. —J. Jewsbury.

[56661.]—**Bending Iron, Gas, and Steam Tubing.**—Gas barrel can be bent cold in a tyre bender, the same as blacksmiths use for bending wheel tyres, or hot by gently tapping it over the beak of an anvil.—F. Smith.

[56661.]—**Bending Iron Gas Pipe.**—If you are not up to bending the tubes with heat alone, you may easily prevent crippling by filling the tube with dry sand well rammed in, drive into the ends of the pipe a couple of wood plugs to keep the sand in, and at the proper heat you can bend the pipe to any curve you want. Five minutes with a practical man would show you more than pages of letterpress.—Invicta.

[56666.]—**Valve-Gear.**—If your new plan gives an admission of steam equal to 30 per cent. of the stroke, it would be applicable for many purposes. A few years since an engine was invented and brought into notice which had no slide-valve at all, the piston acting as the distributor of steam. Such was "King's Valveless Engine," as it was termed. In that engine I do not think an admission of 30 per cent. was possible. I am, of course, speaking from memory solely, and without reference to any description of the engine. Then, again, we have the "Edwards" engine, which had no slide, the piston controlling the steam entirely, whilst I myself designed an engine which was made by an ingenious Yankee friend for his own use, in which the piston controlled the steam. In that case the steam admission could be made equal to any fraction, or the entire stroke, but was a fixed quantity. In an engine of ordinary construction the steam admission is sufficient for many purposes. But whilst cutting away the slide-valve does your plan give either lead to the admission or the equivalent to inside lap compression? If not, the most essential points have yet to be dealt with for commercial engines. The cut-off of "ordinary" engines may be anything. But a very usual proportion is ⅝, or even half-stroke.—Invicta.

[56667.]—**Drill Chucks.**—If "W. E. F." will get the "Little Giant" chuck, he will find it has all the properties he requires. We have used them for many years for all our lathes and drilling machines, and they are good tools, stand hard, rough usage, and will stick to anything. We have some scroll and other chucks, bought for drilling, but the only one of any practical use is the "Little Giant," of which we have about 30 in constant daily use; any of them will hold a 1in. drill firmly for the heaviest cut the drill will stand. —T. F.

[56668.]—**Powerful Bichromate Battery.**—There is an excellent reason for having plenty of solution, for the zincs do not get exhausted nearly so soon as the solution does, and consequently the more solution there is, the longer the battery will keep working. If you want a strong battery for a short time, use large plates of Zn and C in proportion to the quantity of solution. If you want less power, lasting for a longer time, use smaller plates and more solution.—R. A. R. Bennett.

[56668.]—**Powerful Bichromate Battery.**—An electromotor for a sewing machine cannot do any work with four Fuller's cells. The boat you describe will require six cells of a bichromate battery, having carbon plates not less than 6in. by 3in., and zinc about 5in. by 2in., for which you must use a solution of 2oz. bichromate of soda or potash to each pint of water, then stir it with a glass rod, and add sulphuric acid till the liquid gets warm; pour it into the cells while hot, and have the zincs amalgamated. A Grove's battery will do as well with six cells, platinum 5in. by 2½in., but the nitric acid is unpleasant.—J. Sutcliffe.

[56668.]—**Powerful Bichromate Battery.**—Fuller's cells are not suited for driving electromotors, as the internal resistance is too high. You will get a better result from 4 quart simple bichromate batteries, and by using Trouvé's solution you can make them last three or four hours. If you have room, I should put six cells in, and make the cells as large as possible. You will not get much out of six carbons and four zincs in one cell, as there is too much local action, which only heats up the cell and does no good. You cannot do better than two carbons and one zinc in each cell; if you only want the battery for a short time you can make your cells smaller. As the current depends on the chemical action between the zinc and the liquids in the cell, the amount of liquid required must depend on the time the cell is required to work; this can easily be found out by a few experiments, taking different sized pots and filling them to different heights, and notice how long each cell lasts.—Watt.

[56671.]—**Porous Cells.**—I once cleaned some porous cells by burning them in a clear coke fire. They must be well dried, and gradually heated.—Os.

[56673.]—**Mechanics.**—I think a figure is hardly necessary; but if not quite clear, please construct a triangular pyramid A B C D, and let P Q R S be the forces at A B C and D respectively. Let $x$ = distance of centre from B C D, and let $h$ = distance of A from the same: then we have at once $x\,(P + Q + R + S) = hP$; but P is proportional to $BCD = kBCD$, say, $\therefore x\,(P + Q + R + S) = kh\,.\,BCD = k \times$ volume, and since the volume and $k$ are constant, we see that the centre is equidistant from the three faces, and is, therefore, the centre of the inscribed or one of the escribed spheres. If the forces all act in the same direction, it will be the centre of the inscribed sphere; if not, that of one of the escribed spheres.—Hemisus.

[56675.]—**Lemon Juice.**—Heat the juice to the boiling point and put into the bottles hot; fill them right up to the corks; use good corks, and then dip the ends of the bottles in melted resin; if the air is perfectly excluded the juice will keep all right. You can warm the bottles up first with hot water. —Os.

[56675.]—**Lemon Juice.**—Heat the juice to 150° Fahr., filter it, and set it aside in bottles filled to the brim, and corked and sealed so as to prevent the admission of air. The trade uses what is incorrectly called *liquid* sulphurous acid (properly *solution* of sulphurous anhydride), about half an ounce to a gallon; but it is not quite satisfactory, on account of the slight taste it imparts. Salicylic acid is not open to this objection, but is regarded by some as ineligible on other grounds.—Percy Stanley, 119, Manchester-road, Poplar.

[56675.]—**Lemon Juice.**—Strain the juice through flannel, put into bottles, filled only to the shoulder, and cork tightly with a plug of cotton-wool. Into a pan place a layer of hay or straw, about an inch in thickness, on this place the bottles upright, pour into the pan cold water until the bottles are immersed to a fourth of their height, and put on the lid. Place near a fire until the water becomes hot, then over the fire until the water boils, continue the boiling for half an hour, remove from the fire and allow to cool, but *without removing the lid*. When *quite cold* take out the bottles and with a light burn off the loose filaments and apply hot melted sealing wax, beeswax, or paraffin until the wool is quite covered. If these directions be carefully carried out the juice will be preserved, not only for the summer, but for years.—W. H. Darling, Manchester.

[56676.]—**Free Reeds.**—From the wording of this query it is quite evident that the querist is unable to tune reeds, apart from mechanical assistance. I will, therefore, simply make a few remarks on the subject, which I hope will benefit and help him in the future. The best and proper time to tune harmonium reeds is when the reeds are secured to a pan or soundboard on which the reeds are intended to remain. To tune reeds under the conditions suggested in the query is little better (if any) than useless. If a person desirous of learning the art of tuning has not the ear sufficiently perfect to accomplish the operation without mechanical assistance, he is not very likely to be successful, and if any mechanical assistance is required in making a tempered scale (or laying the bearings, as it is sometimes called) I would suggest a set of 12 tuning forks, chromatically arranged, as a guide for producing the scale for tuning. Let me advise the querist to discard the somewhat foolish ideas expressed in the query.—G. FRYER.

[56677.] — **Boring Small Wood Handles.**—Have a drill chuck fixed on the back centre of the lathe. For tools, use ordinary drills, such as are used for metal. I have tried all sorts of drills for woodwork on the lathe, and find nothing equal to these.—OS.

[56684.]—**Electro Motor.**—To MR. BOTTONE.—Wind it with the same sized wires as recommended in my book—viz., 7lb. of No. 16 on the fields, and ½lb. of No. 20 on the armature. But this dynamo is much too large for a sewing machine motor. To work it properly it would require at least 20 quart bichromate cells. Why not rig up a small motor with F.M.'s of about half the size, which will require only about 3 quart bichromates? Jones, of Lambeth, advertises in this paper sets of motors with wires for 5s., I think.—S. BOTTONE.

[56686.]—**Bending Wood.**—Anyone who could tell you that hard wood can be bent at right angles ought to have been able to tell you how it was done.—OS.

[56687.]—**Wheel Calculations.**—One rev. of B gives 1·46 turn of G. Therefore, to bring the wheels in the same position as they were at starting, we find—

$$1 \times 50 = 50 \text{ rev. of B}$$
$$1{\cdot}46 \times 50 = 73 \text{ rotations of G.}$$

—J. JEWSBURY.

[56687.]—**Wheel Calculation.**—The following formulæ will be a guide to "Sammy" for what he requires. According to his plan in query he wants machine to go slower; so by multiplying the number of teeth in wheel B by the revolutions he makes by the handle, say 40 per minute, then divide the total by wheel C, the product will be the speed of A as required; thus, formulæ: $\frac{23 \times 40}{50}$ = 18·20, ratio of shaft A. This will answer either gaining or losing speeds in your case.—COG-WHEEL.

## UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

Since our last, Glatton has replied to 55879.

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**Welding Cast Steel.**—Take rock saltpetre, ½lb., dissolve in ½lb. oil of vitriol, and add it to one gallon of water. After scraping the steel, get it hot and quench in the liquid, and then heat, and it will weld like iron. Better than borax—so it is said.

THE *Steel Age* says that steel rails cut up into lengths of a foot are being successfully melted in foundry cupolas by Mr. R. E. Masters, who has succeeded in producing some very fine castings at a rate of 5lb. of steel to 1lb. of fuel consumed.

## QUERIES.

[56688.]—**Rifle.**—Being about to go to Devonshire for my holiday, and being a member of one of the Mx.R.V.R., should like to take my rifle. Would one of "ours" inform me if the excise officers would interfere with me, if I used a Morris tube for practice only in a field the property of my uncle?—DEVONSHIRE GIRL, ONE OF THE A.P.O.C.

[56689.]—**Battery for Electric Lamps.**—Can anyone tell me how the new batteries for electric lighting are made? I believe that 16 cells will ignite 14 to 16 Swan lamps of 8 to 10 candle power for 12 to 14 hours. I wish for directions as to size of plates and construction of battery, exciting fluids, and cost?—SM.

[56690.]—**Flux for Alumina.**—Will any of our chemical readers kindly inform me what flux can I use to fuse alumina at a heat not much greater than melting cast iron? I am aware that alumina can be fused alone by the oxy-hydrogen blowpipe. Any information on the subject will oblige—EX-GARRISON GUNNER.

[56691.]—**Water Gas.**—We read that our American cousins are trying to produce an incandescent light from water gas, by heating a metallic spiral in the flame. What is this water gas, how is it made, and what gases is it found to contain?—EX-GARRISON GUNNER.

[56692.]—**Carbon in Cast Iron.**—Cast iron, when fused, is found to be capable of taking up an extra quantity of carbon, which is again deposited on the iron cooling. I want to know how much carbon can be thus added to the fused iron, how it is to be done, and what sort of carbon (charcoal, graphite, &c.) should be used? The iron is fused in a crucible by means of a gas-furnace.—EX-GARRISON GUNNER.

[56693.]—**Silos.**—I should feel obliged for any further information on this subject beyond that given in reply to Rob Harris, 55802, No. 1,036. Also respecting the opening for consumption—how long will it keep good after opening? Can it be opened and closed again as required, without damaging remainder? Should this meet the eye of "Day Silo," who replied to "R. H.", Feb. 20, No. 1,039, any information kindly sent to the advertised address would be forwarded to—NEW ZEALAND.

[56694.]—**Butter Kegs.**—Would any of "ours" kindly give instructions how to make these kegs, say, 15in. top and 12in. bottom diameter? Also, what is the best kind of butter worker, and how made?—NEW ZEALAND.

[56695.]—**Block Instrument.**—To MR. STRETTON OR OTHERS.—I am inventing a two-wire block telegraph to meet the requirements of the present system of signaling. Is there any two-wire block now working? If so, where, and could you describe it, as I do not wish to infringe on other patents? What is the tell tale block? Any information will oblige from any correspondent?—ELECTRIC JIM.

[56696.]—**Conductive Glue or Cement.**—I wish to pass an electric current through a series of thin copper plates or diaphragms, temporarily joined together by some kind of glue, cement or varnish, but everything I have tried seems to interrupt the current. Could some of our electrical correspondents suggest some suitable material, not to give great strength, but to resist pretty well the action of the water? I would prefer to apply it to the plates, when wanted, as glue with a brush.—A YOUNG AMATEUR.

[56697.]—**Cutting Glass Bottles.**—I have a number of large glass bottles, with narrow mouths, which would make capital jars for battery and other purposes if I knew a simple and practicable way of cutting off the upper parts. Some time ago a scientific (American) paper gave the following method of doing this. Let the bottle stand in a sufficient depth of cold water on the surface of which floats a small quantity of inflammable oil. On igniting the latter, the heat will cause the glass to crack evenly along the water line. I have tried this with turpentine, but without success. Perhaps some reader of the "E.M." can say if this method is worth anything, and if so, where am I wrong? Any information bearing on the subject will much oblige—SODIUM.

[56698.]—**Quinine Manufacture.**—I wish to attempt this in a small way. Will "Os," or some other of your highly practical correspondents kindly inform me—in view of the explosive nature of mineral oils—how I may safely boil the bark in paraffin oil? I am situated where there is no gas, and the oil I buy for my lamps is in four-gallon tins, called kerosene; but there is nothing on the cans to indicate the nature of their contents, save the American makers' names. On one of them I find the mark "125° oil," whatever that may mean. Is this oil likely to be the same (or an efficient substitute for my purpose) as paraffin, and how could I safely boil it, in fairly large quantities, in an ordinary copper say, and at what distance over charcoal fires, and feel the lives of myself and my assistants free from danger?—D. I. T. B. P. O. V.

[56699.]—**Condensing Engine.**—Will "Invicta," or some other kind reader explain the working of a condensing engine? I am now in charge of a high-pressure horizontal engine, and I have got the offer of a better situation to take charge of a condensing engine? Is it the air pump that a vacuum tells is in good order or what part? Does the vacuum vary according to the h.p. of engine or pressure of steam, and why don't a condensing engine exhaust the steam into the atmosphere like a high-pressure engine, and what is the difference between a surface condensing and any other condenser? If not imposing, and not taking up too much valuable space, I should be very thankful for a sketch of this engine.—ONE WILLING TO LEARN.

[56700.]—**Circumference of Wire Rope.**—What is the circumference of a wire rope, composed of 119 wires, each 3-32 of an inch diameter, the wires supposed to be perfectly laid together without a core?—MECHANIC.

[56701.]—**Pull of Martini-Henry Rifle.**—Will some kind reader inform me the way to ease the pull of the Martini rifle? I have one with a pull of 10lb., and find it very difficult to make good shooting, especially when practising the knee position. As in all competitions we are allowed to shoot with a minimum pull of 6lb., I should be extremely obliged if someone would show the way to get rid of some of the superfluous weight.—INNER.

[56702.]—**Longitude.**—To "F.R.A.S."—I have in my possession, a copy of Sim's "Mathematical Instruments," date 1838, in the appendix to which is a table for finding the longitude by transit of moon culminating stars

$$\text{as } \frac{\text{Diff. Long.}}{\text{Diff. ☽ RA}} = \frac{3600\text{s.}}{\text{Hourly change ☽ R A.}}$$

it might be supposed that the logarithm of the right-hand side of the equation is given in the table. What is actually given, however is

$$\frac{3{,}600}{\text{Hourly change ☽ RA} \times \text{A}}$$

when A is as follows?—

| Hourly change m. | s. | A. |
|---|---|---|
| 1 | 50 | 1·028 |
| 2 | 10 | 1·031 |
| 2 | 10 | 1·034 |

and so on in proportion. Can "A Fellow of the Royal Astronomical Society," give me any clue as to the meaning of this factor? Reference is made to Mr. Riddle in the preface.—H. KING.

[56703.]—**Algebraical Problem.**—Will any of your readers kindly solve the following:—The number of variations of $n$ things $r$ together : the number $r - 1$ together : : 10 : 1, and the corresponding numbers of combinations are as 5 : 3; find $n$ and $r$.—TROPHY.

[56704.]—**Soft Black Carbon.**—I have a large supply of soft black (coal holding) carbon. Could any of your readers inform me if it could be turned into profitable account? Would it make blacking, combined with other ingredients?—NO SIG.

[56705.]—**Potter's Kiln.**—To MR. S. ABLIDGE.—Thanks for your reply. The kiln that I propose to build, is to burn models, busts, thin vases, &c., done in common and also in Parian clay. I should also like to burn, in the same kiln, common red clay, such as is used for making fern cases, rustic ware, and fancy flowerpots.—J. TOWNLEY.

[56706.]—**Microscopical.**—Will some reader kindly furnish me with information respecting use of polariscope? I have the use of a first-class microscope, and am told that the polariscope is one of the principal features. I am only a tyro in this sort of work, so should be obliged if someone would help me, or tell me where to get a good work about it. I have already a small book about it, which simply says it is easily manipulated, and have done all I can to get the colours, but at present to no effect. I have proceeded as follows:—To the bottom of stage where diaphragm slides, I have put one prism; it is mounted in a brass setting, and revolves through tube, having a milled edge to twist it with, and the other prism appears to screw in just above the object-glass; well, on turning the bottom prism, which is the only one that can move under these circumstances, I find the light very much diminished, and sometimes goes out entirely, not because I get my hand in the way of reflecting mirror, because I am careful about that, so cannot help thinking there is something wanting, and if you could help me I should feel obliged.—IGNORANT.

[56707.]—**Electro-plating.**—I am working a brassing solution composed as follows: 2½lb. of American potash in 6gal. of hot water, filter the solution, also dissolve 2½oz. of acetate of copper in strong liquid ammonia, and stir into the first liquid, then add 5oz. sulphate of zinc, stir until dissolved, finally add 2oz. of cyanide of potassium, filter the solution, and work at 100° Fahr., anode brass and currrent stong. Now I am working this, as I believe, quite correctly, right temperature and current strong, as I am using a gallon Bunsen fully charged. All the results I get is—the cathode turns quite black, or not the least action at all, but not the least sign of brass. Perhaps some of my fellow readers may put me right through our weekly paper.—CATHODE.

[56708.]—**Science Questions.**—Will any brother reader answer the following questions?—1. Required the number of sq. mm., sq. cm., and sq. decimètres, contained in the top of a table, measuring 1 mètre by 70 centimètres? 2. The co-efficient of expansion for gases for 1° C. is ·003665? What is the co-efficient for (*a*) F., and (*b*) 1° R.? 3. A balloon containing 1,200cb. mètres of coal gas under a pressure of 770mm. of mercury, ascends until the bar stands at 530mm.? What volume would the gas in the balloon now occupy, supposing none to have escaped? 4. A piece of a certain metal weighs 3·7395grm. in air; 1·5780grm. in $H_2O$; and 2·2896grm. in another liquid. Calculate the sp. gr. of the metal, and of the unknown liquid?—ST. HELENS.

[56709.]—**Lubrication.**—Will any of your correspondents kindly inform me if it is possible to lubricate all the valves and pistons of a compound tandem engine, from one point on the steam pipe between the throttle valve and the high-pressure valve, and if grease will saturate steam, so as to lubricate practically?—W. SYKES.

[56710.]—**Salicylic Acid in Food and Drink.**—Is this easily detected in butter, jam, milk, wine, and beer? Please let me know the process. It is much used now, and is detrimental to the frame, affecting the kidneys. I believe the French government has prohibited its use. PURE FOOD.

[56711.]—**Fulcrum.**—Would any readers of the "E.M." let me know how to find the fulcrum of the following bar?—10in. long, and weighs 4lb., a weight of 6lb. is hung at one end: please show the working how to get the distance from the end so that it will balance.—FULCRUM.

[56712.]—**Shutter.**—To MR. LANCASTER.—Supposing an eccentric attached to the centre of your instantograph shutter, and the elastic wound round it, would it be any quicker than the ordinary one? I saw one made as above by an amateur who contended—1st. That the speed is much quicker. 2nd. That the greater speed is due to the eccentric. 3rd. That it will give the foreground five times the exposure of the sky. The shutter has a square opening over a round one.—DROP SHUTTER.

[56713.]—**Coal versus Coke.**—Can any brother subscriber who has had experience in the use of coal and coke, for steam raising, inform me how coke compares with coal in practice for evaporative power, and if any special arrangements have to be made to secure proper results from the coke?—Asmodeus.

[56714.]—**Heat Absorber.**—Will any of our correspondents give any information regarding the chemical composition of a good heat absorber? If any of our readers are acquainted with the absorber or nonconductor (used by a set of travelling showmen, commonly known as fire-eaters), the describing of the same would doubtless be most valuable, and oblige.—Inquirer.

[56715.]—**Hydraulic Capstans.**—In the goods yards of the L. and N. W. Railway, I have seen a capstan head worked by hydraulic power, and used for hauling and shunting trucks. It could be thrown in and out of work by a pedal actuated by the foot. I should be glad if any of your readers could describe the mechanism, with sketch, if necessary, and say whether ordinary waterworks town pressure is sufficient to work such apparatus.—Asmodeus.

[56716.]—**Hartley's Gas Calorimeter.**—Can any of your readers supply such information as would enable me to construct one? In these days, when so much is being done and attempted, and so many results to be compared, it is necessary to ascertain the thermal power of the gas, and no doubt the information necessary to an intending amateur constructor will be welcome to many besides—Asmodeus.

[56717.]—**Legal.**—A. (deceased) by his will bequeathed to B. a fortune of a considerable amount, but with the restriction that he is not supposed to claim it until arriving at the age of 25 years. At the time of taking out of probate, about two years since, B. received the information that, with the consent of the executors, he cannot be compelled to abide by above, and is desirous to know in what manner to act, in order to regain his property at the usual period, 21 years.—Lexicon.

[56718.]—**Northern Railway of France.**—Wanted the exact distance from Calais (Pier station) to Paris via Boulogne and Amiens.—W. B. P.

[56719.]—**Waterproofing Cloth.**—Can any reader oblige with particulars as under of Belgian system of waterproofing, mentioned on page 576 of Vol. XXXVII.? Are the equal parts to be taken by measure or weight? Should the solutions be made with hot or cold water? Does it mean that articles must be dipped two or three times to make them thoroughly waterproof? About what quantities would be required for each garment (say trousers or summer overcoats)? If the cloth be what is called shrunk, would this treatment be likely to make it shrink again? Particulars would oblige.—E. J. A. B.

[56720.]—**Mirror Painting.**—Can any of "ours" tell me how to make medium for mirror painting? It is claimed for it that it is indispensable to make colours stand cleaning afterwards.—C. A. Palmer.

[56721.]—**Steam Motor.**—To "Invicta."—Some weeks ago you promised to give particulars of a low-pressure steam motor, and I have since been anxiously looking for same, as I should like to make one before next winter, if it is suitable to drive a small dynamo.—C. W.

[56722.]—**Flywheel.**—Will some kind reader give me dimensions and weight of a flywheel for a two-cylinder engine, 4in. stroke by 2in. diameter, running at 350 per minute. boiler pressure being 35lb.? What difference would it make if pressure on boiler were 50lb.—M.

[56723.]—**Chaster's Electro-Motor.**—I am constructing an electro-motor, as described in English Mechanic, Nos. 1,026, 1,027, 1,029, and 1,041 by Mr. J. E. Chaster, but I fail to find in his instructions for winding the wire, "E.M.", No. 1,041, how the armature is wound, and where the ends are connected. Also, does it matter if the saw cut in the commutator is opposite the wire or iron portion of armature? Will Mr. Chaster or others kindly answer this?—A. Hallett.

[56724.]—**Accumulator.**—Can any reader of the "E. M." inform me what size accumulator of the Faure type would be required to light a 5-candle incandescent lamp, stored by means of a small hand dynamo, and how long the accumulator would last? Also, is Faure's cell the best for my purpose?—P. T. H.

[56725.]—**Western Railway of France.**—Wanted the exact distance from Paris (St. Lazare) to Versailles (Rive Droite), and from Paris (Montparnasse) to Versailles (Rive Gauche)?—W. B. P.

[56726.]—**Legal.**—About 28 years ago N—— L—— died at Madras, leaving a considerable sum of money, by will, to his next of kin, and by an advertisement it came to the knowledge of his brother-in-law, who communicated with the London solicitors having charge of the case. When everything appeared completed this brother-in-law died, and Capt. Chas. Handcock, brother to the present Lord Castlemaine, kindly undertook to see after the money for N—— L——'s sister's children, and took the correspondence on the subject with him to London. This gentleman was ordered to rejoin his regiment, and was unfortunately killed shortly after in Madras, tiger hunting, so nothing further was done in the matter of the money. The persons legally entitled to it are very poor, and ask the advice of the Editor or some correspondent how to ascertain whether the money is still to be had?—J. S. D.

[56727.]—**Resistance Coils.**—To Mr. Bottone.—Will you please inform me upon what kind of a bobbin is the G. S. wire wound? A rough sketch would oblige. I intend making a set of above, and should like to start in the right way.—Phono.

[56728.]—**Legal.**—Would Mr. Wetherfield answer the following? I had an agent who collected rent for some cottages 12 months. He paid first three months, but could get nothing more from him except statement showing he owed £13. He will not hand up, but says he cannot pay; he even will not agree to £1 per month. Can I proceed for embezzlement, and how must I commence?—Regulator.

[56729.]—**Clock Winding.**—I am about to add to my business of watchmaking, the branch clock winding by the year. Will some reader, who has experience, say what per year is generally charged? Also, is it according to the number of clocks each party has?—some people have nearly a dozen, others perhaps two. Shall I have to clean them or repair them for same fixed sum, or how? Of course attendance weekly. Any other hints would be acceptable to—Regulator.

[56730.]—**Six's Register Thermometer.**—I have got a Six's thermometer which, in removal, has got both mercury and spirit column broken up and divided. How can I put it in working order?—Them.

[56731.]—**Midland Engines.**—1. Where are the following engines stationed, and to what class do they belong, viz., 1088—1100? 2, How many of the 1700 class are now working, and what is the highest number on the M.R., and where are the 1700's stationed? 3. How many of the 800 class, and where stationed?—Trophy.

[56732.]—**Dyeing Damask Curtains.**—Can any reader kindly inform me how to re-dye some crimson damask curtains that are discoloured by smoke and dirt? What mordant should I dip them in before dipping them into the dye liquor, and can I use Judson's dyes for the purpose, or not?—Charles Cuthbert.

[56733.]—**Problem.**—The hold of a ship is partly full of water, which is uniformly increased by a leak. The vessel is furnished with two pumps worked by A. and B. of whom A. takes three strokes to two of B.'s; but four of B.'s throw out as much water as five of A.'s. Now B. works by himself for the time in which A. alone would have emptied the hold; A. then pumps out the remainder, and the hold is cleared in 13 hours and 20 minutes. Had they worked together the hold would have been emptied in 3 hours and 45 minutes, and A. would have pumped out 100 gallons more than he did. Required the number of gallons of water in the hold at first, and the hourly influx at the leak?—Trophy.

[56734.]—**Testing Butter.**—Would one of your able chemical correspondents kindly state the most reliable method in vogue for testing butter, and also say what is the usual composition of London "cream," or what is sold under that name, and the tests for it? That it is not generally the product of cow's milk is quite evident, if only from its appearance and taste; it can scarcely be made from bullock's brains, as popularly supposed, or their cells would be apparent under the microscope, which they are not, where, besides oil or fat globules, the only feature is an appreciable, but not very large, amount of opalescent amorphous matter.—S.

[56735.]—**Water Gauge.**—Will any correspondent kindly inform me how many cubic feet of water per second will pass through a horizontal slit 27in. long by 4in. deep, when the water stands at 7in. height above the top of the slit? It would also be very useful to me to have the same information for the following heights of water—viz., 8, 10, and 12in.—Manager.

[56736.]—**Partnership Agreement.**—Will someone kindly tell me if a 2s. 6d. stamp is sufficient for an agreement of partnership where the capital is about £500?—Beginner.

[56737.]—**Cutting Indiarubber Discs.**—Can any of the obliging and intelligent readers of "Ours" give me a suggestion? I require to cut out a number of discs of indiarubber, and wish to know how it may be done most speedily and economically. They are to be about 9in. in diameter, and to be cut from web ⅛in. in thickness. If done with a circular knife, what arrangement would be best? What description of table—iron, stone, or wood? What sort of leverage to work the knife? whom I could get to construct the machine? and what would be the probable cost?—Novice.

[56738.]—**Wimshurst Machine.**—To Mr. Wimshurst.—With reference to the 18in. plate machine exhibited by you at the "Inventions," as I am making one of that size, should be greatly obliged if you would tell me how the granulated appearance of the tinfoil sectors is produced, and also the use of the two binding screws on the baseboard, connected together by a piece of wire? Any other useful hints would be thankfully received by—G. Jackson.

**Liquid Glue.**—With any desired quantity of glue, use ordinary whisky, or methylated alcohol instead of water. Break the glue in small fragments and introduce these in a suitable glass vessel, and pour the whisky over them. Cork tightly, and set aside for three or four days, when it will be ready for use, without the necessity of applying heat. Thus prepared, the mixture will keep unaltered for years, and will remain permanently liquid, except in very cold weather, when it may be found necessary to place the bottle in warm water for a little time before using. The vessel in which it is kept must, of course, be kept always tightly corked, to prevent the volatilising of the solvent. A French formula for a liquid glue directs that a solution of 8 ounces of glue be made in ½ pint of water, in the usual way by placing it in a vessel of water until solution is effected. To the solution it is directed that 2½ ounces of strong nitric acid be added, stirring all the while. Effervescence will take place with the evolution of orange nitrous fumes. When all the acid has been added, the liquid is allowed to cool. It should be kept in a well-stoppered bottle, and will remain permanently liquid. It will neither gelatinise nor putrefy, and is said to make a very serviceable cement for various domestic uses, such as repairing cabinet-work china ware, &c. Another formula directs that a jar or bottle be filled with glue broken into small fragments, and the same covered with acetic acid. It should then be placed in a vessel of hot water for several hours until all the glue is dissolved.

## ANSWERS TO CORRESPONDENTS

⁂ *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

### HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

⁂ Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, May 27th, and unacknowledged elsewhere:—

J. McG. Ross.—J. A. Josolyne.—A. Kimber.—C. M.—B.—Bon Accord.—R. W., Newcastle-on-Tyne.—Invalide.—F. M. Wetherfield.—T. H. Bury.—Cosmopolitan.—Medicinæ Doctor.—Artibus Magister.—C. E. Stretton.—Student.—S. J. S. L.—Another Millwright's Apprentice.—A Fellow of the Royal Astronomical Society.—Midland.—Canmore.—F. H. Wenham.—Hemisus.—Rob. Crusoe.

### CAUTION.

We regret to have to put our readers on their guard against a swindler who has recently been making use of our Sale Column. We particularly caution readers *not to send money before they get their goods* except by means of a Post-Office Order made payable ten days after date, and to stop the order and get their money back if the goods do not reach them before the ten days expire. We do our best to keep swindlers out of our advertisement columns, but they easily evade us by changing their names and addresses. Especially during the next few weeks we warn readers against "bargains." People who are ready to part with apparently valuable goods at ruinous prices should always be inquired about before money is sent them.

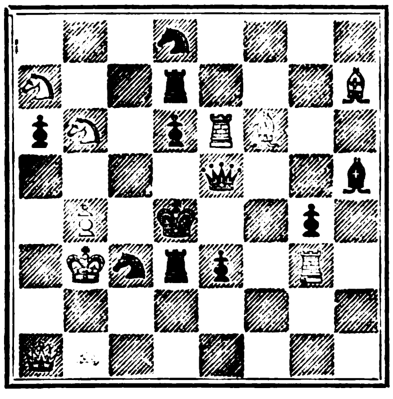
Inquirer. (Yes, amber varnish—to be obtained of any dealer in the best kinds of varnish.)—Picture Frame. (Are you sure a machine is used? A vice is sufficient, and some makers do not even use that.)—Thos. Jackson. (The English Mechanic telephone appeared in the number for August 11, 1876. Number and volume out of print.)—L. (For asthma, see pp. 430, 452, 475, 501, 522, 570, 593, Vol. XXXII.)—Stockport. (The calculus was exhaustively discussed so recently as the last volume. See the index for the references. The best work of an elementary kind is Knox's "Differential Calculus for Beginners" (Macmillan.)—T. Kerr. (The only way is to study the subject of electricity and then attend some such classes as those held at the Finsbury Technical College.)—Ignoramus. (The only way is to apply to firms willing to take apprentices. Fees and terms vary. The best advice is to enter a shop where all sorts of repairs are done, as well as making.)—H. Aston. (There is no book, so far as we know. See the index to Vol. XXXIX. There is a great deal about gas-engines in that volume.)—Desideratum. (Brazing and soldering jewellery fully described in Vol. XXXIII. pp. 22, 44, 70, 119, 170, 264, 334, 455. See also indices generally.)—Trader. (See Hints No. 5. The statement seems to set out the items plainly; but we cannot afford space to print it.)—J. A. Campbell. (We do not remember it. Was its receipt acknowledged?)—F. (You will find a description of the manufacture of macaroni and vermicelli in Payen's "Industrial Chemistry," Longmans.)—Vanduara. (We have no recollection of it, and cannot find it, although we have looked back considerably more than two years. There was a pianoforte hammer, but not a tuning hammer.)—E. M. (See Hints No. 4. Pioneer Paint Co., 5a, Aldermanbury Postern, E.C.)—M. (See indices. The best books are Reed's "Engineer's Handbook," T. Reed and Co., Sunderland, and Ainsley's "Engineer's Manual," T. L. Ainsley, South Shields. 2. For all information about the Whitworth Scholarships see the official manual, to be obtained from the Secretary, Science and Art Department, South Kensington, price 6d.)—A Recent Subscriber. (Such information can be obtained from a patent agent. The query is outside our province.)—D. Jones. (It is simply a little mirror, the position of which is slightly shifted by a lever to give "dots and dashes." See reply on p. 266, or index to Vol. XXIX.)—Metlo. (Scrape off; if the articles will stand it, try heat. 2. We cannot even guess, as you do not say what has been put into the solution. Without an analysis, all that can be said is that it is a mixture.)—G. W. (It ought to keep good time if the cleaner understands his business.)—Birmingham. (Try the wholesale chemists. 2. We could not say without experimenting, but see no reason to imagine it would.)—W. C. (See p. 83, No. 1003. A simple plan with brass is to pickle it in dipping acid containing some iron wire until sufficient zinc is eaten out of the surface to leave it pure copper.)—Albert E. Adlard. (How does such a rail act in hot and also in frosty weather?)—Mizpah. (The only way is to join a class. Try the Working Men's College, Great Ormond-street.)—Londoner. (You appear to know which is the best. The sixth edition was published in 1878. You will find others recommended by referring to indices.)—Charles Mason. (See Hints No. 4. A newsagent will supply you with a list. There are several papers of the kind.)—R. S. T. (It results in the production of pure auric chloride. 2. The silver reduced by the battery is pure. A piece of iron settles with the copper. That question has been frequently answered.)

## CHESS.

ALL Communications for this department must be addressed to J. PIERCE, Langley House, Dorking.

PROBLEM DCCCCXLI.—BEWARE OF THE DOG.

*Black.*



*White.* [9+11

**White to play and mate in two moves.**

SOLUTION TO 939.

| *White.* | *Black.* |
|---|---|
| 1. Q-Q 3 | 1. Anything |
| 2. Q or Kt mates. | |

(Five variations.)

### NOTICES TO CORRESPONDENTS.

CORRECT solutions to 939 by V. S. Pochin (easy on account of White's want of scope, though prettily planned; no power wanted), A. A. E. Lecluse (inferior), Rev. W. Anderson (Old Romney), M. F. B., E. Stanley Follwell (Q only having power to move, solution easy), A. W. Orr, S. L. Chivers, F. O'N. H., I. H., Exon (key easy, but some pleasing mates), and H. Culmer; to 938 by Brum (the best that has appeared during tourney), V. S Pochin (obvious at first sight that Q B R must move first), T. L. Robins, and R. A. Bennett; to 940 by E. S., H. Culmer, and Streetgate (quite a gem).

F. O'N. H.—On Monday, first post, week of issue.

GAMES received from T. Bourn.

S. L. CHIVERS.—You have overlooked in 938 if $1.\ \frac{\qquad}{\text{K moves}}$ $2.\ \frac{\text{Kt-K 3 (ch)}}{\text{K moves}}$ $3.\ \frac{\text{Kt-Q B 5}}{\qquad}$ K can take P.

I. H.—Where is the mate if $1.\ \frac{\qquad}{\text{P (K 3)}}$ takes P ?

**Every Workman** connected with the Building Trades requiring a Situation should advertise in "THE BUILDING NEWS," published every FRIDAY, price Fourpence, at 332, Strand, London, W.C.

"THE BUILDING NEWS" is the Principal Journal representing Architects and Builders, and has the largest circulation of any Professional Journal in the kingdom.

Every Workman should insist on seeing "THE BUILDING NEWS" every week at his Club or Coffee House. He will find more "Lists of Tenders" for new work in it every week than in any similar paper, and can thus judge where work is likely to be had. He is also specially invited to make use of "Intercommunication" if he wants to know anything about his trade; to write to the Editor if he has any suggestions to make, and to advertise in the paper when he wants work.

The charge for Advertisements for Situations is One Shilling for Twenty-four Words, and Sixpence for every Eight Words after.

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5s. 6d. for Six Months and 11s. for Twelve months, Post Free to any part of the United Kingdom. For the United States, 13s., or 3 dols. 25c. gold; to France or Belgium, 13s., or 16f. 50c.; to India (via Brindisi), 15s. 2d.; to New Zealand, the Cape, the West Indies, Canada, Nova Scotia, Natal, or any of the Australian Colonies, 13s.

The remittance should be made by Post-office order. Back numbers cannot be sent out of the United Kingdom by the ordinary newspaper post, but must be remitted for at the rate of 4d. each to cover extra postage.

Messrs. JAMES W. QUEEN and Co., of 924. Chestnut-street, Philadelphia, are authorised to receive subscriptions for the United States for the ENGLISH MECHANIC, at the rate of 3 dols. 25c. gold, or Thirteen Shillings per annum, post free The copies will be forwarded direct by mail from the publishing office in London. All subscriptions will commence with the number first issued after the receipt of the subscription. If back numbers are required to complete volumes, they must be paid for at the rate of 4d. each copy, to cover extra postage.

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Vol. XL. now ready, price 7s. Post free, 7s. 9d.

All the other bound volumes are out of print. Subscribers would do well to order volumes as soon as possible after the conclusion of each half-yearly volume in February and August, as only a limited number are bound up, and these soon run out of print. Most of our back numbers can be had singly, price 2d. each, through any bookseller or newsagent, or 2½d. each, post free from the office (except index numbers, which are 3d. each, or post free, 3½d.)

Indexes for Vols. I., VI., VII., VIII., and IX., 2d. each. Post free 2½d. each. Indexes to Vol XI. and to subsequent vols., 3d. each, or post free, 3½d. Cases for binding, 1s. 6d. each.

## NOTICE TO SUBSCRIBERS.

Subscribers receiving their copies direct from the office are requested to observe that the last number of the term for which their subscription is paid will be forwarded to them in a PINK Wrapper, as an intimation that a fresh remittance is necessary, if it is desired to continue the Subscription.

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| | s. | d. |
|---|---|---|
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| Every additional eight words .. .. .. .. | 0 | 6 |

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*** It must be borne in mind that no Displayed advertisements can appear in the "Sixpenny Sale Column." All advertisements must be prepaid; no reduction is made on repeated insertions; and in cases where the amount sent exceeds One Shilling, the publisher would be grateful if a P.O.O. could be sent, and not stamps. Stamps, however (preferably halfpenny stamps), may be sent where it is inconvenient to obtain P.O.O's.

The address is included as part of the advertisement, and charged for.

Advertisements *must* reach the office by 1 p.m. on Wednesday, to insure insertion in the following Friday's number.

**Epps's Cocoa.**—Grateful and Comforting:—"By a thorough knowledge of the natural laws which govern the operations of digestion and nutrition, and by a careful application of the fine properties of well-selected Cocoa, Mr. Epps has provided our breakfast tables with a delicately flavoured beverage which may save us many heavy doctors' bills. It is by the judicious use of such articles of diet that a constitution may be gradually built up until strong enough to resist every tendency to disease. Hundreds of subtle maladies are floating around us ready to attack wherever there is a weak point. We may escape many a fatal shaft by keeping ourselves well fortified with pure blood and a properly nourished frame."—*Civil Service Gazette.*—Made simply with boiling water or milk. Sold only in packets, labelled—"JAMES EPPS and CO., Homœopathic Chemists, London."—Also makers of Epps's Chocolate Essence

**Holloway's Ointment and Pills.**—Skin diseases scrofula, scurvy. This class of complaints not only affects the individual, but is too frequently transmitted to the offspring. How important, then, under such serious consequences, it becomes thoroughly to eradicate strumous taints from the blood. Holloway's Ointment and Pills uproot all such latent corruptions

## OUR EXCHANGE COLUMN.

*The charge for Exchange Notices is 3d. for the first 24 words, and 3d. for every succeeding 8 words.*

**Good Value Offered** (cash or instruments) for all kinds of sound or repairable Scientific Appliances.—CAPLATZI, Science Depot, Chenies-street, near British Museum. Established 1862.

What offers for half horse-power **Steam Engine**, nearly new, brass cylinder, lagged in rosewood.—Apply, WILLSON, Coney-hill, Gloucester.

**Perambulator Wheels**, new, ⅝ rubbers, turned axles, complete, plated caps. Exchange Silver Curb Albert. Mutual approval.—W. SMITH, Bilston-road, Wolverhampton.

Wanted, Lever **Watch**; good exchange. Wanted, offers for Youth's Tricycle, Meteor pattern; part finished 2-horse engine bed; 120 "E.M."—As above.

**Interior Background**, on roller. What offers in exchange?—G. FRYER, 9, Portland terrace, Ealing Dean, W.

Tough Mild Weldable **Steel**, 5-16in. to 1in. round, or square. Will take anything useful in exchange.—H. GILBERT, Oxford-road, Sheffield.

Warranted Crucible Cast **Steel**, 7-16in. to 1in. diameter, 1¼ to 3ft. lengths. Will exchange for anything useful.—H. GILBERT, Oxford-road, Sheffield.

Will exchange Singer's **Sewing Machine** (new) and Engineering Books for Tricycle; broken or out of repair no consequence, if repairable.—T. PALMER, Keston, Kent.

Offers wanted for **Digitorium**, cost £3 3s., strong pliant springs; also good Opera Glasses, achromatic and telescopic, six achromatic glasses.—HARDING, 196, Holloway-road.

Exchange offers wanted, in cash or otherwise for ORGUINETTE, cost £2 15s., in perfect order, as new, with music.—HARDING, 196, Holloway-road.

Wanted a quantity of **Chemicals and Apparatus** &c., in exchange for other goods, or cash; must be cheap and immediate.—Address as above.

Last year's "**Electrician,**" clean and in good condition. What offers?—E. ROSS, Regent House, Sydenham.

**Cottage Piano**, Truss Legs, Panel Front. Take Tricycle or Harmonium and £8 cash.—C. SEARLE, Sunninghill.

**Freshwater Filamentous Algæ**, comprising the Zygnemaceæ. Exchanges of mounts or gatherings wanted.—C. PECK, Princes road, Heaton Moor, Stockport.

**Micro.-Photo. Objective**, by Dallmeyer, also other Photo Apparatus, for bound vols. of E. M., or offers.—DAY, 56, Driffield-road, Old Ford, London.

**Speculum**, Silver-on-Glass, good definition, 9 inches diameter, 6ft. 2½in. focus. What offers?—DAY, 56, Driffield-road, Old Ford, London.

**Intensity Coil**, ⅛in. spark, half-pint bottle bichromate battery, incandescent lamp, semi do., and galvanometer. Exchange or offers.—G. R. MILBOURNE, Twyford, Berks.

7 H.-P. Brotherhood Patent **Engine**, also nearly finished 50-light Dynamo. Exchange for Microscope, Tools, or offers.—A. J. SELLS, 158, Mare-street, Hackney, E.

Superior **Lathe Bed**, Standards, Flywheel, and treadle, by Milnes, Bradford, to exchange for Safety or 52in. ordinary Bicycle of good make.—F. UNDERWOOD, Beverley.

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The English Mechanic
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*FRIDAY, JUNE 5, 1885.*

# ON FIXING AND SETTING DIAMONDS FOR CUTTING AND OTHER TOOLS.

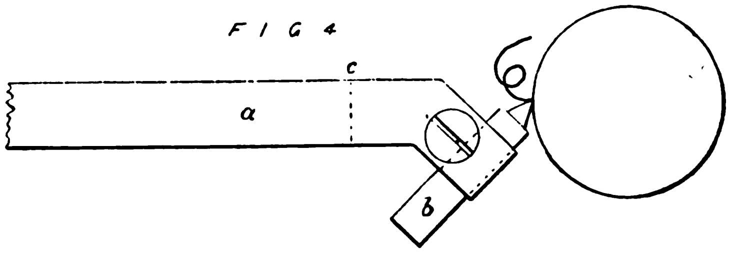
By F. H. Wenham.

ABOUT forty years ago I purchased from a respectable tool shop a piece of diamond, set apparently quite securely in a steel holder with handle, and which was sold for a turning tool or graver for re-touching hard steel engraver's plates. This tool, unfortunately, soon came to grief. I required it for turning glass; but after a few hours' use out came the diamond, and, after a long search down on all-fours, I did not succeed in finding it. I then looked to the way in which it had been set. A piece of steel wire had been drilled up with a hole large enough to admit the fragment; a side hole had been made below the stone as a vent, for preventing it from being driven out by the silver solder and borax used for the purpose of soldering it in place. The thin edge of the socket, or hole in the steel, had been compressed so as slightly to grip the diamond; but a microscope examination showed that the solder had avoided and failed to reach the diamond (for which, of course, it had no affinity), and this had been imbedded only in the hardened borax flux. After this costly bit of experience, I determined not to let such an accident occur again; and as circumstances in the way of business afterwards required me frequently to make use of diamond tools for various purposes, I in future always set them with my own hands. I have mounted numbers without any failure.

First reverting to the usual practice. Non-utilitarian or vanity jewels are set by placing them in a cavity to fit, and drawing and burnishing the metal partly over them. Glaziers' diamonds are set much in the same way; but as these are not for display, the stones may be nearly covered up by the overlapping metal. Having selected the most suitable edge of the natural crystal, and considered its best outward position, a shallow hole is drilled in the end of a stout piece of soft brass wire, and then, by means of small chisels and gravers, the hole is scooped out to fit the diamond. This is then pressed tightly down in its bed, and by means of small drifts and punches the metal above is overlapped and driven down, filing off all exterior surplus during the operation; enough of the wire containing the set diamond is now cut off and filed a little taper, so as to be driven tight into the hole in the swivel-block. I have seen large pieces of black diamond or carbonado mounted in this manner in the ends of soft steel rods ½in. in diameter; to do it well requires much care and patience.

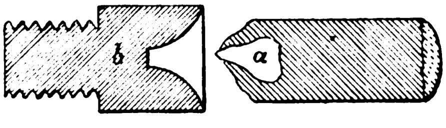
In Young's machine, for redressing or "cracking" the face of millstones, the pieces of "carbonado" of any size were held as follows: On the cutter spindle (which rotated with great velocity) was fixed a stout copper flange with a deep socket. Another similar flange was advanced against this by means of a nut screwing on to the spindle. The diamond was placed between the two flanges with one of its corners projecting just beyond the peripheries, and gripped very securely by screwing them together. The diamond getting partly imbedded in the soft copper the furrows were driven in the millstone by a rotary percussive action, and it would be as well to tighten up the flanges after working a short time, to insure a permanent grip.

FIG 4



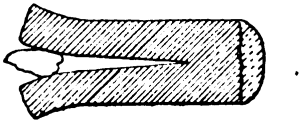
The method I adopted for setting diamonds for turning tools in a speedy and secure manner without using the blowpipe flame and solder is shown by Fig. 1; *a* is the piece of diamond placed in a shallow hole drilled in the end of a copper, soft brass, or steel wire; *b* is a hardened steel plug having a bell-shaped socket; if this is rotated rapidly in the lathe, and the end of wire containing the diamond pressed hard into it by means of the dead centre, with a drop of oil, of course holding the wire so as not to turn, the metal will be compressed and burnished round so as to embrace all the irregularities of the diamond, which at length, if the spinning is continued long enough, will become completely buried, particularly if the centre is withdrawn and the wire oscillated by hand pressure for a sort time in the hard steel socket. In this case a touch on the grindstone will lay bare the end of the diamond ready for use.

FIG. 1.



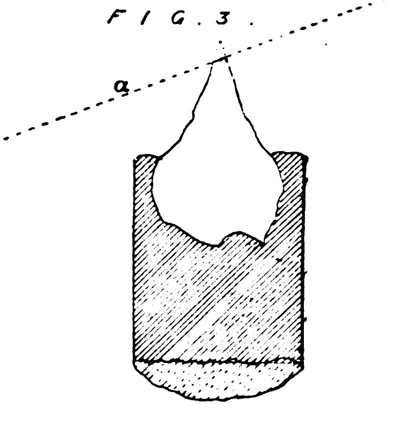
For very small fragments of diamond the soldering process is the most expeditious and easy, and, if managed properly, is perfectly secure. I have some doubts whether large diamonds or fragments about the size of a peppercorn would stand the sudden application of the heat of the blowpipe flame without the risk of cracking. I have been informed by a friend who has visited the Cape diggings, that these diamonds often crack spontaneously from the warmth of the pocket soon after removal from their native bed, thus sometimes reducing them to one-tenth of their former value. In order to avoid this risk, the diggers keep their largest diamonds in a bottle of oil, and suck them dry before showing them to a purchaser; but small diamonds and fragments do not split, nor is their quality or hardness in any way impaired by an ordinary blowpipe heat, and I always prefer to fix them by soldering, as it takes but a few minutes to do. I take a piece of stout copper wire from ⅛in., more or less, in diameter, according to sample of fragment; with a fine saw I split the end of this wire, and open it out in the way shown by Fig. 2. The fragment of diamond, with its selected edge outwards, is then placed in the fork of the wire, and the prongs are squeezed hard together with pliers, and the diamond is thus imbedded in the soft copper; the wire must be gripped and twisted round in various directions, so as to burnish and close up the slit. This is then united by a fragment of silver solder and borax, using the ordinary blowpipe flame; the piece of wire is now screwed into a handle and the surplus copper at the end trimmed off on the grindstone, so that the diamond may project sufficiently for use. This method is the most expeditious, and answers well for light glass-turning, such as trueing up small lenses, which is but a scraping process; but the copper is so soft that with heavy work it is apt to bend, unless the end containing the diamond is cut short off and driven tight into a drilled steel socket or holder; this makes but a clumsy tool.

FIG. 2.



A better way of mounting in an unyielding holder of steel is as follows: Fold a strip of platinum foil tight round the diamond, pressing it down in every part, or else wind close a fine platinum wire over it in all directions. Now drill and broach out a hole in the end of a steel wire thick enough to contain the wrapped stone, to be pressed in tightly, bearing in mind the end of the stone that is to be outwards. If the silver solder is now run in, it will entirely fill the space between the bore of the socket and the platinum casing of the diamond, which will be held as securely as possible; but, as this has been buried by the operation, the overlaying metal must be cleared off on the grindstone, so as to lay bare enough of the end for use.

FIG. 3.



The amorphous "carbonado," or black diamond is very efficient for turning glass, facing stone, and for rock drills; but, for keen cutting tools, I decidedly prefer the larger pieces of bort, or fragments of the crystalline or gem diamond. Properly shaped splinters may sometimes be selected to suit a particular purpose; but, of course, this is all chance. For a correct system of using diamond for cutting, graving, or turning tools, the pieces must be worked to definite and suitable forms.

If a piece of diamond, mounted in the way that I have last described, is held short, and very stiffly, in a wire chuck, running in a small quick-speed lathe, and another mounted fragment is pressed against it, the revolving diamond can be turned to a desired shape by attrition, in which the rubbing diamond suffers an almost equal loss. The dust flies off with a harsh squeaking noise, that may be expressed as "setting one's teeth on edge." With care, the revolving stone may be brought to a needle point, useful for marking, or a tool for a dividing engine; but this form is unsuitable for a cutting or turning tool, by which shavings of metal are required to be taken off; but if a diamond tool of this conical form is held in the vice by its setting, and a piece of steel with a notch in which the point is entered is tapped smartly, it will be broken off in a sloping direction, as shown in Fig. 3, by dotted line *a*. This, used as a graver will take shavings off a surface of hard steel; but for turning tools on hard steel and other metals it is an unsatisfactory practice to depend upon splinters mounted and held radially against the work. Frequent fractures will occur, causing vexation and delay, and a prejudice against this really useful workshop tool. The wire containing the diamond should be held in a simple tool holder of this form. *a* (Fig. 4) is a bar of steel bent at the end to an angle as shown, through this is drilled a hole in which the steel stem *b* of the tool just fits, a saw cut is then made as far as *c*, so as to split the end of the bar, a side screw is tapped into the off half of the split for the purpose of gripping the stem very firmly. The diamond held this way will have almost the strength of a steel turning tool, with the great advantage of retaining an ever-enduring keen cutting edge—at least, as far as I have seen; but should a cutting edge require to be renewed or altered, this may be done by holding the sloping facet at the apex of the cone, against a piece of "carbonado" chucked in the lathe, which serves as a grindstone. This will be apt to make the cutting facet somewhat hollow; which, however, is no disadvantage.

I have worked with diamond tools for years consecutively, and the above method of setting and using them has been from my own practice; but this is, perhaps, but a fragment of what is known concerning them. The limit to the use of diamonds does not so much depend upon their practicable application, as the intolerable dearness of the material. If it were not for this drawback, I have no doubt that, for their hardness and everlasting endurance, large milling machines would be provided with numerous diamond teeth that would shape and dress off all kinds of stone work with great rapidity, instead of their application being limited to the patent rock-boring machines now in use.

## THE INTERNATIONAL INVENTIONS EXHIBITION.—V.

### Railway Plant, &c.

In the preface to Group V., Capt. Douglas Galton says that "the gradual improvements which have taken place in the last twenty-five years in the comfort of railway carriages are traceable to the competition for through traffic of the main lines of railway. Those lines where competition is absent are often treated to scant accommodation, and to antiquated carriages." Unquestionably this statement is true in the main; but we think we could point to some notorious instances in which competition seems to have settled down into a struggle to discover what sort of dirty, badly-lighted carriage the travelling public will put up with. One would have expected that some of the more enterprising railway companies would have exhibited models, at least, of their rolling stock at this exhibition; but with the exception of the South-Eastern Railway Company none of them are represented, for the compound locomotive, which forms so prominent an object in the Middle Court, is exhibited by Mr. F. W. Webb. The S.E.R., as stated last week, exhibit a goods waggon and a coal truck, constructed for running at high speed. These have axles and wheels similar to those used for coaches, rubber buffer and draw springs, screw coupling, and safety chains. Mr. Webb's engine, which has been described as a monster and a mammoth, is really carried on driving wheels only 6ft. 3in. in diameter, while the length over buffer frames is a little more than 27ft. It looks large because the visitor views it from a novel position, so far as locomotives and spectators are concerned, but to the expert it conveys the idea of compactness and power. The high-pressure cylinders, 14in. in diameter by 24in. stroke, are placed outside the frames, and drive the trailing wheels. The exhaust steam from these cylinders is led by pipes inside the smoke box to the valve-chest of the low-pressure cylinder, 30in. in diameter by 24in. stroke, which is placed between the frames beneath the smoke box, and drives an axle in which a crank has been formed in a hydraulic forging press (one of these axles is shown in the rough). The exhaust steam from the high-pressure cylinders is purposely given a long distance to travel before reaching the low-pressure valve-chest in order that it may be slightly superheated. A relief valve, set at 80lb., is placed on one of the pipes leading to the low-pressure chest, so as to limit the pressure which can accumulate there. It may be doubted whether the economy obtained by the expansion of the steam in two cylinders will cover the extra cost of this design; but there are other points which deserve attention, notably the large wearing surfaces provided at important places, which will materially reduce wear and tear, and render the compounds more economical than express engines of the ordinary type. The use of high and low-pressure cylinders also gives four driving wheels without employing coupling-rods. Up to March 31st last one of the earlier compounds, No. 301 Economist, had averaged 301 miles per day for 312 days; and the Dreadnought, which represents the engine exhibited, had averaged for 59 days 291 miles. In fact, all the compounds have been engaged in doing heavy regular work, and they have done it so well that their introduction will leave a mark on locomotive history. The engine exhibited stands on Webb's steel permanent way, with sleepers of trough section, chairs stamped to shape in dies, and lining plates between the chairs and sleepers. Brown paper soaked in tar is used for liners, and all parts are firmly riveted together with one of Tweddell's portable hydraulic machines. Oak keys are used, and never work loose, because the wood swells and fills a recess in the chair, and also because the latter is elastic. There are several other forms of permanent way shown in either this Group or Group III.; but Mr. Webb's exhibit derives its importance from the fact that considerable lengths of it are in use on the London and North-Western Railway. The Acaster Patent Rail Joint Co., of Sheffield, show, in Group III., their two-wedge and three-wedge plans for dispensing with fish-plates. These wedges are rolled with grooves to prevent them shifting, and in the best, the three-wedge, the tightening piece is driven between two other pieces, which bear respectively against the head and the flange of the rail. Mr. Kirkaldy's test gives the strength of a two-wedge joint as 60 per cent. of the strength of the rail; but a three-wedge is said to have 82 per cent., and to weigh only 28lb. There are a variety of improved chairs and fastenings, and several lock-nut arrangements which deserve notice. The exhibits of brakes will probably prove of most interest to the public, so far as Group V. is concerned, and specially noticeable amongst them is the Westinghouse, which is here fitted up with the complete apparatus for working a train of 15 coaches. The 15 brake cylinders are placed vertically at the back, and each is connected with its triple valve and auxiliary reservoir, the whole set being so arranged as to show the working of the brake through a train of the length mentioned, or through a pipe-length of 400ft. The air-compressing pump and main reservoir, which is generally carried under the footplate, are placed at one end of the line of apparatus, and a driver's brake-valve is erected in a convenient position, the whole representing as accurately as possible the actual arrangements and conditions of the brake as applied to a train. The compressed air is forced into the main reservoir by the pump, and, flowing through the driver's brake-valve and main pipe, charges the auxiliary reservoirs throughout the train until the pressure is uniform throughout. So long as the driver's brake-valve and the valves to be used on emergency by the guards and passengers are in the off position the brake cylinders are empty, and the tips of the rods which connect the pistons with the block gear are seen above the cylinders and beneath them, as they are here placed in a line in the vertical position. The triple valve, which is an important feature in the apparatus, is in reality a little piston which carries a slide-valve, and moves up or down when the pressure is increased or decreased in the brake-pipe. When the air-pump is set to work the piston of the triple valve moves up and allows the air to pass into the reservoirs beneath the coaches, while, at the same time, any air which may be in the brake cylinders can escape past the slide-valve into the atmosphere. The pumping being continued the air pressure becomes equal on both sides of the little piston, and it remains in equilibrium. If, now, one of the valves in the train is opened, or a pipe or other connection breaks, the air pressure is immediately reduced on one side of the piston, and it moves the slide-valve into such a position that the compressed air in the reservoir passes into the brake cylinder between the two pistons, and driving them towards the ends of the cylinder forces out the brake rods connecting with the block gear, and the brakes are thus instantaneously applied to all the wheels in the train. The great merit of this brake is that the driver's confidence in it is perfect, for he knows that if it were not in working order it would automatically acquaint him with the fact, while if any serious derangement occurs in the apparatus under a coach, it can be cut out of the system by turning a small tap between the triple valve and the brake pipe. The instantaneous and simultaneous action of all the brakes is readily observed in this exhibit, for as soon as the "driver's brake-valve" is opened the rods of all the cylinders will be seen to rise at once, and as soon as it is closed they all sink back, showing that the brakes have been taken off. The compressed air can also be utilised for communicating between the guard and the driver, for blowing a whistle on the engine, and stopping the train if the warning is disregarded, while a little signal indicates the compartment from which the warning has proceeded. It is difficult indeed to conceive of any arrangements which should be more complete or efficient, and, according to Mr. Harrison, the engineer-in-chief of the North-Eastern Railway, there is great economy in the maintenance of the Westinghouse brake. The standard arrangement adopted by the Vacuum Brake Company is shown at an adjoining stand. A vacuum chamber containing a piston to operate the brake gear is kept in the exhausted state by means of an ejector on the engine, which withdraws the air from the main pipe and, by means of flexible connections and ball valves, from the vacuum chambers and both sides of the brake pistons. As soon as air is admitted to the train pipe the ball valves close the entrance to the vacuum chamber and air is admitted to the under side of the piston, which is forced up by the atmospheric pressure and the brakes are thus applied. The couplings are arranged to separate easily in the event of any portion of the train breaking away. This is the best of the brakes working on the vacuum principle, and is automatic in action. The Welch-Parker-Smith brake is shown by means of a working model, in which a carriage is stopped while at full speed down a gradient of 1 in 12. In this case the brakes act by gravity and are normally on, a heavy piston in a cylinder operating levers which apply blocks to both sides of the wheels. Compressed air or a vacuum is employed to keep the piston up and the brakes off, and while the parts are in order the arrangement is in running condition so long as the pistons are kept up; but should a coupling fail or the vacuum be destroyed or the compressed air leak away (as the case may be), either by design or accident, the brakes are at once applied. By means of a special valve the driver is enabled to reduce the amount of vacuum or air pressure, and so, to a certain extent, can regulate the pressure of the blocks upon the wheels. The Heberlein automatic friction brake is shown in full size, and there are a few others in model or diagrams, which, however, are of little interest in the face of those mentioned above. Signalling arrangements are well shown by W. R. Sykes—the well-known electric interlocking and block system, by McKenzie and Holland, and by Saxby and Farmer, as mentioned in the article on p. 203. The latter firm show a full-size seven-lever cabin with signal-posts and points, and their duplex detector. When the locking handles are once put into position for a train to pass, the points and signals are interlocked, and the position cannot be altered until the train has passed, and by its weight caused a small treadle to make the electric circuit through the block instrument and so unlock the handle. The duplex detector is to avoid danger from a broken connection between the points and their levers, which would allow the signals and the point levers to be shifted without altering the points themselves in accordance with the signals. The detector is a double-action plunger working through slots in the tie-bar connecting the tongues of the points. If the latter have not been put into the desired position, it is impossible to set the signals, for the plungers cannot enter the slots. Contrivances for signalling to and from trains in motion are shown by the Electrical Signal Co., and by Mr. T. T. Powell, of Harrogate. The latter exhibits the model shown at the Crystal Palace, which involves the use of a centre rail, and the system of the former necessitates the erection of contact posts at intervals, which complete the circuit by means of a rubbing lever carried by the engine. The progress of a train can by this means be registered on a drum in the signalman's cabin, and the signals can be repeated on the engine. In connection with signalling arrangements, compensators and arrangements for placing detonators on the line during foggy weather will attract attention. Henson and Co., of Derby, exhibit their patent apparatus for placing the detonators on the line, and indicating by an electric bell whether the fog-signal is on the rail or has been exploded. This is accomplished by means of the detonator itself, which is of the usual shape without clips, and is carried by a holder. As it is pushed out from the box it is made to rub against a contact piece, and so complete an electric circuit and ring a bell in the signalman's cabin. If the detonator should not be required it can be withdrawn, and will again ring the bell as it is drawn back; but should it have been exploded, or merely flattened, it will no longer be thick enough to touch the contact-piece, and the absence of the bell signal will announce the fact that another detonator is required. The case carries 36 of these in a cylinder, and the lever is made to take up the top one. These fog-signalling machines have been at work on the Midland and the Great Eastern Railway for some time, with satisfactory results. The compensator exhibited by Henson and Co. is also a simple and ingenious device. It consists of a weighted pulley, free to move up or down in vertical guides; the signal wire passes round this pulley and is consequently always kept taut. The inner faces of the vertical guides have racks, into which a vee flange on the face of the guide pulley enters as it revolves when the signal wire is drawn upon. The weight of the pulley is thus taken off as it were as soon as there is a pull on the wire, while it at all times keeps the wire taut. A vertical distance of 14in. is provided for the pulley to rise and fall, which is more than sufficient for the longest lengths of signal wires. The Johnson Compensator Company, John Dalton-street, Manchester, exhibit their liquid compensator, which consists of three tubes, the centre one about a third the length of the other two, and fitted with a plunger. These tubes communicate and form the reservoir for the glycerine or other liquid which does not readily freeze. It will be understood that one end of the signal wire being attached to the crosshead of the plunger, and the other to the frame formed by the tubes, an expansion in the wire is compensated for by expansion of the glycerine, and *vice versâ*. The automatic and safety couplings are, perhaps, the most interesting exhibits in this group, but we shall probably illustrate the more promising amongst them in a separate article. The Janney coupler and buffer, which is used to a considerable extent in America, is exhibited by Mr. A. Davis, of Parliament-mansions, S.W., but it is scarcely suited to waggons which have not a uniform height of buffer beam. Mr. G. Turton, of Westminster-chambers, S.W., shows his improved Norwegian hook-coupling buffer, with the patent slack-gathering arrangement for preventing the hook jumping out (an eccentric in the hook), and the springs for keeping the buffer heads in contact while going round a curve. He also exhibits a collection of his well-known patent buffers, in which the piston moves in a long bearing and undue compression of the spring is impossible, while such accidents as happen to the old form with the large hollow plunger are unknown. Mr. Brockelbank shows, in a large working model, his automatic coupling, consisting of a hook on each vehicle, so shaped that on coming into contact one rises over and engages with the other, even if there is a difference of 8in. in the height of the two parts. It is uncoupled by lever and rod worked from the side. One of the best of the automatic couplings is that shown by Mr. G. F. Belling, of Manor Park, Essex. In place of the draw hook there is a ⊐-shaped piece of iron, the upper limb of which supports a pin which swings backwards, and which can be withdrawn from the slot by means of a side lever and rod. A double shackle is pivoted to the draw-bar head, and when two waggons are brought together one shackle rides over the other and enters the ⊐-piece, driving the swinging-pin before it, until it enters so far that the pin falls down, and the coupling is complete. The amount of slack left in this coupling is considerable, and distinguishes it from the devices of those inventors who have forgotten that locomotives cannot always start long trains of loaded waggons unless they are coupled loosely. Amongst safety couplings, that exhibited by Richardson and Greenwood, Harrogate, is deserving of notice. It is worked from the side by lever and rod, and for passenger vehicles there is an arrangement for taking up slack by turning a hand-wheel at the side. Mr. A. Mildred, of Middlesbrough, shows a simple and effective method of fitting ordinary chains so that waggons can be coupled without going between them. It is of the type worked by connecting a link with a rod so as to lift the chain on to the draw-hook by moving a lever at the side. There are a variety of other devices for coupling-up waggons in "safety," down to the simple hook at the end of a pole; but it is to be hoped that some automatic device will be adopted ultimately, as there is considerable risk even when the coupling can be accomplished without going between the buffers. At Stand 663 is shown a device which, if generally adopted, would be a boon to both passengers and station officials. It is a station indicator, the invention of Mr. D. K. Simpson, Liverpool, which has been at work at the Central Station in that city in connection with the Liverpool, Huskisson, Gateacre, and Southport lines. The indicator consists of a sort of Venetian blind arrangement mounted in a frame, the names of the stations being painted on the laths; but the ingenuity of the device is seen when it is discovered that once set it never makes a mistake as to which station any given train will call at. The top of the frame is occupied by wheels carrying figures to indicate the time at which the next train will start. These wheels are operated by little levers at the back, and the time having been set the station attendant consults his "guide," and finds there clearly set forth the exact positions which other levers should occupy. If the train stops at all stations one lever of course turns all the laths outwards and exposes their names; but in the case of the frame exhibited the train service is varied considerably, and there are several levers operating respectively, say three, six, ten, &c., laths, according to the number of stations to be stopped at. The instructions are, however, so simple (they are comprised in thirteen words) that the average station porter learns to work the indicator in about ten minutes, and at a meeting of superintendents held not long ago at the Clearing House, it was much approved, as its general use would save endless questions and prevent not a few mistakes. It should be mentioned that the mechanism can be easily re-arranged to suit the alterations made in the stopping places of different trains. Other inventions which will attract the attention of railway passengers and station attendants and guards are the ingenious improvements in carriage-door locks. Jones and Cunningham at Stand 650 exhibit their patent safety door lock, in which a lever holds the latch until the door shuts, and a spring sends the latch and handle round into the shut position. Mr. W. Payton at Stand 653 shows a different arrangement, in which, as the door closes, a lever catches on a stud and releases the latch. At Stand 628 Douglass and Co., of Queenhithe, exhibit their patent springless lock, which has a latch and a bolt working at different angles. The slightest motion of the latch, such as would be imparted to it in closing the door, throws out a bolt, which holds the door fast. Inventions such as these will relieve porters and others of much unnecessary risk, avoid the objectionable slamming of doors, and probably save some fingers from being smashed. Mr. R. Wright, of Richmond, Yorks, exhibits a model door to prevent the pinching of fingers, the edge being a swinging flap, which readily yields. As he makes a present of it to the public, it is scarcely likely to be adopted. Tramway locomotives are shown by Messrs. Merryweather, the Falcon Engine and Car Co., and Black, Hawthorn, and Co. The last named exhibit Wilkinson's patent, which has cylinders 7¼in. by 11in., four coupled wheels 27½in. in diameter, and a wheel base of 5ft. 8in. In running trim it weighs 9½ tons, and for some time has taken heavy cars of 50 passengers up gradients of 1 in 11½ at Huddersfield. The exhaust and the escape steam from safety-valves is led into a receiver, where it passes into a "hot pot," which also acts as a baffle, and thence, invisibly and noiselessly, into the atmosphere. The Falcon Engine Company's exhibit is a narrow-gauge tramway motor, of the locomotive type, with copper firebox and brass tubes. The cylinders are 8in. by 14in., with 30in. wheels. The wheel base is 4ft. 6in., and the weight, in working order, 9 tons. The steam is condensed in an air condenser on the roof, consisting of 250 very thin copper tubes, fixed in thin cast-brass chambers, and any uncondensed steam passes thence to the smoke-box to be dissipated. An invention of some importance where lines of different gauges are laid down, or found necessary, is the patent wheel and axle of Mr. Mackinlay, of Buenos Ayres, exhibited by Mr. R. McLaren. Without engravings it is not easy to describe this invention; but, in its simplest form, the wheels move along the axle on a screw-thread, and are thus adapted to almost any gauge. Some of the exhibits in this group are obviously only the crude ideas of inventors not sufficiently acquainted with the various conditions of railway work; but, taken altogether, it will well repay the careful inspection of all interested in railway appliances.

## ENGINE-MAKING AT HOME.—VI.

### Fitting the Bed.

WE have presumably all our castings to hand ready for fitting up, and naturally consider where we shall begin. In workshops, of course, all the parts are turned, planed, filed, and drilled before they are brought together at all, and the man who erects simply has to put everything into its proper place ready for working: and a little easing of parts is usually all that is necessary. But an amateur likes to build up as he goes along, the saving of time is thought less of, and gives place before the interest which he experiences in seeing the work grow under his hands. Hence I shall describe the fitting and putting together in detail just as I imagine nine out of ten of my readers would do, and this plan also will prevent too frequently recurring references to the same parts.

Commencing with the bed as the basis of operations, it will be convenient to bolt it first to a heavy block of wood, or stone, or metal, and allow it to remain there while the fitting up of the various parts is being carried forward. Before proceeding, however, with the business of fitting up, it will be well to know what kind of permanent foundation it is to be fixed to, and, if possible, to use that as the basis of operations. Not that it is necessary by any means to fit the engine up in its permanent position, since, if its bed is once got level, it may always be levelled again on any fixing by packing and wedging up. But it will, nevertheless, be convenient at this stage to decide the question of the final fixing, even though we do not make it just at present.

The simplest and easiest bed to make would consist of a block of wood, such as deal, or a harder wood. Its depth will be governed by circumstances. If it is to go directly on the floor of a workshop, it should not be less than a foot deep—better if it exceeds that dimension, and its width should be sufficient to insure steadiness, say 15in., which will, however, necessitate the cutting out of a piece to clear the flywheel (Fig. 79). It may be fastened to the floor with angle brackets, or, if convenient, with bolts, passing through to the beams. Coach screws will fasten the engine bed to its foundation.

A stone foundation should have similar proportions; but the hold-down bolts for the bed must be "leaded" into the stone (Fig. 80). The tapered tail of the bolt, usually rectangular in section, is jagged, and molten lead poured into the easy-fitting hole which receives the bolt holds it firmly in position.

But the best bed-plate is one of cast-iron, shown in Fig. 81. It is stiff, elegant in appearance, and easily fixed both to the floor and to the engine bed. The base is spread to afford the necessary firmness of bearing. It would weigh

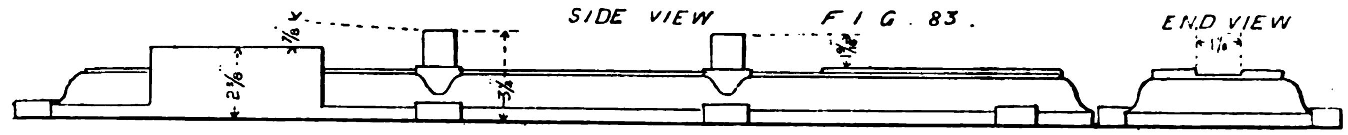


FIG. 83.

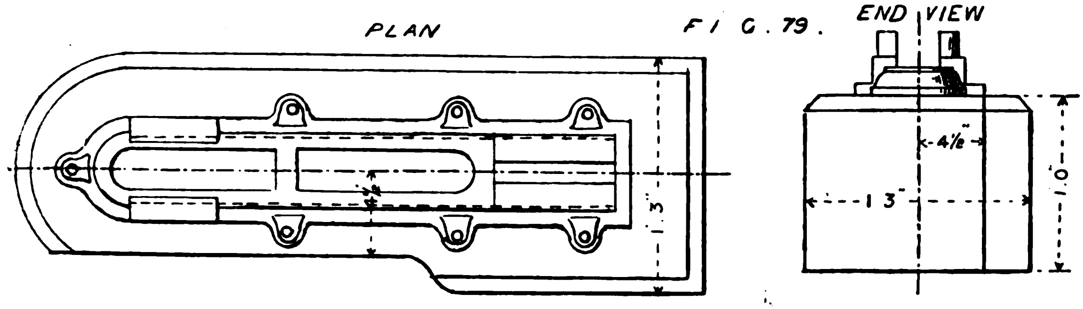


FIG. 79.

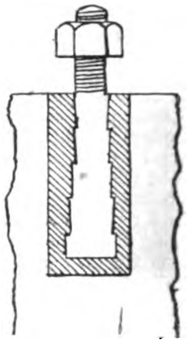


FIG. 80.

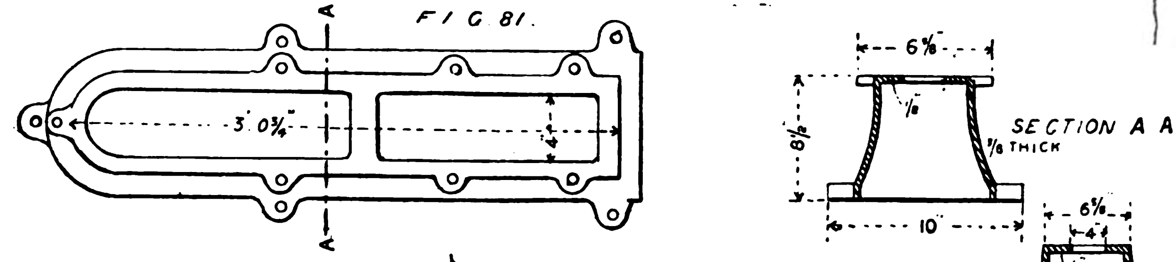
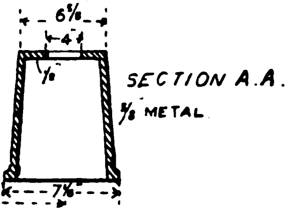


FIG. 81.



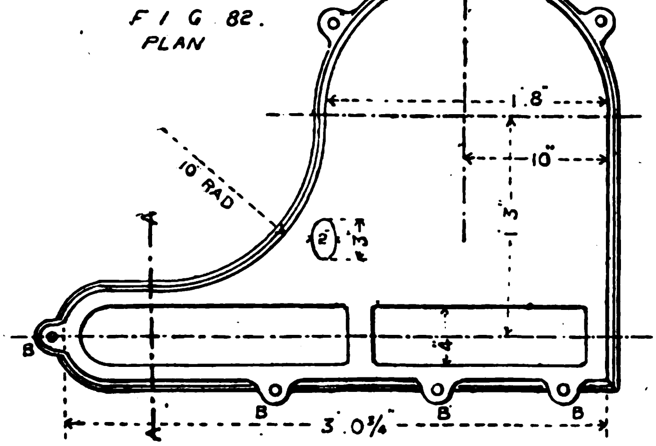


FIG. 82.

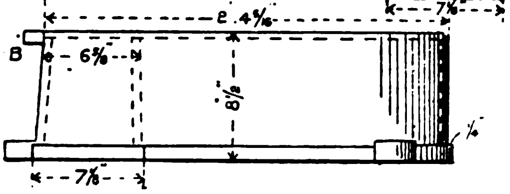


FIG. 82.

85lb. But whoever makes an engine will want a boiler to feed it, and the most compact form of bed-plate, therefore, is that which combines provision for both boiler and engine. Such a one is shown in Fig. 82: it is proportioned for a vertical boiler of from 16in. to 18in. in diameter, that being about the size which such an engine as this would require. Everything is thus compact; the steam pipes are connected up in the shortest possible compass, and the weight of the boiler deadens any vibration which might otherwise be communicated to the foundation by the motion of the flywheel. Further, by plating over the bottom of the casting, and casting an oval hole in the top plate, the foundation will make a very good feed-water tank, and, by passing the exhaust steam through it before allowing it to escape into the atmosphere, the feed-water will be warmed. If it is plated on the bottom, a narrow fillet strip should be cast around its edge to provide for level bearing.

It will be observed that I have given abundant slope to the sides; hence no taper will be planed in the stuff for the pattern, for the pattern moulding face downwards, the top sand will lift away from the internal portions, and the outside of the pattern will afterwards lift away from the bottom sand. The only portions which have to be left loose are the lugs, B, B, B, B, B. If, however, the bottom is plated, the pieces composing the plate must be left loose, in which case the holes in the top of the bed-plate will sustain the central greensand core, aided by chaplets under the boiler plate. This is the bed which I should employ in preference to any other. It would weigh, with the bottom plate, about 240lb.; without the plate, 170lb. Since some of my readers will know nothing about boiler proportions and construction, I will, at the close of these articles, draw and dimension a vertical boiler for this foundation, and show how the pipe connections are made.

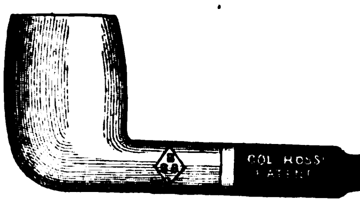
Going back now to the point from which we diverged—the setting of the engine bed—it is not necessary that the bottom of the bed be planed, so long as it is not strained or pulled out of truth in the bolting down. Undoubtedly, planing makes a better job, especially where it fits upon an iron foundation; but it is not essential. If the bottom of the casting is uneven, as it is almost sure to be, it will be packed with paper, thin millboard, or thin slips of metal, in order that it shall not rock upon its foundations, and shall bed evenly everywhere before the bolts are put in. It will be well also to interpose a thin layer of white and red lead between the bed and its foundation before bolting down. If the lugs are not properly packed in the way just described, the chances are that the screwing down of the nuts will break them off. Half-inch bolts will be suitable for bolting down.

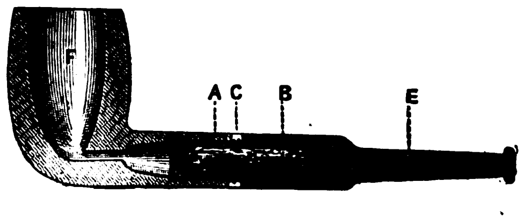
Set now the block upon which the bed has been fastened in a position from which it will not be moved while fitting, wedging up the foundation, or otherwise adjusting it, until the top of the engine bed is as true as the rough casting will allow of, testing the whole with a spirit level. If it has been possible to plane the facings on the bed before putting it upon its foundation, the amount of wedging must be that which will give perfectly accurate results when the top is tried with a level. But I prefer to suppose that the use of a planing machine is not to be obtained, and that the file is to be relied on throughout—no great trouble, since all the surfaces are small.

When the casting is levelled, the facings for the cylinder, the bosses for the guide bars, and the facings for the crank shaft bearings are to be filed, each to their respective heights (Fig. 83), the level and straightedge being employed to test their accuracy. The level must be tried across and along the facings for the cylinder first, then across the guide-bar bosses, until all four are level relatively to one another, and 1$\frac{5}{16}$in. above the cylinder facings, then across the blocks for the crank shaft bearings, until they stand ⅞in. below the guide bar bosses. The heights of these facings must be measured relatively to one another, and not from the bottom of the rough bed. When the facings are very nearly true, the file must be used carefully, and frequent use be made of the straightedge and level, since reducing one portion overmuch will entail a corresponding reduction of all the other faces. Too much pains cannot be taken in this part of the work, for the truth of the after results and facility in putting together will depend to a great extent on the exactitude of the base upon which we build. The guide edges for the joggle on the cylinder foot will be filed to a width of ⅞in. between, and parallel with the edges of the bed.

## COL. ROSS'S IMPROVED FILTER PIPE.

On p. 471, No. 984, we illustrated and described the new pipe introduced by our old contributor, Col. Ross. The *rationale* of the pipe was there fully detailed, and we need only





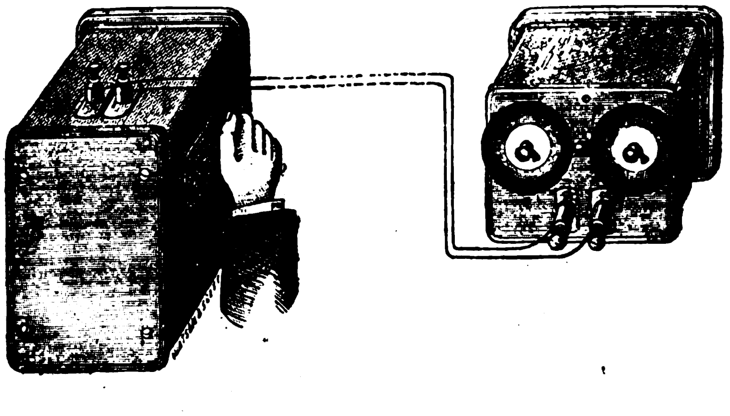
here say that in the new form now illustrated, while retaining all the essential points of his invention, Col. Ross has simplified the pipe and greatly improved the shape, getting rid altogether of the oval receptacle for the sponge.

In the sketch, A is the smoke chamber, B the sponge, C the ivory non-conductor, E the mouthpiece, and F the bowl. Col. Ross claims that the only way to effect a complete separation of the volatile nicotine from the smoke is by *condensing* the latter upon a cold filter, such as a piece of sponge, and that the only way to keep such a sponge sufficiently cold in a short pipe is by isolating it from the source of heat (the bowl) by means of a *non-conductor*, such as we see in the handles of tea and coffee pots. Anyone who understands the subject scientifically will at once see that the essential oils (for this pipe separates two, one thin and dark yellow, the other thick, pasty, and of a brown colour), being quite as volatile as the smoke itself, render all the receptacles, inner tubes, &c., which we see in some pipes, *simply useless*, except for catching the superfluous essential oil which, because it cannot all volatilise as smoke through the narrow bore, condenses in the bottom of every pipe. This is quite another matter from "screening" or "filtering" the smoke, which no pipe, unless made upon the condensing principle, will effect. In the new form of "condensing smoke-filter pipe," the sponge should be carefully cut with scissors out of a small fine Turkey sponge (which are to be had for 4d. each, and make from four to six filters) from the middle of the root to the surface; it should be about 2in. long, slightly wedge-shape, and nicely rounded so as to fit the tube of the pipe, the narrow end being inserted nearest the mouth. Such a filter lasts two or three months.

The Prince of Wales has recently accepted one of Col. Ross's pipes, and a good show of them are on view at the Inventions Exhibition.

## DOMESTIC MAGNETO BELL.

THE annexed engraving illustrates an arrangement of electric bell which dispenses with the battery, and obviates all difficulties with "chemicals" and dirty contacts. The "set" shown in the engraving has been introduced by Messrs. Blakey, Emmott, and Co., of Halifax, to supply for domestic purposes an electric-bell arrangement similar to that used by many of the telephone exchanges. The "set" consists of a magneto-generator, bell, and 24 yards of wire; but obviously the bell may be placed at any desired distance from the generator, in which the current is generated by turning the handle. These instruments are very durable, and will ring over a distance of several miles, while, if necessary, a switch can be placed on the generator with a number of extra terminals, so as to use the one instrument for several bells.



## THE MOTION OF THE STARS.

ON May 23, in the Museum Buildings, Trinity College, Dublin, Dr. Ball, Astronomer Royal, delivered a lecture on "The Discovery of the Motion of Stars in the Line of Sight by the Spectroscope."

Dr. Ball said: I have this afternoon to unfold one of the most modern chapters of astronomical research which has led, and promises still further to lead, to discoveries which are of a nature not to be made by any other means. This method of research tells us what no other method can tell. Let us first see clearly what the problem is. Look at a star with a telescope. Apply the resources of the observatory to the determination of the place of that star. We observe it with the meridian circle. We determine its right arc and declination, and we determine the place which the star occupies in the heavens. Years roll on, and the place of the same star is again determined. The observations are purged from all sources of error, and yet the two places of the star do not agree. There is only one conclusion to be drawn—the star is not at rest. It must have what is called a proper motion. This proper motion varies greatly in different stars. In some cases the star hardly appears to move in the course of centuries: in other cases the motion is sufficiently rapid to be detected in a year or even less. Yet the distances of the stars are so great that the apparent displacement of their positions is but small to ordinary observers. Even the most rapidly-moving star, which hurries along with the stupendous speed of about 200 miles a second, is so far off that it only accomplishes about seven seconds of arc in a period of a twelvemonth. Nine years would be necessary before this star traversed an arc equal to a single minute, while about 250 years must elapse before this star would traverse a distance equal to that subtended by the apparent diameter of the moon. We can show, in a more striking manner, the effects of proper motion by making an attempt to estimate what proper motion can do towards deranging the shapes of the constellations.

Look, for instance, at the constellation of the Great Bear, which has been known from all antiquity. The stars of this constellation are endowed with proper motion, so that the Bear of our Northern skies must have somewhat changed his lineaments from the Bear which Homer said feared to dip in ocean. Dr. Ball then exhibited views of the Great Bear, or rather of the seven principal stars in the constellation. Each of these stars, he said, was endowed with a proper motion, in virtue of which it gradually drifted through space. It was a somewhat remarkable feature that there appeared to be a regular set of the stars in the constellation in one direction. This was at all events true so far as the central stars of the group were concerned. The two first stars of the tail and the three adjacen stars of the body are all apparently drifting in one way, while the two extreme stars at the end of the tail and at the other end of the body are moving in a nearly opposite direction. In consequence of these changes there was a continual development going forward in the features of the Great Bear. They had there two views, one representing the present lineaments so well known to everyone, the other depicting the appearance which the Great Bear was destined to assume. But the rate of change in the great constellation was indeed a very slow one when compared with their ordinary conceptions. The transformation from one picture to the other demanded a period of about 36,000 years. Until within the last quarter of a century astronomers were necessarily in profound ignorance of the movements which stars might have in the line of sight. A star might be hurrying directly towards one system with a velocity of hundreds of miles a second, or it might be receding to the depths of space with a velocity greater than that of a comet in its whirl around the sun, and yet they should have remained in ignorance of that motion, for how could it be detected? No doubt there would be some infinitesimal increase in the star's brightness as its distance decreased, but this would be far too small for the most delicate photometers to grasp, and, even if the change in brilliancy could be discerned, yet it would have been impossible to determine it from the other and well-known causes of variability in stars. A combination of statistics and the theory of probabilities here stepped in, and gave them very precarious assistance. From it they learned that the true proper motions of the stars must on the average be about one-third greater than the apparent motions, but they had no means of conjecturing the true proper motion of any individual star which might in any degree exceed the apparent proper motion. Such was the state of astronomical knowledge when the spectroscope was invented and applied to this particular problem; but how, it might well be said, was the spectroscope capable of affording any information on a matter so recondite—how could the spectrum of a star show whether that star was moving towards the earth, or receding from the earth, or, still more wonderfully, measure the velocity of the motion? All they could learn of the character of the stars should be derived from the rays of light which they transmitted. That ray was usually a very component beam. It consisted of all the colours of the rainbow blended together. The spectroscope acted as the magician's wand, which sorted out all those intermingled colours. It placed the red here and the violet there, and the intermediate lines occupied intermediate positions. It showed how these lines were marked over by dark lines, and it gave wondrous information as to the significance of these dark lines. He had, on that occasion, to dwell on one aspect only of the multitudinous uses to which the spectroscope was subservient to the astronomer. They had not now to dwell on the interpretation of those lines which gave them information as to the actual ingredients of the heated atmosphere which enveloped the star. They had now only to speak of the effect which was produced on the position of those lines by the movements of the star. The lecturer then briefly referred to the wave theory as to light, and dealt with the rotary motion of the sun and of the planet Jupiter. In describing the uses of the spectroscope and the practical application of the instrument in connection with the observations of stars, the rays of light from the star, he said, were received on a large object-glass, and proceeded to a focus. They then passed through a powerful battery of prisms, and were thus expanded out into a spectrum characteristic of the source from which the light had come. In the case of several of the stars there was a considerable range of choice as to the lines by which the measurements could be made. He should, however, refer chiefly to but one star and to one single line in the spectrum of that star. The star of greatest interest in this branch of astronomy was that which claimed special attention as the most brilliant gem in the heavens. It was the peerless Sirius. When this star was viewed in the spectroscope it was found that it belonged to a small and remarkable class which exhibited a spectrum composed of comparatively few lines. These lines were, however, exceptionally dark and broad, and they had been almost all shown to be identical with certain lines in the spectrum of hydrogen. The hydrogen spectrum of Sirius had indeed been confirmed by Dr. Huggins in a very interesting manner. He had obtained photographs of the spectra of Sirius, and on these photographs were depicted many lines on the invisible part of the spectrum, which were, however, sensitive to the indications of the photographic plate. One and all these lines coindided with certain lines obtained in the photograph of the spectrum of hydrogen, as obtained by the electric spark on the earth. Of the visible lines, which they attributed to hydrogen in Sirius, the most conspicuous was that known as the line F on the solar spectrum. In the sun that line was comparatively sharp and well defined. In the spectrum of Sirius F was rather a broad band, not very well defined, except in extremely fine weather. They had there a diagram which gave a view of the F line in Sirius, shown in comparison with the dark line F in the solar spectrum. This figure did not, of course, represent the actual observations, for it was not practicable to introduce the solar spectrum to a comparison with that of Sirius. That view was rather for the purpose of showing the magnitude of the various quantities involved. The broad band was the F line of Sirius, the narrow line was the F line in the sun. The scale showed the motion in miles per second. For instance, the centre of the F line was to the right of the corresponding line in the sun. This would correspond to, perhaps, a tenth part, or less, of the distance of 500 miles, and this would show that Sirius was receding. Continued observations of this star had brought a very unexpected circumstance to light. In 1868 Mr. Huggins first directed attention to this method of research, and he found that the F line of Sirius was displaced towards the red end of the spectrum. This displacement admitted of exact measurement, for it was found possible to introduce into the spectroscope the electric spark in a tube of hydrogen. Dr. Ball then referred to a bright line on the board, and said that if Sirius had no motion relatively to the earth, then, of course, the line F of Sirius should be symmetrically placed with respect to the bright line. As there shown, however, the F line was manifestly towards the red end of the spectrum. It therefore followed that at this time the star Sirius was receding from the sun with a velocity of about 20 miles a second. Subsequent observations confirmed the retreat of Sirius. Even down to 1875, and still later, the same observations were made. About the year 1881 it was perceived that the retreat of Sirius was much less than it had been. From 20 miles a second it had fallen down to two miles a second, and in the subsequent years the retreat of Sirius was entirely reversed. Dr. Ball then referred to figures for the purpose of showing the motions of Sirius from 1875 down to the present year. The difficulties of observation were, he said, such that too great reliance should not be placed on the actual figures of the numerical results. Enough, however, had been done to establish conclusively the remarkable change in the relative motion of Sirius and of our system. It was impossible to pass from the subject of Sirius without offering a conjecture as to why these movements should take place. The movements of this star had already furnished a deeply interesting chapter to the journals of astronomy. Many years ago it had been noticed that the proper motion of this star, as observed in the ordinary manner, exhibited certain fluctuations. It was proved that the motion gave an average of about a thousand miles a minute, sometimes more, and sometimes less. Such irregularities as these admitted of only one interpretation. They should arise from the attraction of some other star in the vicinity. Indeed, in many ways the problem of Sirius was analogous to the ever-memorable researches into the movements of Neptune. The irregularities of Sirius led to the prediction of the existence of a companion to it of considerable size. In some degree even the orbit of this satellite was computed, and the period of the revolution was assigned at about eighty years. These predictions were fulfilled. The companion was detected, and its movements were found to correspond with the time anticipated. It would be of extreme interest to see how far these new movements of Sirius would throw any light on the orbit of the satellite. At present the observations had not reached the necessary completeness. It should, however, be noticed that if the orbit of the satellite were seen edgewise, as was indeed most probable, then during one half of its journey, Sirius would be moving towards us, and during the other half it would be retreating. There was another interesting branch of sidereal astronomy in which these spectroscopic researches were calculated to shed some light, and that was as regarded the motion of the Solar System through space.

## ROSENTHAL'S GALVANOMETER.*

All the galvanometers now in use, such as those of Thomson and Wiedemann, present the same disadvantage—the arrangement of the spirals is very unfavourable, so that in order to increase their sensitiveness, it becomes necessary to considerably increase the number of the wire's revolutions, thus increasing the resistance of the apparatus. It often becomes necessary even to add to a bobbin that is to serve for different experiments a series of bobbins capable of being substituted for one another, according to the requirements of the experiment. Thus Wiedemann's compass always requires three pairs of bobbins, one for thermo-electric currents, one for hydro-electric ones, and one for physiological experiments. By a new arrangement of the spirals M. Rosenthal has succeeded in constructing an apparatus that has a resistance of but 30 ohms, and that far exeeds in sensitiveness all the instruments hitherto known. The apparatus presents the further advantage of being capable of serving for electro-physiological experiments and for thermo-electric currents. The utility of so great sensitiveness is especially apparent in the methods of reduction to zero, such as the measurements of resistances by the aid of Wheatstone's bridge, and the measurements of electro-motive force by Poggendorff's compensation method. The use of this instrument is very simple and its price very moderate. Figs. 1 and 2 show the arrangement of the apparatus. Fig. 1 gives a general view of it. To a marble base, T, provided with three levelling screws, $e$, $f$, $g$, are adapted two columns, $m$ and $n$, which support the discs, $i$ and $k$. To the disc $k$ is fixed the deadener, $d$, held by a screw, $q$, whose extremity enters a groove, $u$ (Fig. 2). At $a$ and $b$ are terminals that communicate with the extremity of the bobbins.

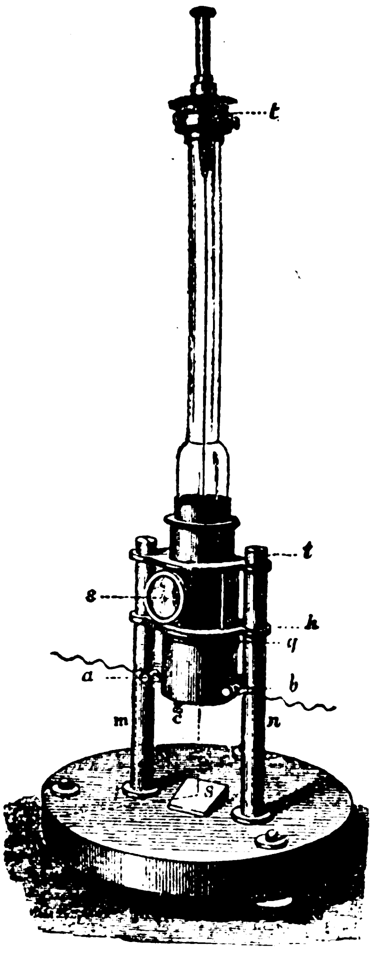


Fig. 1.

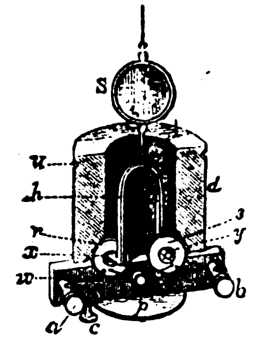


Fig. 2.

Between $i$ and $k$ there is a movable case containing the mirror, and formed of two half-cylinders. To the disc $i$ is screwed a tube, A, which contains the suspension thread, and which is surmounted by a revolving piece to which the thread is attached.

The arrangement of the essential parts of the instrument is shown in Fig. 2. The needle is a small horse-shoe magnet, $h$, to the polar ends of which are fixed two horizontal curved appendages, $x$ and $y$. These latter, which are cut from the same piece as the magnet, form the poles upon which the deflecting action of the bobbin is directly exerted. As the distance between these poles and the bobbins is as small as possible, the action is as efficient as can be. The polar appendages are arcs of a circle whose centre is in the axis of rotation, and they freely traverse the bores of the two bobbins, $r$ and $s$. Each of these latter consists of 200 revolutions of $\frac{1}{200}$in. insulated silver wire wound upon ivory spools that rest in cavities in an ivory support, $w$, to which the terminals, $a$ and $b$, are fixed. This support has the form of a parallelopiped, and engages with two longitudinal slits in the copper deadener. It is held therein by a glass plate, $p$, which, through three small screws, $e$, is fixed to the deadener and closes it at the bottom. The latter (the deadener) is a large hollow copper cylinder. The magnet supports the silver mirror, $s$, at its lower part, and both are suspended by a cocoon fibre. The manner in which the apparatus is mounted may be readily seen. The deadener must be so placed that the slit with which the bobbin-support engages shall make an angle of 45° with the line of the poles. In order to facilitate the manipulation connected with the regulation of the instrument, there is placed upon the marble base a mirror, S, which reflects the whole interior of the apparatus in the direction, T.

The dimensions of the instrument are as follows:—Total height, 18in.; height of tube, 10in.; height of deadener, 1·5in.; external diameter of deadener, 1·5in.; diameter of cavity of deadener, 0·8in.; height of magnet, 1·0in.; weight of magnet and mirror, 60 grains; external diameter of bobbins, 0·46in.; thickness of bobbins, 0·12in.; diameter of bore of bobbins, 0·2in.; resistance of the two bobbins, 39 ohms. In order to give an idea of the sensitiveness of the instrument, M. Rosenthal cites the following data:—(1) Without compensating magnet (of Hauy), a deflection of 0·04in. is equivalent to $54 \cdot 10^{-10}$ amp., the distance from the scale to the mirror being 9ft. (2) With a compensating magnet and the same distance of the scale, a deflection of 0·04in. is equivalent to $12 \cdot 10^{-11}$ amp.

The current from a German silver thermo-electric pile due to a difference of 10° C. temperature at the solderings, and traversing 1,000 ohms, gives a deflection of 4·8in., the scale being 9ft. from the mirror. The inventor has verified the ratio of the slight deflections to the intensities. To this effect, he placed a galvanometer in a derived circuit taken from a platinum wire 3·28ft. in length, stretched in a straight line. The principal circuit was formed of one Leclanché element of 6,600 u. s., and of the platinum wire. In causing the distance between the two points of derivation to vary upon the platinum wire, deflections of the galvanometer proportional to such distances were obtained. The following data are given by M. Rosenthal:—

| Distance of points of derivation on rheostat. | | Deflection of scale. | | Means. |
|---|---|---|---|---|
| 10 | .... | 6·0 | 6·0 | 6·00 |
| 20 | .... | 13·0 | 12·0 | 12·50 |
| 30 | .... | 18·0 | 17·0 | 17·50 |
| 40 | .... | 24·0 | 24·0 | 24·00 |
| 50 | .... | 29·5 | 30·0 | 29·75 |
| 100 | .... | 59·5 | 61·0 | 60·25 |
| 200 | .... | 118·0 | 122·0 | 120·00 |
| 300 | .... | 176·0 | 184·0 | 180·00 |
| 400 | .... | 240·0 | 245·0 | 242·58 |
| 500 | .... | 296·0 | 305·0 | 300·50 |
| 600 | .... | 355·0 | 267·0 | 361·00 |
| 700 | .... | 415·0 | 432·0 | 423·50 |
| 800 | .... | 476·0 | 495·0 | 485·50 |

The concordance is quite sufficient, when we take into account the imperfection of the experiment. The errors do not exceed the limits that ought to be expected with the experimental arrangement that the inventor chose. M. Rosenthal has made a series of measurements of resistances in order to ascertain the degree of approximation that the instrument is capable of reaching, and has found that it is possible to estimate variations of 0·005 per cent. The instrument is peculiarly convenient for electro-physiological experiments, and in these is capable of rendering genuine service.

## INOCULATION FOR CHOLERA.

The statements made in connection with the alleged success of cholera inoculation in Spain are thus commented on by the *Lancet*:—

The *furore* excited by Dr. Ferran's alleged protective inoculation of cholera continues unabated, or rather with increasing ardour. Last week it was reported that he had operated upon 8,000 persons in Valencia alone, including two Madrid doctors—Moreno and Tolosa—who thereby became converts to the new doctrine. It is also stated that four hours after their inoculation they experienced the cramps, diarrhœa, fever, and delirium of cholera, and that after sixteen hours "they were all right again." Further proof of the efficacy of the measure is cited from the Alcira Hospital, where all the inmates were inoculated, with the exception of two, who declined to submit to the operation. Cholera attacked these two recalcitrants, and they succumbed to the disease. It may be remembered that Dr. Ferran adheres to the bacillary doctrine of the etiology of cholera, but that he declares that Koch's comma bacillus is but one stage in the development of an organism whose germs he avers to have discovered. Although we are unwilling to condemn on *a priori* grounds a discovery of such moment as this would be if verified, we are yet very reluctant to admit that such vaccination can protect from true cholera, or to see in the results as reported anything more than coincidences. Asiatic cholera is not prevalent in Alcira, nor, so far as we know, has it reappeared anywhere in Europe this year, and therefore the conditions of a crucial test are wanting. We are not surprised at the excitement that has been caused by the announcement of the alleged prophylactic; for the history of epidemics of this disease shows how much the people dread its invasion; and they would willingly submit to any measure that promised them immunity from the plague. It is significant that at the recent conference at Berlin not even Dr. Koch himself as much as hinted at the possibility of a protective vaccination amongst the measures of meeting the disease; and Ferran's work was only cursorily mentioned by one speaker, Professor Virchow, who believed that the various forms described by Ferran were the results of disintegration of the bacilli, and not stages in their evolution. The matter has, however, reached a stage in which it ought not to be disregarded without a full and sufficient investigation; and although we doubt very much the possibility of arriving at any satisfactory conclusion except in time of epidemic, it is very desirable that Dr. Ferran's labours should be submitted to such an examination by competent and trustworthy authorities. We fully approve of the step somewhat tardily taken by the Spanish Government in prohibiting any further inoculations until such inquiry has proved the efficacy of the measure. For if the whole thing be proved fallacious, the task of dispelling the delusion will be the greater the larger the number of the inoculated; and if it be shown to be really efficacious, no harm will be done by deferring it until this is proved. The position of Dr. Ferran is a difficult one; for, although he has acted in good faith, he must either be a misguided enthusiast who has pushed his conclusions far beyond their legitimate limit, or a great discoverer. Pending such an inquiry it would be unfair to judge him, but we cannot refrain from once more pointing out that to rely upon "protective vaccination" and to suffer the continuance of those insanitary conditions that favour the spread of cholera would inevitably lead to disastrous results. Nor is it possible to view with equanimity the prospect of an application of these inoculation measures to other specific diseases, an extension which would be sure to be attempted if Dr. Ferran were proved to be in the right.

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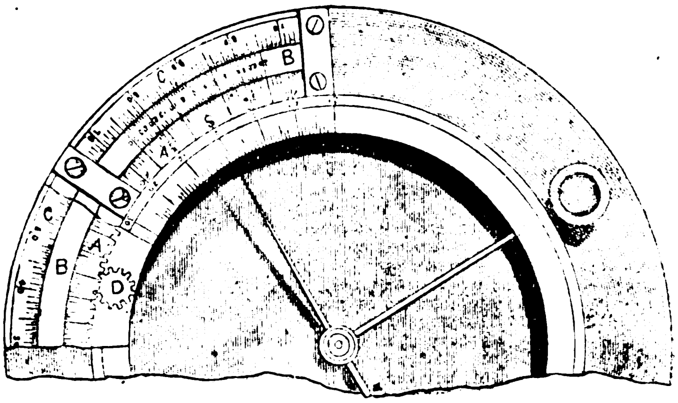
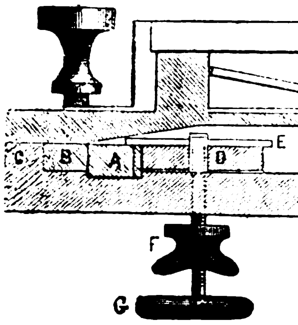
* From *La Lumière Electrique.*

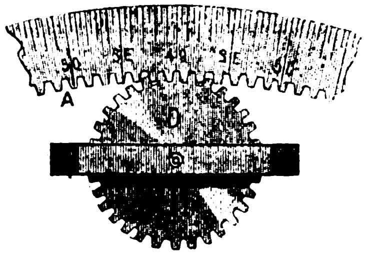
## NIXON'S COURSE READING ATTACHMENTS FOR TRANSITS.

THE device shown in the annexed engraving is probably, says the *Scientific American*, the most important improvement made in surveying instruments since the invention of the transit some fifty years ago. The great source of error, in producing meander or preliminary lines with either a transit or a compass, has always been in the necessity of calculating the course of each line by either adding or subtracting the deflecting angle to or from the preceding course. Especially are these calculations liable to error when the addition or subtraction of the deflection angle will put the course of the new line into another quadrant from the one in which the preceding course was located. Every engineer of any experience knows the great loss of valuable time and the annoyance often caused by errors of transit men in calculating courses.

The inventor of this improvement, Mr. T. L. Nixon, of Tacoma, Washington Territory, has had extensive experience in transit work, and after some study contrived this simple but valuable improvement. Any one can understand the working of the instrument by a glance at the illustrations. The course ring, A, can be revolved upon the lower plate, or can be clamped to it at any desired point. This ring is divided into the different quadrants, and graduated so as to read by the vernier exactly the same as the vernier reads upon the outer circle, which circle is graduated from 0 to 180°, just the same as the old style of instrument. Therefore, instead of deflecting an angle upon the outer graduated circle each time and making the calculation of the course, with this instrument the zero of the vernier is set at the course of the back sight, and then, when the upper plate is unclamped and the telescope directed to the forward tack and the upper plate again clamped, by a look at the vernier and course ring the new course is read at once correctly, down to the finest graduation of the instrument, no matter whether it is known which way the deflection was made or not.







The revolving movements of the ring, A, are accomplished by means of the pinion, D, which is rigidly mounted on a spindle extending through the lower plate, and provided at its lower end with a thumb wheel, C, by which it may be readily turned. The ring, A, may be clamped in any position by turning the jam nut, F, so that it will bear against the plate. The vernier, B, is attached to the upper plate, and is fitted to travel immediately outside of the ring, A, and inside of a graduated circle, C, of the lower plate. The vernier is graduated to read minutes or half minutes, as desired, and the graduation extends to both edges, so that it will read precisely the same angle upon either the course ring or the circle, C.

## PHOTOGRAPHIC MAPS OF THE STARS.*

### By S. J. Perry, S.J., F.R.S.

IT is interesting to watch the steady progress that is being made in a most important branch of celestial photography. The accurate mapping of stars, which is so fundamental in astronomy, is a work always very laborious, and for certain positions in the heavens almost impossible. The lamented death of Chacornac put a stop for a time to the valuable series of ecliptic charts that he had constructed with such marvellous accuracy, and when an attempt was made by the brothers Henry to complete his great work, they found, on arriving at the portion of the sky traversed by the Milky Way, that the task of mapping by hand with the required accuracy all the stars above the 15th magnitude was beyond their powers. Recourse was therefore had to photography, and they have now constructed an object-glass that gives good results down at least to the 14th magnitude stars. The immediate object of Messrs. Henry was to complete the ecliptic charts of Chacornac, but it is to be hoped that their success may encourage them to extend ultimately their field of operations.

In the meantime most excellent results in the same direction are being obtained nearer home by one of our amateur astronomers. Mr. Howard Grubb has lately constructed an 18in. Cassegrain with a very short focus, with the view of enabling Mr. J. Roberts to photograph at his private observatory, Kennessee, Maghull, the whole of the northern heavens. The mirror has been excellently mounted, and is now used on every fine night. The 3in. photographic plates cover an area of the sky two degrees square, or about 16 times the area of the full moon. I had the pleasure of examining one of the plates two days ago, and found, on comparing it with Argelander's star atlas, that the photograph contained, along with the 58 stars of the map, at least 32 new ones, all probably below the magnitude 9.10 at which Argelander stopped. The exposure of the plate was 20 minutes, but Mr. Roberts is of opinion that rather less than a quarter of an hour will furnish the most advantageous results with the plates he is now using. To facilitate work, and to secure always perfect adjustment of instrument, Mr. Grubb is at present constructing for this Cassegrain mirror a collimating eyepiece, designed by Mr. G. Johnstone Stoney, which will enable the observer to collimate his telescope with the greatest nicety, and with very little loss of time, whenever the position of the instrument may require to be altered. The use of this Cassegrain is confined entirely to photography, and it is mounted on the same stand with a refractor, thus forming a duplex equatorial similar to the one that is doing such excellent work in the hands of Dr. Huggins. The progress of Mr. Roberts in the construction of his celestial atlas will be followed with the keenest interest by all lovers of photography, and we must all earnestly hope that health and strength for the prosecution will correspond to the zeal shown in the undertaking of so great a work.

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* From the *British Journal of Photography*.

## JABLOCHKOFF'S NEW BATTERY.

THE following account of a new battery, called the anti-accumulator, has been presented to the Paris Academy of Science by M. Jablochkoff, and appears in the *Comptes Rendus*, from which we make the following extract:—It is a battery with three electrodes, and comprises first an oxidisable metal which forms the first electrode; then a plate formed of a slightly oxidisable metal, such as lead, or of porous carbon capable of polarisation, forming the second electrode; and, lastly, another electrode formed of lamellæ or tubes of very porous carbon immersed in air. Among the various types employed, I will describe only the most recent. It is composed of a flat vat of lead, or lined with lead, in which are placed fragments of the oxidisable metal, which may be sodium, sodium amalgam, zinc, iron, &c. When this metal is put into position, the vat is filled up to its edge with any spongy matter, packing cloth, wood sawdust, &c. Two cases may then occur: if we use sodium it is not necessary to introduce water, as the sodium becomes oxidised, forming caustic soda, which attracts moisture; if the metal employed is zinc or iron, the spongy mass is moistened with a solution containing either common salt or, preferably, chloride of calcium, which attracts and retains moisture. Lastly, upon the levelled spongy mass is placed a range of tubes of porous carbon. For this grouping I prefer to substitute for the leaden vat one of paraffined carbon. The action set up in this battery is as follows: when the element is formed but remains open there are established local currents between the oxidisable metal and the electrode upon which it is placed. This latter is polarised, and its potential rises until it has reached that of the metal; the action is then arrested or reduced to a minimum. If we wish to collect the exterior useful current, it is sufficient to connect by a conductor the electrode thus polarised to the other electrode of carbon; the discharge begins; the local currents resume their action, and restore to the electrode its charge in proportion as it is expended. The elements of this battery have been determined on several occasions, and found as follows: the electro-motive force depends on the oxidisable metal employed; with sodium amalgam it is 2·2 volts; with zinc, 1·6 volt; with iron, 1·1 volt. The internal resistance of an element measuring a decimètre on its side varies between a quarter ohm and half an ohm, according to the thickness of the spongy layer and its degree of moisture. The external dimensions are one decimètre in square by 25 millimètres in height; the weight is from 200 to 250 grms. The advantages of this battery are its simplicity and convenience of manipulation. It is managed in this manner: the elements are ranged in batteries of a regular form, and connected in groups of ten at most. The battery may be charged with oxidisable metals for several months, and it is merely necessary to renew the liquid from time to time. For that purpose we take a group of elements, steep it in pure water, withdraw it, let it drain, and then steep it in a trough filled with a solution of chloride of calcium. This is taken up by the spongy body, the excess is poured away, and the battery returned to its place. This simple operation needs only be performed very rarely if the battery is used for such work as bells, telegraphing, &c. If the current is employed for light or for mechanical power, the liquid must be renewed every 24 or 48 hours. We may remark that this battery works only when its current is utilised, and that it gives off no odour. It utilises the local currents which are so injurious in ordinary batteries, and, above all, it yields electric energy very cheaply, as the metals are employed in the state of waste, filings, turnings, &c. If we suppose that iron is used, it is known that to obtain one h.-p. for an hour 850 grms. of metal must be consumed. But iron turnings are worth five centimes per kilo, or for this quantity four centimes. As for the chloride of calcium it has no value. We may therefore affirm that this battery gives the energy of 1 h.-p. hourly for an outlay of 5 centimes (say one halfpenny)—which has to be proved.

## THEORY AND PRACTICE OF PHOTO-MICROGRAPHY.—I[*]

By Maurice N. Miller, M.D., Instructor in Biology in the University Medical College, New York.

If an illuminated translucent picture on a plane surface be placed at a considerable distance from a convex lens, a much diminished image will be formed at a point near the focus of the lens. If a minute and brightly illuminated translucent object be placed near the focus of a convex lens, an enlarged image will be found at a considerable distance from the lens. The conditions described in the first proposition, using an ordinary photographic negative, a microscope objective, and a sensitive film to receive the image, are required in the production of micro-photographs. The second arrangement, introducing a mounted microscopic object, a microscopic objective, and a sensitive film, presents the conditions necessary in the production of photo-micrographs. A micro-photograph is simply a reduced copy of a photographic negative; while a photo-micrograph is the fixed image of an object greatly enlarged by the microscope. It is with the production of the latter that we are engaged this evening. In order that we may the better appreciate the conditions required in the production of enlarged pictures of minute objects, let us examine the simplest arrangement that may be employed for such purpose.

First, a microscope stand is required. This is placed on a table so that the optical body is in a horizontal position. The eyepiece is now removed and a long bellows camera box is connected with the microscope tube so as to make a light tight joint. The whole being firmly fixed to the rigid table, the latter is placed so that the sun may shine on the mirror of this microscope, and on this alone. (Let me say just here that it is with translucent objects only that we have to deal. Little effort has thus far been directed toward the production of enlargements of opaque objects, and, inasmuch as we can operate with the lowest powers only in such work, it is not probable that the results thus obtainable will ever be much sought for.)

We now proceed with the description of the steps necessary to produce an enlargement with our simple apparatus. A microscopic object is placed upon the stage and then held in position by the spring clips. A piece of blue glass is now placed beneath the stage and the mirror; so adjusted that the sun's rays are brought to a focus a little beyond the object to be photographed, and, for illustration, we will take a mounted specimen of a small insect, which will afford us sufficient defferentiation with moderate amplification. A 1in. well-corrected objective is put on the microscope, and we adjust the camera so that the ground glass is about 18in. from the stage. Now, covering the head with an opaque cloth in the ordinary way, we reach the coarse adjustment, and obtain an image, which we then sharpen with the fine focussing screw. You will observe that the camera is not too far distant, and we easily reach the milled heads of the focussing mechanism. By the time we have proceeded thus far it is probable that the sun has moved, or, more correctly, the earth has progressed, so that the mirror needs another adjustment in order that the picture may have purely central illumination. Well, we give the mirror a final touch, substitute our sensitive plate for the ground glass, and expose. With the low power we are using there is plenty of room for a little cap over the nose of the objective, and this affords the best simple means of exposure. If higher powers be employed, and consequently less distance between the lens and the object, a swing shutter must be introduced within the camera.

Well, what is our result? We develop, and, if we have been moderate in our desires, using a low power—not endeavouring to amplify beyond thirty diameters—we will get moderately successful pictures. Our principal difficulty is to get an even illumination. The centre of the field will, perhaps, be over-exposed, while a ring of darkness appears without this point. This is due to two principal causes, and one of them is easily eliminated. Reflections come from the inside of the tube, or from the mounting of the objective. Even the edge of the stage diaphragm may be bright enough to cause trouble, and the edge of the mirror-mounting introduces another source of unequal illumination. It is not enough that the afore-mentioned places be black—they must be *dead black*. I will allude to this again. But a much more serious cause of unequal illumination is found in the scattering rays from the mirror itself. The whole method is deficient.

Let me now describe, in contrast with the above, what I regard as the very best arrangement that can be made, with ample means and convenient surroundings. We will then compare the two, and see how far we may be able to dispense with the more expensive and complicated apparatus. The first question to settle is the source from which we must obtain our light; and I unhesitatingly answer directly from that great source of all light—the sun. Electricity comes nearest to sunlight in value for photo-micrographic purposes; but unless the operator has a very large stock of patience I advise him to have nothing to do with it. The only form that is of the slightest use, except for low amplification, is that evolved from the arc lamp, and thus far we have no regulators that are certain to remain in the optical axis of our instruments for a single second. The incandescent lamp is of no use, except as previously for very unambitious attempts with low powers. I have travelled most thoroughly and conscientiously this electric road, and let me sum up my advice to you in this little word—*don't*!

The calcium jet is far better for our purposes than the electric light. It is easily regulated, can be kept steadily in adjustment, but it is a very expensive luxury. Besides this, there is a certain hardness, a cold black and white that is inseparable from this mode of illumination. I used to think I could pick out calcium-light negatives from pictures made with other modes of illumination. I don't know that I would be willing to say as much now, but that there is a cold chalk-and-charcoal feature to prints from such negatives I presume many besides myself have noticed. The minor methods of lighting—by oil, gas, &c.—do not deserve any consideration at our hands at this time. We are engaged in the attempt to produce the very best results obtainable, and I know very well that no amateur is going to be satisfied with silhouettes made with a dark lantern attached to a camera box. I never knew of a lens with power enough for an amateur. Far be it from me to discourage small beginnings; but I want you all to aim high, and never rest until you can say your work is good enough to offer as patterns for others to equal.

In presenting what I regard as the best arrangements for our work, it will, in reality, be a description of the apartments belonging to my new laboratory, now in course of construction. First, a room which has one window, at least, facing the south, is a great desideratum. But, as an illustration of what may be done under disadvantages, many of you may, perhaps, be surprised to learn that the laboratory of the late Col. Woodward was so located that all of his work had to be done before eleven o'clock a.m., on account of the shadow of an adjoining building. Premising that we have a southern exposure, we must next be able to secure absolute darkness in our room. This is best accomplished by inside shutters of painted wood, although all the windows save one may be darkened in any way thought desirable. Let me again say that nothing short of absolute darkness will answer. With our present highly sensitive plates, the twilight of our old-fashioned dark rooms will not answer. Our one room may possibly answer, not only for the purposes of an operating apartment, but also serve for the development and preparation of the plates. Indeed, we may work quite conveniently, using the room in this double capacity, if we have at our command one or two dark boxes in which to allow slow developments to proceed while we are otherwise engaged, and while the room is lighted. Of course, a separate dark room is preferable. Attached to the window-ledge, and outside the window, level with the bottom of the latter, we have a strong, rigid shelf for the heliostat. This shelf should be so strongly affixed that it is in reality a part of the building. Mine is of slate (although painted oak answers very well), and the length is equal to the breadth of the window, while the width should be at least twenty inches. To the window-frame, which is, of course, the one with the southern exposure, we must affix two inside shutters. By this I mean a double shutter, opening vertically in the centre of the window. The left half of this shutter, as you face the window, need not be hinged, but fastened permanently and rigidly to the window-casing. The right-hand shutter is hinged to the casing, and must be well fitted, so that, when closed, the room is instantly in perfect darkness. This requires the service of a good mechanic.

Another shelf is required inside our room for our microscope and accessories, and for this purpose a pine plank, two inches thick and ten by twenty-four inches, answers perfectly. This is fastened to the bottom of the window-casing by one end, and the other end is supported by a brace or leg to the floor. This should be a permanent fixture, or, at least, so fastened by screws as to be perfectly rigid. I should have said in the beginning that the building, if in a large town, ought to be on a good foundation and free from tremor. Our large buildings that tremble with every passing truck will not answer the purpose.

One more fixture, and we are ready for the placing of our apparatus. We require no camera box other than our apartment—we simply need a frame to hold the ground glass and the plate-holder. A frame of this sort can be easily made, or a camera box may be utilized by removing the front. This should be affixed solidly to a stand that may be raised or lowered—an iron camera stand answering the purpose perfectly—especially if, after the proper position has been obtained, it may be readily and securely fixed to the floor.

(*To be continued.*)

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[*] A paper read before the Photographic Section of the American Institute.

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# SCIENTIFIC SOCIETIES.

## ROYAL MICROSCOPICAL SOCIETY.

The eighth meeting of the session was held on the 13th ult., at King's College, Strand, W.C., the President (the Rev. Dr. Dallinger, F.R.S.) in the chair.

Mr. Beck exhibited the "Star" microscope (in two forms) which his firm had recently brought out, with a view to supply a want which had been felt for an instrument which should be at the same time very cheap, but yet thoroughly reliable. To explain what he meant by cheapness, he mentioned that it was proposed to offer the cheaper of the two forms for 3 guineas, with two objectives (1in. and ¼in.). He believed it would be found that the instruments were suited to all the ordinary requirements of the botanist, the student, or the amateur. He had thought of reading an introductory notice of the instruments which had been prepared for circulation; but, instead of doing this, he thought it would be better to present an instrument to the society, so that those who were interested in such matters might have the opportunity of seeing what could be done with it.

The President, in thanking Mr. Beck for his donation, said he was exceedingly glad to welcome such an instrument, for he was himself constantly realising the need of a very cheap form of microscope which was capable of doing work in a reasonably good manner. A large number of boys and youths were prevented from taking up microscopical studies by the expense connected with them, and to be able to have a microscope of this class with two objectives at the price mentioned would therefore be a great boon.

Mr. Guimaraens exhibited six slides of Pathogenic bacteria prepared by Dr. A. C. Abbott, of Baltimore, U.S.A., from materials supplied by Dr. G. M. Sternberg, and mounted according to his directions. He considered *Bacillus tuberculosis* in sputum, stained by Frenkel's method, and *Bac. anthracis* in liver of rabbit, deserved especial commendation. There was also an interesting slide of *Micrococcus* of swine plague, pure culture. Dr. Klein maintains the disease is caused by a *Bacillus*, whilst Drs. Salmon and Sternberg consider the form to be a *Micrococcus*.

The President called particular attention to the slides, which he considered were very beautifully mounted, bringing out the *Bacilli* in a most perfect manner.

Mr. Groves exhibited and described one of the new Cambridge rocking section cutters, the principle of which was somewhat new. The razor was firmly fixed at one end of the bed-plate, the imbedded specimen being held in a brass tube fitted upon the end of an iron arm, which was mounted upon trunnions after the manner of a gun. There was an ingenious contrivance by means of which the arm was raised clear of the blade, the section being cut as it descended, and dropping directly upon the slide upon which it might be mounted. The machine was capable of cutting the thinnest possible sections. During a recent visit to Cambridge he had found this machine to be the one in general use. In reply to questions, Mr. Groves stated that the machine was not adapted for freezing, nor for cutting sections of hard substances; but for soft tissues it worked admirably, and, although the sections were not cut in a straight line, they were parallel to each other, and the arc described was so slight that it made no practical difference to the flatness of the section.

Mr. Crisp exhibited a mirror made by the Bausch and Lomb Optical Company, to which was fitted a diaphragm with an oblong slit.

Mr. J. Mayall, jun., said that the principle of having a diaphragm over the mirror was applied by Dellebarre in the last century, and had been subsequently repeated. He remembered having seen Dr. Charles Robin use similar diaphragms, which he found very useful.

Mr. Crisp mentioned that a short time ago a traveller in Asia gave an account of his discovery of the "Wax insects"; but stated he had no means of examining them otherwise than by the naked eye. This led him to look up the account of Gray's water microscopes, in order to call attention to the very simple means by which magnifying power might be obtained under the circumstances in which this traveller found himself placed. Even a drop of water on a piece of glass would have furnished the power required. Mr. Mayall had constructed a model of Gray's apparatus, which he would describe.

Mr. J. Mayall, jun., said that Gray had described his process very clearly. He employed a plate of metal $\frac{1}{16}$in. thick, with a hole drilled through it about $\frac{1}{30}$in. in diameter, one side of which was countersunk to $\frac{1}{8}$in. in diameter, and the other side to about half that extent. A drop of water was then put in each of the countersunk spaces, and it was quite surprising how much magnifying power was obtained, and how clearly the object was shown. Gray suggested that a little cavity should be made in the support in which to put a drop of water containing organisms for examination; but this was not quite so successful. It was not necessary to employ metal for the purpose, as a piece of cardboard or wood answered perfectly. Gray's object was to make a simple as well as an effective apparatus, and in this he had been quite successful, and when an observer found himself without a lens he could not do better than follow the suggestion. Gray found it preferable to use a solution of isinglass, which would remain where it was placed better than water.

Mr. Beck said that some years ago, before the race of street "Patterers" became extinct, there used to be a man who went about selling microscopes made somewhat on this plan, but the lens was made of a drop of Canada balsam.

Mr. Mayall said that in addition to Canada balsam there were other substances, such as castor oil, and, in fact, many of the highly dispersive oils, which would give even better results.

Dr. Maddox read his paper, "An Experiment on Feeding some Insects with a 'Comma' Bacillus, and also with another Bacillus (*Bact. subtilis*)," illustrating the subject by preparations exhibited under the microscope.

Mr. Cheshire said that he must, in the first place, congratulate Dr. Maddox on the time he had been able to keep his bees alive in a state of isolation. They were not at all easy to keep so under ordinary circumstances. He had tried himself some similar experiments, and thought he had succeeded in infecting *Musca Vernitoria*; but it might be well to remark that in one hive bee he had found eight or ten distinct kinds of bacilli, one of which had a distinct curvature. Amongst bee keepers there used to be an idea that the bees had no diseases, although there was one affecting the larvæ, but directly a careful examination of the bees was made it was found that they were subject to a great many. One kind had the curious effect of causing all the hairs to fall out, and on examining bees which were so affected he found them all to contain large numbers of the short red bacillus. If anyone intended to experiment in these matters it might be useful to know that if the bees were fed with food stained with aniline dyes very curious effects were produced upon the internal organs. Differentiation took place within the body, and when they came to dissect them afterwards they would find it a very great help.

Mr. Crisp announced that the Council had decided to place one of Prof. Abbe's apertometers in the library for the use of any of the Fellows who might wish to test the apertures of their objectives. Also that it was intended to publish in the *Journal* in future portraits of the presidents of the society. It was also contemplated to publish the portraits of past presidents, but as it would be quite impossible to give whole-page plates of the whole 18, it was intended to give one of Prof. Owen, as the first president of the Microscopical Society of London, and another of Mr. Glaisher, as the first president of the Royal Microscopical Society after the charter, the others being printed in two groups. To enable the plan to be carried out they would be glad if any Fellow of the Society who had photographs of either Dr. Lindley, Mr. Jackson, Dr. Lankester, Mr. Farrants, or Mr. Reade, would lend them for the purpose of being copied.

Dr. J. D. Cox's paper, "Structure of the Diatom Shell, Silicious films too thin to show a broken edge," was read.

Mr. E. Wethered read his paper on "The Structure and Origin of Carboniferous Coal Seams," the subject being illustrated by large diagrams, as well as by numerous preparations exhibited under microscopes.

The President said he should only be expressing what he was sure would be the feeling of the whole of the Fellows present in thanking Mr. Wethered for his very interesting paper.

Dr. Hudson's paper on "Four new species of the genus Floscularia and five other new species of Rotifers" was read. The paper described F. mira, F. mutabilis, F. calva, F. edentata; Corrochilus dossuarius, Notommata spicata, Stephanops armatus, Pompholyx sulcata, and Taphrocampa ocellata.

Mr. Mayall, jun., said he wished to correct and supplement certain points in his description of Nobert's ruling machine as reported in the *Proceedings* of the April meeting. (1.) The divisions to five minutes in arc on the bands of silver imbedded near the circumference of the division plate were in all probability made by means of a large circle divider, and from them the 21 (not 20) rows of "dots" would have been made with great accuracy. The divisions, therefore, should not have been referred to as supplementing the "dots," but as the prime factor of accuracy of the dividing engine. (2.) The stud and dots might have been used for cutting toothed wheels, but not for ruling diffraction gratings or interference plates. These latter would require the greatest possible accuracy, and therefore Herr Nobert would assuredly adopt the most certain method, which was to work with the division plate and the micrometer microscopes. The tangent screw caused the division plate to rotate with great accuracy, so that Herr Nobert may not have found it necessary to inspect the divisions by the micrometer microscopes for each line. He may have tabulated the error of the tangent screw and made periodic allowance for it. (3). In order to reduce the motion in arc when ruling fishplates, where the movement of the fishplate represented the size of the arc motion of the division plate, Herr Nobert would probably use the arc motion only for the production of the bands of lines, and in moving the fishplate over the blank spaces between the band would utilise the fine micrometer screw attached to the agate plate, fitted within the hollow steel cylinder carrying the test-plate, by which the bottom could be easily moved $\frac{1}{2000}$in. (the average width of the blank spaces between the bands), or even less. In this way he would reduce the total arc motion to about one-half. To minimise this differential motion, Herr Nobert doubtless used the greatest possible eccentricity of the short arm of the lever, so as to use the smallest motion in arc required for his subdivisions.

The following instruments, objects, &c., were exhibited:—Mr. Beck, "Star" microscopes; Dr. J. D. Cox, photographs of broken diatom valves; Mr. Crisp (1) Bausch and Lomb Optical Company's mirror with diaphragm; (2) simple microscope with "multiplying glass" as the illuminator; Mr. Groves, Cambridge rocking microtome; Mr. Guimaraens, six slides of pathogenic bacteria; Dr. Maddox, slides illustrating his paper; Mr. J. Mayall, jun., model of Gray's water microscope; Mr. Wethered, slides illustrating his paper.

**The Mint.**—The 15th annual report of the Deputy Master of the Mint states that the amount of gold coined during the year 1884, though exceeding by more than a million the amount coined in 1883, was not large, and the silver coinage, which in 1883 reached the abnormal figure of £1,274,000, did not greatly exceed the average. The coinage of bronze, on the other hand, was larger than in any year since 1875, and the colonial coinages executed were unusually numerous. The coins struck during the year 1884 were no less than 34 different denominations, and the total number of good pieces struck was 56,363,301, as against 39,119,714 in 1883, and their value, real or nominal, £3,157, 966 10s. 1d. The good pieces of Imperial coinage consisted of £2,336,513 in gold, £664,433 in silver, and £69,346 in bronze. With regard to the bronze coinage, of the amount issued in 1884, £44,450 consisted of pence, £14,990 of half-pence, £5,895 of farthings, as against £37,590 of pence, £9,350 of half-pence, and £2,830 of farthings in 1883.

## SCIENTIFIC NEWS.

THE death is announced, at the early age of forty-six, of the Rev. R. Bailey Walker, the secretary of the Vegetarian Society, and editor of the *Dietetic Reformer*. The deceased was an ardent supporter of the co-operative movement; but of late years has been identified with the vegetarians.

Mr. Joseph Sidebotham, F.R.A.S., and F.S.A., died on Sunday last, at Bowdon, Cheshire. The deceased gentleman was well-known in Manchester for his scientific attainments, and for the energetic part he took in connection with the Literary and Philosophical Society of that city. He was a founder of the Manchester Photographic Society, an enthusiastic entomologist, and an able astronomer. He rendered Mr. Nasmyth useful assistance when the latter was writing his work on the Moon.

Mr. Alexander Croall, curator of the Smith Institute, Stirling, and author of "Nature-printed British Seaweeds," a valuable contribution to that branch of science, died recently, aged seventy-six.

By the death of Peter William Barlow, F.R.S., the Institution of Civil Engineers loses one of its old and distinguished members. Mr. Barlow was engaged principally in railway construction, much of the South-Eastern system being his work; but he also designed Lambeth Bridge, and that unique device, the Tower Subway. Mr. Barlow had retired from practice several years; but continued to contribute papers to the Royal Society. He had attained the age of seventy-six years.

The trustees of the Lick Observatory, Mount Hamilton, California, anticipate that the great telescope will be ready for use not later than the autumn of 1887.

The Leander McCormick Observatory, attached to the University of Virginia, established at a cost of £13,000 by Mr. L. McCormick, has a telescope of 26in. clear aperture. Mr. Ormond Stone has been appointed director of the observatory, an endowment fund of £10,000 having been provided by public subscription. The observatory is intended for the use of students from any part of the United States who may desire to become astronomers, for which reason the directorship of the observatory is a distinct post from that of professor of astronomy in the university.

Prof. Chrystal will preside over Section A at the next meeting of the British Association, Prof. Armstrong over Section B, Prof. Judd over Section C, Prof. McIntosh over Section D, General Walker over Section E, Prof. Sidgwick over Section F, Mr. Baker over Section G, and Mr. F. Galton over Section H.

The International Sanitary Conference has evidently determined to support the old quarantine system, and that in spite of the fact that numerous vessels are continually arriving in England from cholera-infected ports without bringing the epidemic even when deaths have occurred during the voyage. The *Times* is justified in the remark that "If other nations could show as clean a bill of health, they would be in no such hurry to propose preposterous regulations which are really designed to cover their own sanitary *lâches*."

Attention is being called to the position occupied by Gresham College, the endowments of which are little better than wasted. The lectures delivered there are scantily attended, the most attractive being those on astronomy and music; but the place of delivery being located in the heart of the City, the time fixed (6 p.m.) is too early for those who would gladly avail themselves of the opportunity of listening to an instructive and interesting lecture. The *Times* says the proper City of London College is Gresham College; but the latter, as it is, "has been for centuries, and is doomed to be, a burlesque of collegiate life. Its lectures must be equally dead whether delivered in a dead or a living tongue. Its choice is between becoming something more or something less than it is now. If it cannot develop, it had better cease to be." Sir Thomas Gresham's trust is vested in the Corporation of London and the Mercers' Company: it is time that it was employed in the manner which was intended by its founder. According to the strict letter it is; but the present method would not have pleased Sir Thomas Gresham.

Last week, at the Royal United Service Institution, Lieut. Chisholm-Batten, R.N., delivered a lecture descriptive of the applications of electricity to naval purposes, in which, after describing the benefits of electric lighting on board ship whether in harbour or at sea, he referred to the advantages of firing guns by the current. In the case of a broadside, the explosion was more simultaneously effected than could be done by hand firing; the firing could be directed by an observer clear of the smoke of the gun deck, when the crew was lying out of the way, and it could be effected at any particular moment. Moreover, electricity admitted of ships firing guns with effect even when the ship was rolling, as the circuit could be so arranged that the guns would be automatically fired when the vessel had arrived at a given inclination. The use of electricity to propel, discharge, and fire torpedoes was also illustrated, and the lecturer mentioned its applications in resisting night attacks.

The Arctic steamer *Alert* is now on an expedition to Hudson's Straits and Bay to examine the harbours on the south and west of the Bay, and to report on the condition of the Straits, with the view of establishing a trade route between the Western Territory and Europe. It is doubtful whether the Straits are sufficiently open for more than six weeks in the year.

The turtle-decked, mastless steamer *Meteor*, which was to have crossed the Atlantic in five days or less, is, we learn, to be employed in America for towing purposes, and yet she is credited with having "made most 16 miles an hour" with 140lb. of steam pressure; but that, we understand, was with a strong tide in the river.

A paper was read recently by Mr. V. J. Bouton before the King's College Engineering Society on the "Construction of Locomotives," in the course of which the author referred to the subject of crank axles, and showed by a tabular statement the failures of axles in 1883, pointing out the superiority of steel over iron. He also referred to four-cylindered locomotives, and described the systems of compounding adopted by Mallet and Webb respectively, expressing a hope that compound locomotives would ultimately be adopted on all English railways.

Mr. E. S. Bruce is experimenting with incandescent lamps in translucent captive balloons, and by making and breaking circuit he proposes to flash Morse signals by night. He is to lecture at the Birkbeck Institute on June 10, and will describe this invention.

A "telpher" line is to be erected at the Sussex Portland Cement Works at Heighton, near Newhaven. The line will be a rod of steel ·75in. in diameter, resting on cast-iron saddles raised on the average about 12ft. above the ground. The supports will be about 22 yards apart.

The Bartholdi statue, when erected in New York Harbour, will be lighted at night by electric lamps at the base, the rays being cast upwards by means of strong reflectors. From the uplifted torch there will be thrown a vertical beam of light, intended to reach the lower cloud stratum, from which it will be reflected far out to sea. The idea of rays streaming from the diadem has been abandoned.

The experiments made by the National Fish Culture Association to acclimatise the American white fish (Coregonus albus) have met with gratifying success. A number of those hatched at South Kensington were transferred to the ponds at Delaford, where they have thriven well for the last two months.

**The New Chicago Clock.**—A new clock of great size, weighing 10 tons without the bell, which weighs over two tons more, has just been completed in the clock tower of the Board of Trade Building, Chicago. The materials employed in its construction are iron, steel, and bronze. The pendulum alone weighs 750lb. The works, which are on the plan of the great Westminster clock, are divided into a time train, a hand train, and a striking train. These trains are separate machines, resting side by side, on separate frames. Each of these trains is actuated by a separate weight, and the three weights together weigh 3,500lb. The hammer that strikes the bell was to have weighed 120lb., but a patent hammer weighing only 80lb. has been preferred. The clockwork is below the dials, which are 10 feet 10 inches in diameter, and the bell is above them, and 250 feet from the ground.

# LETTERS TO THE EDITOR.

[*We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.*]

*All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

*All Cheques and Post-office Orders to be made payable to* J. Passmore Edwards.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original."—*Montaigne's Essays.*

## THE FOCAL LENGTHS OF DIFFERENT FORMS OF TELESCOPES — EVOLUTION—PREHISTORIC MAN—JUPITER —THE LATE REV. PREBENDARY WEBB — ZETA HERCULIS — THE SEPARATION OF DOUBLE STARS— THE NEW TIME—LONGITUDE BY MOON-CULMINATING STARS.

[24307.]—I am sure that Mr. E. M. Nelson will forgive me for pointing out, in connection with the dictum of mine which he quotes in his article on p. 247, that it was given with reference to the achromatic astronomical telescope, an instrument differing wholly in principle and construction from the Galilean form, which is that employed in the ordinary binocular field-glass. In the achromatic an image is formed by the object-glass, and magnified by the microscope which we call the eyepiece. In the Galilean telescope the rays which traverse the objective are intercepted by the concave eyeglass before they have formed any image at all, and the only effect of that eyepiece is to render them more nearly parallel, or perhaps it would be more rigidly correct to say, less convergent. Hence, the only limit to the approximation of the eyeglass and object-glass in this form lies in the violence of the curves necessary to produce any sensible increase of power when they are too close together. Be it carefully noted that I am not writing this for Mr. Nelson, who is as familiar with the optical facts and theory as I am, but for many who will, I am a little afraid, rather misunderstand his reference to what I said.

"Pre-Adamite" (letter 24257, p. 258), may, with considerable advantage, study Chapter XV. of Professor St. George Mivart's classical work on "The Cat."

"Dens" (reply 54825, p. 262) should certainly obtain, and carefully read through, Joly's "Man before Metals," which forms Vol. XLIV. of the "International Scientific Series." The practice of making oneself acquainted with facts before theorising upon them can hardly be too highly commended or sedulously followed.

The part of *Ciel et Terre* for May 15th contains the first part of a very interesting paper on the physical constitution of Jupiter, by M. J. C. Houzeau, the late Belgian Astronomer Royal. After a précis of the history of Jovian discovery, M. Houzeau goes on to give an account of the salient features of the planet, and of the hypothesis which was formerly advanced to explain them. This in effect referred the belts so familiar to all observers to the presumed analogues of or parallels to our trade-winds in Jupiter, and assumed that they were gaps in the illuminated atmosphere of the planet through which its darker body became visible. M. Houzeau, of course, has no difficulty in showing the untenability of this idea, and in demonstrating that Jupiter is at present rather in a quasi-solar state than in one at all resembling that of our own earth. All interested in the physical structure of the members of our solar system should obtain and read M. Houzeau's essay. I shall myself look out curiously for the second part of it. The first instalment, on which I am commenting, is illustrated by two chromo-lithographs from drawings of the planet, made by MM. L. Niesten and E. Stuyvaert, by the aid of the 15in. equatoreal of the Royal Observatory at Brussels with a power of 360.

It was with most sincere and unaffected grief that I read the paragraph with which your "Scientific News" begins this morning. Few, indeed, are the British amateur astronomers who will not feel that in Mr. Webb they have lost a personal friend; albeit they may never, in this life, have seen his face. It would be hard to overestimate the extent and value of his labours in inspiring and developing that taste for observational astronomy which has so enormously increased in this country, during the memory of the majority of those who will read these lines. The late Admiral Smyth, by his "Celestial Cycle," did much in this direction in the days of our fathers; but where he addressed scores, Mr. Webb has appealed to hundreds, and perhaps even thousands, by his more recent and compendious work. It would be almost an impertinence to speak in his praise to those who had had the privilege of his personal friendship or acquaintance. His holy, simple, and beautiful life may not be dwelt on here. Emphatically of him may be said, however, that "he being dead yet speaketh."

I have to thank Mr. Sadler for his notice of my question in the latest of his invariably instructive letters (24270) on p. 276. I must certainly make another attempt at ζ Herculis. As I have seen it distinctly double in former years, I cannot imagine why I recently failed to do so, especially as I employed a telescope which shows the *comes* to δ Cygni—a really difficult object with such an aperture. (Since writing these lines I have easily and distinctly divided ζ Herculis in twilight.)

In reply to letter 24272, p. 276, I may say to Mr. Nelson that cæteris paribus, the diameter of a star disc does vary as the aperture; and that Mr. Knott's measurements were made by stopping down his 7·33in. Alvan Clark refractor. The focal length of an objective has nothing whatever to do with its separating power, which is strictly a function of aperture. In connection with this, by the bye, I should like to remark, with reference to the concluding paragraph of Mr. Sadler's letter, that Dallmeyer's formula for the separating power of an achromatic objective was $\frac{4\cdot33}{\text{aperture in inches}}$; though, of course, even this would not explain Dawes's astounding optical feat which he there records. What I meant by the passage quoted by Mr. Nelson was simply this: that when the images of the components of a double star were in contact as formed by the object-glass, it was no more possible to divorce them by any subsequent amount of amplification by the microscope which we call the eyepiece, than it would be to convert a figure 8 into two noughts, thus: $^{\circ}_{\circ}$, by a pocket lens, be it ever so powerful. Theoretically, star discs should increase pari passu with the power; but I am unaware whether any experiments have been instituted to test this. Sir William Herschel's micrometers were, I should think, not sufficiently delicate for such very refined measurements as these.

May I venture to point out to "Conservative" (letter 24294, p. 282) that I have never, either in these columns, or out of them, advocated the astronomical change of time until such date as the not particularly rapidly moving department in Verulam Buildings shall be in a condition to introduce it into the *Nautical Almanac*. I do not think that astronomers, pure and simple, would be materially troubled by the change, the correction for it being a constant quantity; but the muddle and confusion it would introduce in our mercantile marine are awful to contemplate. Jack's *Nautical Almanac* says that the day begins at noon, and just so long as the aforesaid Jack, with his delightful old rule-of-thumb method of computing his quantities, finds this statement definitely made, just so long will he conduct all those computations upon supposition. If the law says one thing and the *Nautical* another, calculations will be fearfully and wonderfully made with a vengeance! This, however, will not prevent the division of the civil day into 24 hours, commencing at midnight, being made obligatory.

In the absence of the context it is not easy to answer query 56702 (p. 289) categorically. When the places whose difference of longitude is to be determined by the observation of moon culminating stars are at any considerable distance apart, inasmuch as the moon's motion in right ascension is not uniform, the simple proportion embodied in the formula no longer exists, and the increase of the moon's R.A. between the two given meridians, must be obtained by interpolation. The A. of Simms's table seemingly represents the factor by which the observed hourly change must be multiplied to render the proportion practically correct.

**A Fellow of the Royal Astronomical Society.**

## A CORRECTION.

[24308.]—Would you kindly correct a statement in your report of the Special General Meeting of the R.A.S.? I said at the meeting that, owing to a *printer's error*, the wording of the resolution would have to be altered, &c. This was wrong, and I should have said, though much care had been given to the wording of the resolution, it would have to be modified in the word *Lists*.

As it would appear that I seemed to cast an imputation of carelessness upon the honorary secretaries of the society in not revising the proof of the circular, may I ask you to insert this explanation in your next issue, with the assurance that nothing was further from my thoughts?

Haigh Hall. **Crawford.**

### THE ASTRONOMICAL SOCIETY.

[24309.]—My attention has been called to an error in your report of the special general meeting of the Royal Astronomical Society on the 8th inst., which I beg to correct.

The exact wording of the alteration of By-law 12, finally handed in by Lord Crawford and agreed to by the meeting, is: "Any list addressed and posted to the scrutineers of the ballot by any Fellow not present at the meeting shall be accepted if duly verified by the signature of the absent Fellow on the envelope."

**Ed. B. Knobel, Secretary R.A.S.**

### ASTRONOMICAL.

[24310.]—As some discussion is going on *re* ζ Herculis, I may say I found it very easily visible on May 23 with 4in. stop, and am quite sure a smaller aperture would do it. Σ. 1932 being again within my range, I tried it, and found it easier than it appeared last year being about the disc of larger star clear apart. The opinion of its extreme closeness, given last year, must therefore be a mistake caused by unsteady air. $\mu^2$ Boötis I find is now clear disc of larger star apart, P.A. about 100° ±. η Coronæ the discs are just clear. ζ Boötis I could not see divided, the discs being in contact and angle 285°. Of course, with so close a star, greater steadiness of air is required than I ever got to measure P.A.'s with any exactness. γ Coronæ appears elongated, and also 25 Canum. I have totally failed to see *comes* of τ Boötis.

**Edwin Holmes.**

### ζ HERCULIS.

[24311.]—Having read the letters in the English Mechanic about the visibility of the companion of ζ Herculis, I last night, May 29th, turned my 8½in. reflector, with full aperture and power 190, on the star; I suspected the companion, but could not be sure, the power being too low to form a clear disc. I at once put on 700, and the two stars stood out well apart; I then tried 300—companion well seen; the aperture was then reduced by a 6in. stop, still well seen; next a 5in. stop was tried, and the smaller star was now visible as a brighter point on a broad diffraction ring. With a 4in. stop I could just detect it, knowing where to look for it, but I should not have seen it had I looked for it first with that aperture; but the reflector, thus stopped down, was under the disadvantage of having too large a flat (1½in. diameter) for this contracted aperture. I believe a 4in. refractor would have shown the companion last night.

Shaftesbury. **T. Perkins, M.A.**

### ORIGIN OF COMETS.

[24312.]—As this problem has yet to be solved, I may venture on starting what, as far as I know, is a novel idea, and I do so with some little confidence, since it seems to fulfil certain conditions.

Space is intensely cold, and if there is moisture in space, there would be ice in space. Why should not a comet be an iceberg, which, from being more or less transparent, would pass the sun scarce affected by his heat?

Meteors are of earthy substance. Why should not comets be of watery matter?

June 1st. **J. D. S.**

### COMETS AND METEOR RINGS.

[24313.]—My remarks, as summarised in the report of the last meeting of the Liverpool Astronomical Society (English Mechanic No. 1,052, p. 254), do not quite convey the meaning I intended. My criticism of Mr. Sutton's paper was not suggested by any desire to endorse the theory propounded by Mr. Proctor, that the various groups of elliptic comets were originated by eruptions from the larger planets of the Solar System near whose orbits their aphelia are congregated. My purpose was more to show that a comet or mass of meteoric particles revolving in a closed orbit might be expected to form a ring in process of time. The resolution of a comet into a continuous stream of meteors may, of course, be a work of many ages, and brought about by natural processes, all of which will hardly have been sufficiently considered in the inquiries hitherto directed to this question. If the individual fragments of the group were in orbits of much the same shape, the differences in perihelion distance would mean a difference of periodic time (*i. e.*, the interior particles of the orbit would constantly gain ground on the outermost particles), and thus at each revolution the relative displacements would go on lengthening the mass until the complete ellipse is formed. This accords with what I mentioned, that comets might possibly have had a derivative source in planetary eruptions, and as your able correspondent, "W. C. E.," remarks in letter (24274), p. 277, there is nothing to absolutely negative that supposition; "but whether the total mass of meteors, say, in Tempel's meteor comet, might not be so great as to render its planetary origin improbable, as Mr. Sutton supposes, it is not easy to say." I think that Swift-Tuttle's comet III., 1862, and its associated system of meteors (the August Perseïds) forms an instance even more significant than that cited by "W. C. E." This stream is vastly greater in breadth, is more evenly distributed, and extends to a far more remote distance than the Leonids of Tempel's comet. Its width must be some 35,000,000 miles, and its aphelion distance lies far beyond Neptune, while the aphelion of the Leonids is just outside Uranus. The latter, though forming a continuous stream, are thickly grouped near their derivative comet, and are very thinly represented along the greater part of the orbit. In the case of the Perseïds, we have a very rich shower annually, and this, taken in conjunction with the exceptional breadth of the system, and its distension to a very remote distance, prove it to be one of immense extent, and of such character to suggest an origin in some other cause than that of a mere planetary eruption. It is true that the aphelion distance (48·6) of this stream and its allied comet is situated much beyond the orbit of Neptune, and does not, like the comet of Tempel, and many others of shorter period, nearly coincide with the distance of a known planet; but I suppose there is no material reason for assuming this to mean a difference of origin, especially as there is a doubt as to the exact time of revolution.

The April meteor system, which, if really pursuing the same orbit as Thatcher's comet I. 1861, has a period of 415·4 years (Oppolzer), and at the aphelion distance (110·3) is at an enormous interval outside the bounds of our system, unless, indeed, the supposed trans-Neptunian planets of Prof. Forbes extend its limits to an almost inconceivable degree. The meteors from Lyra form a very narrow stream, and there is evidence of its continuity; but observations must be maintained for several centuries before the fact can be demonstrated.

As to Biela's lost comet, and the slow meteors of Nov. 27th, radiating from Andromeda, it is questionable what has become of these phenomena. Next November ought to definitely settle the point whether the meteor shower has been so disturbed by planetary perturbations as to have finally withdrawn from the region of the earth's orbit. On one of the nights during the last week of the ensuing November, there may be a splendid display of these meteors, as the conditions are very favourable; but, of course, everything depends upon whether the condensed part of the stream has preserved the same orbit since the observed *rencontre* of Nov. 27th, 1872. For myself, I do not anticipate any great revival of the shower, my opinion being, after the negative results of 1879, that the orbit has been much changed.

Mr. Proctor has ably discussed the phenomena bearing upon his hypothesis of planet-born comets; but it is difficult to comprehend the matter in its entirety, and to give proper weight to all the elements affecting the question. It is certain that before any hypothesis can be definitely accepted, there is a pressing necessity for further observations, especially of meteor showers and their varying richness from year to year. The successive returns of periodical comets also require much public investigation, especially as regards their probable decadence, and the orbital and physical changes to which they are commonly subject. Questions affecting their origin and the probability of their dispersion into meteor orbits hardly admit of satisfactory settlement, as nearly all the evidence we possess concerning them is of comparatively modern date; much of it, indeed, quite recent. **W. F. Denning.**

### SUNSPOTS.

[24314.]—I observed the extraordinary, large spot on the sun's disc on the 25th. It was a beautiful sight. Since the 23rd it had thrown a bridge across the centre, and one half had the appearance of an Indian's club, broad at the top, and tapering to a blunt point at the bottom. The penumbra was unusually striking, as there were several streaks sloping towards the nucleus. To me they appeared as though they were portions of the photosphere which were being sucked or drawn inwards, which forced the impression on my mind that it was a tremendous whirlpool. At one time I noticed a violet hue encircle the whole of the spot, but it did not last more than four seconds. I was using a ruby-coloured sun-cap, but cannot account for the violet tinge, as I have never seen such a tinge of colour on sunspots before. Was it the fault of the eye or the telescope? Those of your astronomical readers who took holiday from their observations on the 25th missed a treat. The spot was visible to the possessors of nothing but a piece of smoked glass on Saturday, the 23rd.

5, Rownsley-street, Leeds. **D. Booth.**

### THE MOON'S DISTANCE.

[24315.]—Is it possible to explain to a non-mathematical reader the way in which the distance of the moon is ascertained? If, for instance, a moon or other globe subtends a given angle, that alone would not give its size unless the distance were also known; nor vice versâ, because a body at twice the distance if twice the size would subtend the same angle. In the case supposed neither size nor distance can be predicated, and we need one of these, in addition to angular measurement, to ascertain the other. **Essex Clod.**

### THE CASSEGRAIN.

[24316.]—I am glad to see the letter of "A. S. L." (24278) upon this subject. It wants looking into in a thoroughly mathematical and practical way, and settled once for ever—i.e., as to whether a Cassegrain with a spherical convex and a suitable elliptical concave will give definition equal to a parabolical Newtonian, or near enough to it to satisfy those who prefer the Cassegrain form of reflector. To this end the suggestion of "A. S. L." is very good, it being practical, if only our mathematical friends will calculate the eccentricity of the ellipse, or give us a rule to do it. Then we could put the pinhole, as it is called in testing, in one focus, and the shutter in the other focus, and work our concave so that the shadow comes on all over alike and goes off the same; or we could use stops, and see if all the rows were the same in focus. Thus we should get the ellipse absolutely; or if the further focus would be too far off the concave to be tested in our testing chamber—in my case this is my cellar, where I have about 30ft. of testing space—then our mathematical friends could calculate for us at centre of curvature (so-called), or give us a rule to do it ourselves. The aberration of the zones of the ellipse. I divide my mirrors into six equal parts; five I calculate and test, and the centre we can ignore, as the hole would be there. Then we could test in a space double the focus for parallel rays of the ellipse. All this would be as easy as the testing of the parabola for a Newtonian. Now, I am not much in favour of the Cassegrain, though I believe it is a far more practical form than the Gregorian. Nevertheless, I should be glad to help anyone in the testing of the mirror of either form, and I hope all will feel free to make use of my services. The cost will only be the carriage, and then certainty will be obtained, and the value of the Cassegrain form with a spherical convex and *suitable* elliptical concave will be proved once for all, and it would be a real kindness to all after comers to settle this question, and I wonder that those who like this form of reflector do not set about it in this way, instead of, as "A. S. L." justly puts it, "At present a tedious process of trial and error has to be gone through till an approximately correct result is obtained, more by chance than by knowledge." It seems strange to me that those who spend a lot of money upon this experiment should waste their time in this tedious process when a certain and quick mode is at hand. I hope our friends who like the Cassegrain form will not be offended at my remarks, as they are not intended to grieve, but to urge to a saving of time and money too, and to a certain way of settling this vexed question.

I feel sorry, like "A. S. L.," that Dr. Royston Pigott's articles on the Cassegrain are not continued. I had hoped the Doctor would have given us the result practically of his experiments on his large Cassegrain, such as to the definition, &c., and as to whether he thinks it will ever equal the Newtonian. There are great advantages, I admit, in the Cassegrain, but there is one disadvantage I have noticed in all I have examined, and I am sure "A. S. L." and others, and myself as well, would like to know from the Doctor how far he has succeeded in overcoming it—viz., the getting rid of the stray light that enters the eyepiece with the light reflected from the convex. The light passing by the convex from the sky near the object under observation will enter the eyepiece at very nearly the same angle as the light from the convex, and I have always noticed the absence in the Cassegrain of that dark background that enhances the value of the Newtonian form. May we trouble the Doctor for information on these points? I am sure "A. S. L.," who from his previous letters evidently prefers the Cassegrain, and others, I have no doubt, would feel greatly obliged to the Doctor for anything he can give us on these points. **H. A. Wassell.**

Addenbrook Villa, Love-lane, Stourbridge.

### HIGH POWER OPERA-GLASSES.

[24317.]—On the day on which "Montmartre's" letter appeared I sent an order, with cash, for one of the powerful opera-glasses. The cash was retained; but a request was sent for the ticket number, which I forwarded to "Montmartre," who had given his address, begging him to do the needful. In consequence, I had one of the glasses within a week of the announcement; but any other friend's ticket number would have done as well. Indeed, at the stores at which I have had tickets, they seem pretty well satisfied with any number of about five figures. I do not remember figures well, and, when asked, I boldly give the number as well as I can remember it. It may be right, or it may be wrong; but it always seems to be satisfactory.

I like the glass very much indeed; but I have not used it inside a building, where I think it would be most useful. I lent it to a lady, confined to her room for some weeks, and it has been the greatest interest and delight to her. "I could see the flowers coming out as well as if I was in the garden" was her testimonial, and, I think, a pretty graphic one.

C. B. D.

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## POWERFUL OPERA-GLASSES.

[24318.]—I SEE by G. Dickson's letter in last week's "E. M." that he cannot obtain in England the high-power opera-glasses alluded to by "Montmartre"; and as other readers may like to test for themselves these much-talked-of glasses, an optician in London has obtained a set of the different sizes, and they are now on view at the address advertised on front page. These can be tried side by side with glasses constructed in accordance with the results of an experience extending over a period of 30 years, not in a limited way by merely looking at letters of various size at comparatively short distances, but in the field and at the seaside, at such places as Wimbledon, Sheeburyness, Altcar, &c., where the atmosphere has a curious effect on glasses disproportionately powerful.

I cannot too strongly endorse "Experience's" recommendation to "try before you buy" such (to my mind) unsatisfactory glasses, for they are anything but pleasant to use with such a limited field of view, and, with the exception of the large one, have nothing remarkable to commend them in the way of power, and the latter is behind, in power and definition, the first size new form of wide-angle binocular telescope, which is less than half the size, and therefore more convenient.

I was very glad to see that an authority like Mr. Nelson laid great stress, in his article on Terrestrial Telescopes, in the "E. M." of May 21st, on the importance of considering light and field before power, and what holds good with the hand telescope is doubly important with a binocular, which generally has to be used quickly, and is required primarily to give clearness and an extensive view of landscapes or groups on a stage.

New Wandsworth. G. R. Baker.

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## THE MICRO-OBJECTIVE.

[24319.]—SELECT a bit of the clearest plate-glass about ⅛in. thick, not less, and cut it ⅝in. square; nibble the corners away to make it round as possible, and fix it with sealing-wax on an iron chuck. Grind one side to an inch radius curve, reverse it, grind the opposite side to the same curve, and we have 1in. focus biconvex of ½in. diameter.

The iron chucks I use are made of any convenient bits of round iron, screwed to go into the lathe-nose, or occasionally I run it in a drill-chuck; but I prefer the former plan.

The chucks must be turned true and flat on the face, and be the same diameter as the lens when finished—in this case ½in.

The roughly-shaped bit of glass may be made approximately lenticular by grinding on a lap with emery, or on a grindstone, and finished in the mould by which I mean the true grinder.

For mould I generally use a piece of glass—common stuff if to make a simple lens; but if I make an achromatic pair, I hollow out a piece of flint glass and use it, thereby "killing two birds with one stone."

The piece of flint glass should be at least ⅝in. diameter, and be secured to a chuck like the crown lens, and when the two curves are true in figure they may both be perfected in the fine grinding by running the convex and concave in the lathe alternately until both are perfectly fined for polishing.

The lens in the hand is not to be kept still and concentric with that in the lathe, but be moved over its surface with a circular motion of the hand through 30° or 40° of arc in all directions.

The finest grinding can be done with washed emery only, instructions for getting which have appeared in the papers on specula-working.

To measure the curves of small lens, cut a hole in a piece of zinc with drill, rimer, centre bit, or any available tool of the required radius, cut the piece in two with shears, and snip off sufficient to leave about 120°, which use as gauge applied to the convex, of which the concave should be a counterpart.

The concave curve must be ground so as to extend to the edge of the disc of glass, so that $\frac{1}{16}$ of the polished curve may be ground away afterwards, for that much of the margin will be faulty and useless.

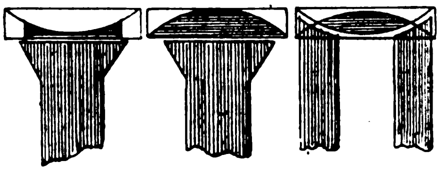
The convex will also lose about that amount in grinding, and if it be desired to get a lens which will be good to the edge, and also to have that edge as thin as possible—a knife edge—the surface first finished must be supported by a glass holder (instead of iron) ground to fit it; then the second lens surface must be ground and polished as desired (holder and all), and when finished and removed all marginal errors are in the holder; but the lens is perfect to the edge.

The best material for these holders is stout glass tubing, like steam-gauge tubes; there being no centre, they are soon ground out on the end to fit the curve of the lens.

The figures will make all clear about the removal of faulty margins; but the concave must have its plane surface made before its margin is removed. I will attend to the plane faces in my next paper.

In the figures the outline shows the glass circle; the shaded parts show what remains as a lens when the other part has been removed. I have used a deeper curve in the Figs. than would make our lens, as it shows the process better. Figs. 3 and 4 are on the iron chucks, and 5 on the glass tube.

FIG. 3. FIG. 4. FIG. 5.



Rob. Crus.

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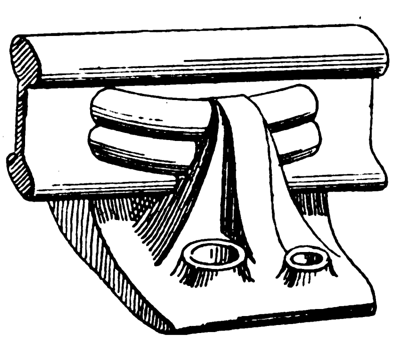
## CRANK AXLES—ELASTIC KEYS.

[24320.]—"LOCOMOTIVE," p. 235, is quite right in his idea that permanent way should be "elastic." Such a system is good and practical, and is employed experimentally, being known as "The Steen Chair and Spring Key System," and the following sketch and description will, I trust, interest "Locomotive" and your railway correspondents. The difficulty of permanently holding rails in place is a matter of such general knowledge, that the solution of the problem has occupied a host of inventors, more to the profit of the Patent Office than to their own benefit, and wood keys continue to be very generally used, despite the various drawbacks inseparable from them. The nature of the above mode of fastening will be understood at a glance from the annexed drawing. The fastening consists of the strong curved steel spring formed in the centre to suit the inner side of the horn of the chair, while the ends press against the web of the rail. If a special form of chair be used, like that shown, the contact surfaces of the spring key, and its abutment on the chair, would be so shaped as to combine convenience and cheapness of production *with secure locking*; but the spring is, of course, applicable to any ordinary chair to the shape of which the bearing of the spring can be adapted. The latter has sufficient elasticity to allow of its being driven into place, and it can be forced out when desired; but the form adopted and material used insure the rail being tightly held at each end of the key, while the middle is held tightly against the chair horn. It seems to me that this arrangement gives just that elasticity which seems to be required to save axles from the "pinching action."



Midland.

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[24321.]—I HAVE been much surprised at the statements made by various correspondents *in re* crank-axles. In the first place, it is news to me that cranks are made the wrong way of the grain, and it is also the first time I have seen the statement made that they mostly break across the web. I could fill a page of "Ours" with sketches taken from broken cranks, not one of which had so broken; and as to the twisting business all I can say is, that if a smith made a crank in the manner described (grain wrong way and twisted), his first would be his last (for me), at any rate. And I think loco. superintendents and managers are too wide awake to allow such rubbish to be palmed on to them. During an experience extending over more than 20 years, I have never seen but three cranks that had been twisted, and they were all one make, and were carefully wrapped up in tar cloth and sent back again, with a statement of their faults, and a request that the firm should not send any more cranks so made; and, indeed, they did not receive any more orders, in consequence. But that is twenty years ago. In a properly-made crank there is no grain, for it is made out of the best-use iron, and the various parts are faggoted and forged under the steam hammer until it is impossible to find which way the grain is; or, in other words, you could not find a way in which the iron would break rather than another. I have myself cut pieces from a crank and bent them into a ring cold, and yet they showed no sign of cracking; and the slabs of iron removed from the crank throws (in the slotting machine) have been subjected to severe tests to see if they were weaker one way than another. And, further, I witnessed some tests that were made of cranks that had been running, and were broken under the steam hammer, and only one out of some six or seven, broke across the webs; then as to twisting, there was not the slightest necessity for that, as each throw was built up and welded in its proper position.

And now for periodical examinations. I must say I have the greatest faith in these if done by experts, or men who know what they are looking for. The Midland Railway Company have long had these systematic inspections and with good results; and I say it to their credit, they take every precaution to prevent accidents through breakages; but I remember an instance which will show that flaws are not always to be seen. I was examining a crank and I felt a strange presentiment that it was not sound, and after spending double the time on it that I did on others, I got a powerful glass to it, but not the least sign of flaw could I find, and yet it broke the next trip but one; it broke across the web. I most certainly recommend hoops; the G.N.R. used them years ago, and the M.R. are using them of late; an engine will sometimes come home with the hoop when she would have had to be fetched home if she had not had it.

In conclusion, I should like some of our practical readers to take up this question, and if there are any crank makers among them, let them speak out, and I am sure good will be done by so doing: but the worst of it is that a great many who write are not practical, and hence a deal of chaff and but little wheat.

Original Lockstitch.

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## LATHE MATTERS.

[24322.]—IF a screw has been cut with a milling tool, and finished up with a revolving lap, made in shape to conform to the curve of the thread, the surface to the eye of an expert using a magnifier will indicate such a mode of finish. If this is a true method, there is no need to disguise or alter it by any after-operation.

In this discussion, when it has been shown collectively that there is no reliable basis of truth in the conditions, and that the practice is productive of error, the resource is to seek for inconsistencies in verbiage. In this I have not acquiesced in mandrels with soft noses, but have advocated hard ones, and would have no other. I agree with "Vulcan," that with a special arrangement hardened mandrel noses, if required, can have their screw threads ground to form. I have a frictionless arrangement for screw cutting that has now been in constant use for several years that will do this perfectly, working alternately backwards and forwards, as there is no backlash. I have long promised to publish this in the "E. M.," but as a set of drawings to scale would be required, I have not been able to spare a day to make them, but I will endeavour to redeem my promise shortly. I do not see any occasion to carry remarks on screw threads formed with revolving cutters any further. The original error is sought to be smothered and hidden by a mass of unreadable "terminology" and endless repetitions, absolutely nil in relation to any practical results.

I may inform Mr. Hines that my large 10-ton screw-cutting lathe had reverse hardened steel cones and collars. The mandrel may, as he says, have been of Yorkshire iron, casehardened, but both in the nose and cones it was file-proof. When running at a high speed during polishing work, the mandrel would sometimes jam instantly and stop without warning. I therefore drew it out to see if anything had gone wrong. The cones and collars were as hard as could be, with a superb mirror-like surface.

As to the gross of mandrels that a competent workman could make so that when screwed into a test chuck, the free ends would run quite true—surely Mr. Hines can do this. If not, of course he is entitled to one vote against its practicability. An error might arise in the final hardening; but I do not admt that with proper precaution this need occur.

The Berlin lathe-makers that I referred to are not "unknown," but are in an extensive way of business, and any young mechanician who can manage to make a start with a lathe of the first maker, complete with all its clever milling and wheel-cutting arrangements, which specially adapt them for his work, considers himself set up for making a home living. I much dislike anything in the way of indirect or gratuitous advertisement. When I stated what I knew to be a fact—that certain lathe-makers used diamond turning tools for cutting hard steel, I first met with a flat contradiction from one whose knowledge in the matter is shown to be nowhere. I was then challenged to name any maker; then accused of making paltry excuses. I am next taunted for having done so. Very liberal-minded, all this. Mr. Hines knows nothing practically of the use of diamond cutting tools, and is therefore no authority. Their application will be an increasing one. From the ever-enduring ruby file for hard steel, known to the watch-pivot turner, we have advanced to the wheel-cutter furnished with shaped ruby teeth used by the Waltham Watch Co. (first noticed in a recent leading article in this journal). The first cost of this cutter would be very great, but it would probably operate for years without the necessity of resharpening, which, from its frequency, makes the steel cutter a troublesome tool to maintain. With these remarks I leave Mr. Hines in the position that his own letters have placed him.

**F. H. Wenham.**

[24323.]—"Vulcan" is quite right in saying that, what he dignifies by calling a "diagram" on p. 237, Fig. 3, is misleading. One side consists of a considerable blot, and the other, for the most part, of a very crooked line. I dare say they are just as I drew them.

The groove should have been a very open V, inclosing about 85°, with perfectly straight sides for about two-thirds of the depth of cut, and rounded for the remaining one-third. The Figure 2, of a less angle, on p. 259, shows better, being something superior to such a very rough sketch. I have no recollection of ever calling these grooves U-shaped. On p. 237 I said "one," that is, a V-groove, "with a curved bottom," in contradistinction to a "sharp V groove" in the previous line.

I should have been suspected of magical arts had I more precisely stated on p. 237 what I meant by bending the file the reverse way. Say you take a long file of triangular section. Heat the middle of its length, leaving the ends cold; bend the hot part one complete turn round a cylindrical bar, leaving the ends parallel and one V-edge inwards; you would then get a tool which would assimilate in its action that of the teeth of a screw die, and from the very method adopted in forming it would come out ready provided with winding surfaces. A straight file applied to any but a very low pitch of thread would require twisting first. I believe that sticks of wood wrapped in glass paper are used in the manner of files in smoothing the so-called "Elizabethan twist" work.

As I had the pleasure of a visit from Dr. Edmunds on Whit-Monday, and we occupied our time in discussion and actual cutting of screws, and find that we are much more of agreement than either of us supposed, I shall follow "Vulcan's" lead and drop the matter here. I will leave one of the results of my screw-cutting at the Editor's office for anyone who wishes to look at it. "Vulcan" accurately describes the curves in his 9th paragraph, p. 281.

**J. K. P.**

## THE PRODUCTION OF SCREW-THREADS.

[24324.]—Your correspondent, Dr. Edmunds, invites me (24263) to reconsider the sketch I sent you, illustrating one of the defects of the system of cutting screws with revolving cutters, and which you were good enough to publish on p. 236. He still maintains that there is no such distortion.

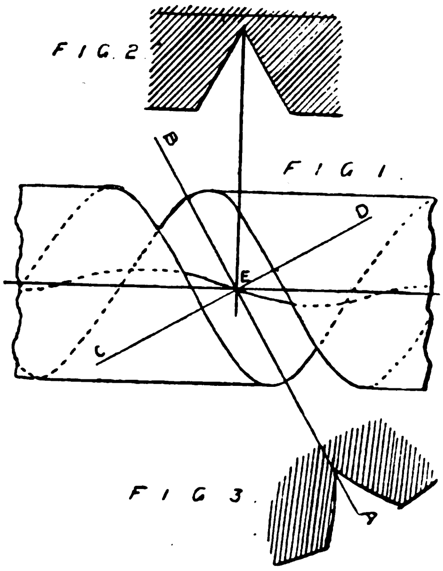
I now send another example, which will, I trust, illustrate the matter more clearly.

Fig. 1 represents a cylinder with a screw-groove cut on it, Fig. 2 being a section of the groove taken horizontally. Line A E B is then, as before, the angle at which the cutter would be set to cut such a groove. C E D is then the cutter's axis. I now confidently assert that Fig. 3 is an *exact representation* of a section of the groove taken along line C E D, so that the point E passes through the axis of the screw. In my previous sketch I slightly exaggerated the distortion for the sake of clearness, but I have not done so here.

I say again that for this reason a revolving V-cutter, or lap, the sides of the V being straight lines, used in the way Dr. Edmunds has explained, *must* produce a screw-thread with hollow sides.

Fig. 3 is obtained, not by any mere guesswork, or viewing of the matter in the mind's eye, but by the ordinary rules of practical geometry and projection, which enables one, when three views of a body are given—viz., side elevation, end elevation, and plan (drawn, of course, in parallel projection), to obtain any other possible view or section with as much accuracy as if the result of a mathematical process.

I thought of sending you, Sir, a full description of the method of obtaining Fig. 3 by projection, but found it would take up too much of your valuable space, and involve a good deal of engraving. Most of your readers, too, are probably acquainted with the principles involved, and so able to work it out themselves, which I would invite any of your readers interested in the matter to do; and I submit, Sir, that it would be only fair to all concerned, if any of your correspondents, who may think of writing to say my figure is incorrect, to satisfy themselves on the point before doing so, either by drawing as indicated above, or by means of a carefully-made model, as the mind's eye is hardly to be trusted to arrive at a correct conclusion without assistance.



The distortion shown varies in amount as the tangent of the angle of the pitch, and, therefore, would not be great in screws of large diameter and small pitch, but even then would be enough when taken in conjunction with the other error, explained by "J. K. P.," to condemn the system, except for use in cases where great accuracy is not required, and where, from some peculiarity of the work, the ordinary method is not applicable, as, for instance, cutting screws on glass.

May 25. **Canmore.**

## CUTTING SCREW-THREADS WITH A REVOLVING CUTTER.

[24325.]—If I may be allowed a few words on this much-debated subject, I should like to remark on "Hadah's" letter, p. 235, that it really explains the whole matter with a clearness and simplicity of language which some of us would do well to try to imitate. The surface of a V-thread is a "ruled surface," i.e., can be generated by a straight line; there should, therefore, not be much difficulty in settling (theoretically, at least), how a lap or cutting-wheel, which has also a "ruled surface" generated by a straight line, should be applied, so that screw-thread and cone shall touch each other only along one straight line. Imagine a cylinder having the curved line called a helix traced on its surface, and let an isosceles triangle be moved along this cylinder in such a way that its vertex moves along the helix while its base moves along the axis of the cylinder. Then the triangle describes the surface of a screw-thread, not such a one I imagine as would be of any practical use, but still a screw-thread of a certain kind, and one that could be cut by a lap or wheel having its axis parallel to the axis of the cylinder. With such a thread the section given in "Canmore's" letter, p. 236, Fig. 3, would be correct, so far, at least, as this, that the sides of the V in a section so taken would be curved, and not straight.

Now let the triangle be turned about its axis, and, instead of moving with its base along the axis of the cylinder, let it so move that the axis of the triangle is, as before, always at right angles to the axis of the cylinder—the vertex of the triangle, as before, always on the helix; the plane of the triangle always at right angles to the helix. The triangle now describes an ordinary V-thread, to cut which the lap or cutter must have its axis "at right angles to the rake of the thread," as "Hadah" puts it; in other words, the axis of the cutter must be parallel to the plane of the describing triangle.

**W. A. S.**

## ASTATIC GALVANOMETER.

[24326.]—The galvanometer described below is suitable for use with a Wheatstone's bridge. If properly made, one cell will give a deflection of 20° and upwards through 1,000 ohms. The sizes given are those of the smallest I make; but the sizes of all the parts, except the needles and coils, may be increased with advantage.

A round wooden stand, 8in. diameter, ½in. thick, has a groove turned in its upper surface to hold a glass shade, 7in. high and 4in. diameter. Three levelling screws are next made. Three pieces of brass rod, 3/16in. thick, have a screw-thread cut on them, and are forced tightly into three wooden heads. The screws work in three equidistant holes drilled and tapped near the edge of the stand, and opposite to the brass support described below. Then the bobbin: Get three pieces of wood, 2¼in. long and from ¾in. to 1in. wide. Two of the pieces are ¼in. thick, the other 3/16in. thick. Two ¼in. holes are drilled in each in the middle of the width, the centres of the holes being 1¾in. apart. In each of the thicker pieces a slot is made almost joining these holes, 1¼in. long, ¼in. wide. Two rods of wood, 1¾in. long, ¼in. diameter, are pushed through these holes and glued. The two thicker pieces are on the outside, the other in the middle. There are thus two spaces, ½in. wide, between the inner pieces and the outer piece. These spaces are filled with 20 or 22 silk-covered wire. Leave about 6in. of the end for connection. Fill one space first, then pass over, and fill the other, winding as regularly as possible. When finished, the loop joining the coils can be easily bent out of the way. Saturate the coils with thin shellac varnish. When dry, the centre piece of wood is split in two, and the pieces pulled out. There is then left a space between the coils to lower the needles into. The bobbin is then fastened centrally to the base board by two brass lugs. Two holes in the board are drilled. The ends of the wire are passed through and led underneath to the terminals.

Take a 3½in. card, graduated in degrees, and cut a slot 1½in. long, 3/16in. wide. This slot should be along the line joining the two 0° divisions on the card. It is then fastened centrally on the coils by two small brass screws. The support for the needles is made of brass rod, 3/16in. thick, 8½in. long. It has a screw cut on the bottom end, and is screwed into a hole in the base board. This hole is about ¼in. from the groove for the shade. A piece of the card outside one of the 0° divisions has to be cut away to allow the rod to pass up. About 6½in. from the bottom end the rod is bent at right angles, and when in position overhangs the slot in the card. At a point vertically above the centre of the card and coils a hole is drilled and tapped, through which a brass screw works vertically. Its use is described below.

The needles are made thus: A piece of thin brass sheet about 1in. long and ⅛in. or less wide, has cemented to it by varnish two parallel pieces of magnetised watch spring, 1¼in. long, and from ⅜in. to ⅝in. apart. The north pole of one needle must be over the south pole of the other. The brass strip is at right angles to the needles, and one end projects beyond the top needle. This end has a hole in it to which the fibre is attached. This fibre, which is drawn from a silk ribbon, is fastened to a hole in the bottom end of the screw overhead.

When using the instrument, turn the screw till the needles are at the right height, and then adjust the levelling screws till the needles swing freely in the centre of the coils. I omitted to mention that a pointer of thin brass wire is stuck on the top needle. One of these instruments may be seen at work, during the first four evenings of the week, at the address given below.

96, Crawford-street, W. **G. Bowron.**

## A NOVEL CLOCK.

[24327.]—Referring to "Garrison Gunner's" letter 24297, p. 282, the following paragraph from a paper on Horology, in "Chambers's Information for the People," published in 1857, will show that "G. G.'s" idea was anticipated at least 28 years ago: "In another, the dial formed the brim of a plate, filled with water, in which swam a tortoise, turning marvellously with the hour, and ever even pointing towards it by magnetic attraction, as everyone would now readily conceive, and this favourite idea was varied by many other simple contrivances."

Birmingham. **C. F. A. Underwood.**

## EVOLUTION.

[24328.]—A "Convert from the Theory of Evolution" makes a statement at the head of his letter which is rather too positive, and which makes his following words, "some who know so well," look rather ridiculous (and this applies still more to a subsequent statement in his letter). I can't see *why* life must have been a process of evolution in order that evolution should exist, neither does the "Convert" tell us. Why may not life be the *cause* of evolution? The following words, "habit, custom, and necessity," of his letter seem to me to presuppose life. The second question he asks might be asked in hundreds of cases of everyday events, which I think even he would admit are not special creations; but which he, nevertheless, cannot explain.

I should like the "Convert" to distinguish in his next between "evolution of life itself," "spontaneous generation," and "special creation." One of these terms has no meaning at all for me, and the other two seem to be synonymous. We do not know what life is, and until we do I don't see that we can tell whether it was originally "evolved" or "spontaneously generated" or "specially created," or has existed as long as matter itself.

The "Convert" also asks, "What need even for sexual arrangements?" This may be asked with regard to "special creation"; sexual arrangements seem to me to be more unnecessary to special creation than to evolution; for if "evolution of life from elements is certainly more simple than reproduction by complex processes," is not "special creation" simpler than either? Are not "evolution" and "reproduction" more compatible than "special creation" and "reproduction"? And in saying that "evolution of life from elements is certainly more simple than the reproduction" which does go on, the "Convert" seems as likely as anyone to answer his first question (since he "knows so well").

The "Convert" says, "The truth is, the theory of evolution is thoroughly unscientific," which is something like saying that Darwin was thoroughly unscientific. I wonder the "Convert" was *ever* influenced by "the speciousness of the theory." Neither theory is *known* to be true, therefore the one is as much "a scheme of suppositions" as the other; and if the method is a "novel" one that is nothing *against* it. As to "amputation of argument," I think this, like many other of the "Convert's" statements, applies to both sides, and "random assertions of some who should know better" have been made on both sides. Whether rudimentary organs are perfecting or the reverse, it is evolution, and, therefore, "real evidence." Lastly, the unity spoken of seems to me to extend the theory of evolution if anything, and not in any way to disprove it. I sincerely hope the above contains "some common sense," and will do a little towards reconverting the "Convert," and shall look forward to seeing another letter from him soon. **Crumby.**

## EVOLUTION.

[24329.]—"F. W. H." in letter (24282, p. 279) begs the entire question, when he asks "how can any man know that a 'quality' is not previously existent, even in a latent state"?

I go back to what is called the first simple organic form, and I say that that form contained in a latent state all the multiplex characteristics, structural, as well as mental, which have since then been in existence; or else, it did not.

On the assumption that it did, evolution is a possible explanation of nature as we find it; but then, the march has been retrograde, not progressive. From an apparently simple physical form, yet nevertheless, an inconceivably complex one, we have, during the life-history of this planet, been marching towards forms structurally more complex, none of which, however, contain in so concentrated a degree the essential characteristics, physical and mental, which the original form possessed.

I repeat, that it is inconceivable that this first, so called simple organic form, could have held latent within it, all the characteristics, physical as well as mental, which have existed or are now in existence between simple protoplasm and adult man.

"F. W. H." invites me to the consideration of embryology—a study which I have not altogether neglected, where, "we have an infinitely small speck of protoplasmic matter, evolving within the short space of 20 years, a perfect adult man."

I confess it is sufficiently embarrasing to conceive how such a small speck (*not infinitely small*) of protoplasmic matter can contain latent, the diversified characteristics of one adult man; but how such a small speck of protoplasmic matter can contain latent the diversified characteristics, physical as well as mental, of all men, *and of every organic form which exists or has appeared*, is, to me, unthinkable.

On the other hand, this first organic form or protoplasm *may not have contained latent* all these varied characteristics.

It may have contained some, or a few, which, for convenience, we may designate—those of its own species.

Now, what I was anxious to point out in my letter (24256, page 257) is, that "evolution" claims as a necessity (the agency of which, or the explanation of which, it cannot elucidate further than to say that it is something outside of natural selection) that new and previously non-existing characteristics do, from time to time appear; and these, I hold, can only be referred to "creation." If "F. W. H.," or any other, can give me a scientific explanation of how these new and previously non-existent forms do appear, I will be only too glad to accept it.

I need scarcely point out that in these discussions, and, as a matter of convenience, it is customary to use figurative language. When we say "creation" does so-and-so, we obviously personify it, and refer to a creative power; and when we say "evolution" does so-and-so, we personify it, and refer to the protoplasmic matter itself, with its latent qualities, or else—let others correct me—to the struggle for existence. For the sake of sense, this fact should not be lost sight of.

Further, it is, in my opinion, desirable that in discussing such subjects, preconceived theory or belief should be, as much as possible, laid aside, if reason is to have fair play.

If "F. W. H." had been so guided, he would not have imputed to me, in the closing paragraphs of his letter, sentiments which I have not either implied or expressed.

I do not hesitate to say that, with the evidence before me, I believe that "creation is constantly at work, producing fresh 'special' previously non-existing qualities," not in man only, but in all organic forms, and I challenge "F. W. H." to show how otherwise these "special, previously non-existent qualities" which "evolution" requires but cannot explain, can have been brought into existence. He ought to have observed that my remarks were directed solely to organisms, when I spoke of the appearance of new and previously non-existent characters, and that I did not even suggest the appearance of totally new matter which previously had no existence, or "something out of nothing."

The artlessness of "Crumby" is truly refreshing, and the example he affords of working up to a preconceived theory is typical of many, on either side of the question, when he says, "I think if 'P.' studies the chain of existing and fossil creatures known, he will find that there are no very great gaps; some gaps may be greater than others, but I don't think that is any reason for rejecting the theory for them, even if they are inexplicable from an anatomical point of view."

Let "Crumby" and those whom he represents go to the root of the matter, and explain to "Ours" how new and previously non-existent organic forms or varieties can have come into existence without "creation."

I ask this the more readily because "Crumby" disagrees with me in my statement, that previous discussions on this subject seem to have brought the disputants back to where they respectively started from. **H. B. F.**

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[24330.]—"PRE-ADAMITE" seems to be in a fog, as the rest of the world was when he came into ? "being," or when the final step (? is it "final") in his evolution was taken. He must give it up as a hopeless conundrum. If he gets away from his wicket too soon, he is stumped. If he remains humbly waiting for the next ball, he is bowled out. Evolution seems to have required "from eternity" to arrive thus far, and to need "to eternity" to complete itself. Will it evolve itself from nothingness to nothingness, and then, winding itself up, begin again? It is too deep for **Pre-Adamite.**

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[24331.]—HAECKEL says ("Pedigree of Man," p. 33): "The first of these two inquiries, that as to the first appearance of living beings, can only be decided empirically by proof of the so-called archebiosis, or equivocal generation, or the spontaneous production of organisms of the simplest conceivable kind. Such are the Monera, Protogenes, Protamœba, Protomyxa, Vampyrella, exceedingly simple microscopic masses of protoplasm without structure or organisation, which take in nutriment, and reproduce themselves by division. Such a Moneron, discovered by Huxley, the Bathybius Haeckelii, appears as a continuous thick protoplasmic covering at the bottom of the ocean, in depths from 3,000 to 30,000ft.

It is true that the first appearance of such Monera has not, up to the present moment, been actually observed; but there is nothing intrinsically improbable in such an evolution, &c.

Further on (p. 34) Haeckel puts the case in a nutshell—viz., it is substitution: "In the place of an arbitrary act of creation, we have a necessary law of evolution." **F. W. H.**

## EVOLUTION—TIME TABLES.

[24332.]—"F. W. H." (letter 24282) is right in holding the idea that something can be made out of nothing to be mere nonsense; but he should remember that the Christian definition of creation is that "things which are seen were not made of things which do appear" (Hebrews xi. 3), which implies that they were made out of things that previously were invisible; and surely in these days of the liquefication of gases such a statement cannot be regarded as "unscientific." Whence those invisible things came is another question, and has nothing to do with Darwinism.

Printing p.m. hours in thicker figures than the a.m., or *vice versâ*, would be a far better plan than going on to 13, &c. The hour meant would be seen at a glance by the most hurried traveller. **K.**

## THE NEW TIME.

[24333.]—WILL you allow me space for a short comparison of the merits of the present and proposed methods of marking the time? I have put down, as far as I can see them, the reasons for and against the new time, and leave it to your readers to draw their own conclusions.

In favour of the new system. 1st. That the new time is more scientific and accurate than that at present in use. 2nd. That it would form a basis for a universal time. 3rd. That railway time tables would be more simple and less likely to be misunderstood if the 24-hour notation were used. 4th. That a few people—perhaps one in ten thousand—are in favour of the change.

For the retention of the present method of marking time. 1st. That the present system is more convenient for the reasons below.

In naming any hour, the use of one syllable instead of two or three which would be required under the new system, is an advantage, still more so in writing. That there is no form of clock so simple and easy to read as the 12-hour one; watches and clocks showing 24 hours either have the hours crowded, or require extra mechanism to show the hour, and in either case the figures are less plain and cannot be seen at the same distance as an ordinary dial.

That none of the advocates of the new system agree as to the best plan of striking the hour; the plan advised by "F.R.A.S." would lead to much expense with no adequate advantage. To alter the church dials all over the country would be a great and unnecessary expense, and if done only in part would be a great cause of confusion and discomfort. The same may be said of the clocks in everyone's house.

2. That even if a universal time is desirable, of which I have some doubt, the present system being in almost universal use, is at least as well suited to the change as the 24-hour system.

3. That with ordinary care there is no difficulty in finding the times of trains starting by the ordinary railway time-tables. When mistakes do occur they are mostly caused by careless printing of the tables; under the new system a greatly increased number of figures would be required, and mistakes would be more likely to occur.

4. That no one felt the least difficulty with regard to the 12-hour system until the new time was proposed, and that the bulk of the people are not at all inclined for the proposed change. **Lavant.**

## THE USE OF COMMUNICATION CORDS ON RAILWAYS. — TO "CARLISLE PASSENGER."

[24334.] — CONSIDERABLE doubt has always existed as to what constitutes a "reasonable and sufficient cause" for a passenger using the communication cord on trains. Several passengers have at various times been fined, and consequently instances do occasionally occur in which trains are not stopped when they should be. My own opinion certainly is that your correspondent would have had "reasonable cause" to stop the train. Having been requested by several passengers to communicate with the company upon the subject, I wrote to the general manager, and now inclose his satisfactory reply.

**Clement E. Stretton.**

Saxe Coburg-street, Leicester, 26th May.

COPY.

"Midland Railway, General Manager's
Office, Derby, May 25th, 1885.

"Dear sir,—In reply to your letter of the 22nd, I think, under the circumstances, a passenger would have been justified in using the cord communication.—I am, yours faithfully,

JOHN NOBLE.

"Clement E. Stretton, Esq., Leicester."

## JERKS IN RAILWAY TRAINS.

[24335.]—IN reply to your correspondent, "One of the Passengers," I may say that the jerk is caused in the first instance by the running of the unbraked fish vans at the end of the train into the front portion, which is retarded owing to the action of the brakes. When the train has stopped, the compressed buffer springs react, and the fish vans are forced backwards, thus causing a sudden wrench on the couplings. There are still many of the Midland trains running with the "leak-off" form of the vacuum brake. This makes the effect of the above-mentioned jerk more serious, for as soon as the brake leaks off there is nothing to hold the train, and it is suddenly jerked backwards, sometimes for a distance of two or three yards.

It is, unfortunately, too common an occurrence for railway companies to run vans, horse-boxes, &c., unfitted with a brake at the end of a train which is fitted. I have known numbers of couplings to have been broken from this cause. It is also a very common practice to fit such vehicles as the above with connecting pipes only, the brake itself not being applied to the wheels. These vehicles are then run in all portions of passenger trains next to the engine, in the centre of the train, or at the back end. The effect of this dangerous practice is easily seen. In my opinion, *all* vehicles intended to form part of a passenger train should be fitted with a reliable continuous brake, and this brake should be applied *to the wheels* of all such vehicles, whatever their description.

The carriage-trucks, horse-boxes, fish-vans, &c., on the North-Eastern Railway, are nearly all, if not all, so fitted, and great praise is due to the company for this reason. Unfortunately, this railway is one of the exceptions.

Your correspondent has evidently read the discussion on "Jerks in Trains," which took place in your columns some years ago. I may mention that the jerk there mentioned is not of the same character as the above, and by no means so severe in its effects. In order to shelter themselves from blame, some companies give out that the passenger leaves the train "when in motion." Certainly the train is "in motion"; but this motion is entirely due to their own negligence, and occurs at a time when the passenger has a right to leave the train. The sooner some companies understand that they cannot trifle with the safety of their passengers the better. Heavy damages in a case such as the one mentioned would go a long way towards producing some effect. The Midland Railway Company are among the greatest offenders in respect to cases like the above. **Meteor.**

## MUSICAL SCALE.

[24336.]—DURING my experience I have frequently sung the chromatic passage referred to by Mr. Hardie in his last letter on the musical scale (24265) for the purpose of comparing the three semitones contained in it, and am satisfied that the middle semitone is less than the other two, which are equal.

Each of the intervals (G—F) and (F—E) is a major semitone, and is expressed by $\frac{15}{16}$. The sum of these intervals is $\frac{125}{256}$. If this compound interval be taken from $\left(\frac{5}{6}\right)$, the minor third between E and G, the remainder or middle interval will be $\frac{128}{156}$ which is less than $\frac{15}{16}$ by $\frac{2025}{2048}$. **W. U.**

## LEGAL REPLIES.

[24337.]—EXECUTORS — SECURITIES (56345). — These securities should certainly be placed in a bank, I should say. There is no regular rule in such matters, which are generally arranged amicably. There could be no legal effect given to the wishes of the majority.

REFERENCES—POSSESSION OF DOCUMENTS (56355). —These references were apparently written as private letters to the querist's late employer, in answer to applications from him. They are, therefore, the private property of the employer as much as any other letter addressed to him would be, and so cannot be claimed by the servant on leaving. I should hardly think copies would be of any use, and the only way is for the new employer to write to the references over again.

MORTGAGES—SALE—TITLE (56381).—I cannot see what the sons mentioned have to do with this property, as far as the facts are stated. Mother and daughter seem to have joined in the mortgage, and I do not think the mortgagee would have advanced his money without seeing that they had a good title. Even if there ever was any claim in the sons, as the sale seems to have been over 12 years ago, it is barred by the Statute of Limitations.

EMPLOYERS' LIABILITY ACT (56457).—In the case put by this querist, I do not think that either the employer or the millowner would be liable. Employers are only liable in the special cases set out in the Act of 1880, none of which would cover this question, as the foreman ordering the dangerous work to be done was not in the master's employment. If workmen will put themselves in positions of danger, they must take the consequences. The rule of law, as to the risks of the service, is not altered by the statute. As I understand this case, the workman set to work upon machinery in motion, well knowing the danger. He should have refused. If, however, the machinery had been stopped, and then set going while the man was at work, he could have recovered damages from the millowner. It is quite a mistake to imagine that every case of injury gives a right of action against somebody. The legal maxim is certainly that for "every wrong there is a remedy." But that means a wrong in the legal sense—that is, an actionable wrong, and it can generally only be supported by proof of negligence.

NOTICE TO QUIT—EJECTMENT (56467).—The rent of the shop is not stated; but I presume it is under £50 a year. If so, the querist's best and quickest course is to bring an action of ejectment against his tenant in the county court in the district of which the premises are situated, and upon proof of the tenancy and the notice to quit, he should receive judgment to obtain possession.

PROMISSORY NOTE—SOCIETY—FRAUD (56471).—This querist does not appear to have read the note itself before signing it. If it is drawn for £4 10s., he has made himself liable for the whole of it, unless he can show that his signature was fraudulently obtained, and that he really only meant and was intended to be surety to the extent of £2. To prove fraud he can give evidence himself, and call the borrower as a witness to support his contention; but I am quite unable to say what decision the judge will come to after hearing both sides.

COMPANY—DEBT—WINDING UP (56522).—If the querist has a valid claim against the company, all he can do is to send it in to the liquidator in the winding up. His being paid will depend upon the assets of the company, and he may only get a composition.

JUSTICE'S MANUAL (56529).—The best, simplest, and most readable book of this kind is undoubtedly "The Justice's Note-Book," by Mr. Knox Wigram, a lawyer and justice of the peace. The fourth edition is now published by Stevens and Sons, Chancery-lane, at 12s. 6d., cloth. I have used it myself, and never found it to fail me when looking up a point of magistrates' law. It is as wittily written as it is complete and accurate. The other works are "Oke's Magisterial Synopsis," a large expensive book in two volumes; and "Greenwood and Martin's Police Guide," also costly. The "Justice's Note-Book" is really a concise and alphabetically-arranged epitome of the criminal law that anyone could read and understand.

RATES AND TAXES—ASSESSMENT (56532).—The Queen's taxes will follow the assessment for the poor-rates, and, therefore, as the querist has got his rates reduced from £40 to £32, his taxes should come down from £50 to £40. Upon a proper representation to the collector or surveyor for the Queen's taxes, I think this view will be adopted.

LEGAL NAME (56545).—I see this query has already been answered by two correspondents, who differ. I do not agree with the Vicar, who is evidently writing what is ecclesiastical law. As far as there is such a thing as a "legal name" at all, I should say it was the name under which the child was registered, which in civil law quite supersedes the baptismal name. But a man may take any name he likes, only he runs some risk of confusion if property should be in question. For the rest I agree with "B. Sc., Plymouth."

**Fred. Wetherfield**, Solicitor.
2, Gresham-buildings, Guildhall, E.C.

## HOW SHOULD THE STARS BE MAPPED?

[24338.]—OF how flat a curvature can glass spherical segments be blown? The question arises now that the stars are to map themselves, because plane fields, wider than a few degrees, cannot take images distinct at both their centre and margin; so that the number of them to map the whole heavens will be many. Whether plane or not, they should all be equal circles; and whatever their number, 12 each should overlap five neighbours, and the remainder each overlap six. A whole set must be a number of one of these two forms; either $10 a^2 + 2$, or $30 a^2 + 2$: the former when each pentagon presents a side towards each of its nearest fellows, and the latter when it turns a corner towards each. (The centres of two neighbour pentagons are always distant by the arc whose tangent is two.) Thus the 16 simplest sets are—

| | | | |
|---|---|---|---|
| 12 | 122 | 362 | 752 |
| 32 | 162 | 482 | 812 |
| 42 | 252 | 492 | 1,002 |
| 92 | 272 | 642 | 1,082 |

But if the 32 were made with their 20 hexagons regular, the side common to these and the pentagon is 23° 16′, making the circumscribing radii for the two very unequal, 20° 5′ and 23° 49′. These should be equalised, each 22° 41′, by making the hexagon's sides alternately differ. In other cases the hexagons, or some of them, will not be quite inscribable in a circle; but more nearly so the more numerous they are. In the next case the 30 are all alike, but require one diagonal twice 20° 53′, while the halves of the other two can be equalised to the pentagon's circumscribing radius, about 20°. The next set, 92, can all be circumscribed very nearly by a radius of 13°, but even this is too wide for plane maps.

Probably the 362, admitting a common circumscribing radius of 6° 31′, will be the fewest planes to take the whole sky. Will not glass rather be taken then on the mouth of a wide funnel, into which a measured quantity of air can be sent and not allowed to contract?

The age of planetule hunting of course will end, as all those bodies, known and unknown, will declare themselves in lines instead of points.

Photographs taken on a concave surface could, by the same lens, or one of equal focus, be copied on a plane, either of nearly the identical scale or larger; but I never heard of this being done: nor have I seen any picture of great angular width and the distinctness this would give.

2nd June. **E. L. G.**

# REPLIES TO QUERIES.

⁂ *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[54698.]—"**Round**" or "**Around.**"—For the information of "Os," I will give the following quotations from the best of English authors to show that "around" is not an Americanism, nor a survival in America of an obsolete English term, but that it is English "pure and undefiled." As "Os" objects to poetic quotations, I have taken them from articles on astronomy. To be brief, I have taken but one quotation from each auther, whilst I could give a great many more. I have no work on astronomy that has not *around* in it. Newton's "Principia," by Motte, Book III., proposition xiii., thorem xiii.: "They less disturb the motions of the planets *around* the sun." Written 1729. Nicholson's "Encyclopedia of Arts and Sciences": "The circle *around* where the earth and heavens seem to meet" (1805). "Edinburgh Encyclopedia," by Brewster: "There is no nebulous appearance *around* the planet Juno" (1812). "Outlines of Astronomy," by Herschel, 10th ed. page 42: "He will then perceive above and *around* him a vast concave hemispherical vault." "Christian Philosophy," by Dick, page 83: "She is the constant attendant of the earth, and revolves *around* it in 27 days." "The Moon," by Nasmyth and Carpenter," page 53: "The moon, while revolving round the earth, is, with the earth, revolving *around* the sun." "The Moon," by Proctor, page 17: "The equatorial telescope turning *around* its polar axis." "Arnott's Physics," Art. 1,027: "An unobscured view of the horizon *around.*" "Climate and Time," by Croll, page 1: "Agencies at work *around* us." This needs no comment; but I will say to "Os," "F.R.A.S.," and others, read English works on astronomy, and mind what you read, and you will not need an American to enlighten you further with regard to the English word *around*, nor will you any more make America a scapegoat for your ignorance concerning it. "Abed" was used by the poet Spenser over 200 years ago, so it is no exotic in your soil; and if it has become fossilised, you can dig it up: you need not import it. Would "F.R.A.S." wish to ignore the 100,000 or more words introduced into English since the days of Shakespeare, and fall back upon the 8,000 words used by him? I think not.—JAMES BIRD, Atlanta, Louisiana, U.S.A., May 11th.

[54825.]—**Salt, &c.**—"F. W. H." fails to understand why I should begin with a civilised man. The reason is this: it is a law of Nature uniform in its operation, and admits of no exception, that you cannot get out of anything what is not in it; consequently, if these so-called primitive men were our ancestors, they must have had in them all the powers and capabilities of the human race. Then if the lower (or so-called lower) contained all that is in the higher, in what sense or how could they be lower? If the fitness of things, the history of the past, as well as the every-day experience of the present time are also taken into account, then beginning with man in the full possession of his powers is a necessity of the case. Besides, this trying to begin with low-type man and so on up to higher is only a quasi-arrangement to suit a theory, and this theory of the self-advancement of a species, whether of men or animals, is in flat contradiction to the law and facts of Nature, as well as the experience of every-day life, and stands in the position of being a conclusion in search of its premise. "F. W. H." also, in letter 24282, seems to have allowed his great love of evolution to mix his "embryology." A human embryo is not "an infinitely small speck of protoplasmic matter," and it does not "evolve." It is a human being, having in it all and everything that it will ever possess, and it grows in strict harmony with the law of its being; and the same with the acorn, which contains the future tree. As to the difficulty of a special creation, the difficulty is not in the doctrine, but with those who will not have it, although many of them are prepared to believe and accept the doctrine that man with all his powers was evolved from a "squid" (see Darwin's "Descent of Man").—DENS.

[This must end the long series of rejoinders. "Salt is good," &c.—our correspondents will remember the rest of the text!—ED.]

[55819.]—**Micro. Adjustment.** — Thanks to "Menesicus" and "Glatton" for their replies; but am sorry to say they are not applicable to my stand —a Jackson-Lister. The one I want is with the lever in the form of a ring bearing on both sides of objective tube, and worked by milled head on side of body.—SEMPERVIVO.

[55826.]—**Gas Oil.**—To "INVICTA."—In reply to above inquiry you promised to forward pamphlet if I advertised my address, which was accordingly done in issue of March 6th last. As yet no pamphlet has arrived. Please explain and oblige.—JAY JAY SEE.

[56204.]—**Calorimetry (U.Q.)**—A summary of the researches of Favre and Silberman on the heat of combustion could not be given in the space of a reply: it would need an article. If there is any special point upon which "Equivolt" desires information, I shall be glad to help him—if able.—WM. JOHN GREY, Analytical Chemist, Newcastle-on-Tyne.

[56411.]—**Power of Electro-motor.**—What does this querist mean? How is it possible to tell what power the motor will exert with such data as he gives?—S. T.

[56412.]—**Fire for Brazing.**—Any fair-sized blacksmith's fire will do.—ANVIL.

[56419.]—**Veterinary.**—There seems some mistake in this query: quinquinia is not quinine; but the quinine should be dissolved in the iron solution before adding the strychnine tincture.—M. P. S.

[56420.]—**Waste Oil.**—Filter through felt, then through animal charcoal, and you will soon discover whether the oil is of use or not. It would be scarcely worth while to steam it, and add acid, as in the usual bleaching process.—ESSAR.

[56423.]—**Electro-Brassing.**—This querist should look up his back numbers for methods of electro-brassing, notably No. 825, on p. 441 of which he will find an article describing the process. Details of various processes in Gore's "Electro-Metallurgy"; and a special article in Vol. XXXVI. ENGLISH MECHANIC, p. 290.—CYRAX.

[56424.]—**Softening Sheepskin Rug.**—Lay a damp cloth on the skin side until quite soft, and then work the skin well and frequently by crumpling it, as it were, between the hands, or stretching it over the back of a chair. Repeat until dry, and you will probably find it soft. To wet leather, and leave it to dry, is to find it hard.—NUN. DOR.

[56426.]—**Old Locomotives.**—Apparently the list refers to the first engines on the Liverpool and Manchester line—at any rate, the first eight names are well known as the engines that took part in the formal opening.—MOTION-BAR.

[56430.]—**Leaky Air Cushions.**—Paint over the leaks with solution of rubber in bisulphide of carbon, and, if necessary, stick on a patch of linen or calico with the same solution, and coat the outside well.—NUN. DOR.

[56431.]—**Pickle for German Silver.**—"Max Tour" should wash the pieces thoroughly after pickling, and dry off in hot sawdust. Keep in dry bran or chalk.—BRUM.

[56432.]—**New Midland Engines.**—Have these engines been taken off the Scotch expresses? I fancy I saw one of them running through Kentish-town the other day with an express train.—ARGUS.

[56435.]—**Cutting Clock Wheels.**—Simply a milling tool; but an index plate is required.—GARNAULT.

[56436.]—**Chemical.**—It is not quite clear what it is this querist wishes to learn. Glauber's salt is "sodium hydrogen sulphate."—M. C.

[56437.]—**Chemical.**—"X. Y. Z." can be referred to the *Transactions* of the Institute of Chemistry and Payen's "Industrial Chemistry."—VIDEO.

[56438.]—**Fastening Fish-forks in Handles.**—Use a powder of rosin and brick dust, half and half.—ESSAR.

[56449.]—**Filling Sand Holes in Brass Rollers.**—The best way is run them in with brass solder or spelter; but they may be filled with ordinary hard solder.—RETOUCHER.

[56452.]—**Tennis Lawn.**—The lawn on a clayey soil will take a long time. Proper turfs should have been laid on drained ground.—T. H. L.

[56453.]—**Paper for Copying Process.**—Tissue is too thin and delicate. Use one of the strong thin papers commonly called foreign post, and coat with wax, paraffin, or Canada balsam.—N. E. CHILD.

[56455.]—**Hancock's Inspirator.**—This is a sort of double injector, in which the water is drawn into one chamber by a small jet of steam, and is forced into the boiler by an ordinary injector jet. I believe it has been illustrated in back volumes; but have no time at present to look.—NUN. DOR.

[56547.]—**Geometrical.**—It may be interesting to "M.I.C.E." and others to consider the general theorem of which this is a particular case. If *a . b . c . d* be the four lines forming four triangles, *a b c, a d c, a b d, d b c*, we get—(1) By projection. Projecting all the circles into conics passing through two fixed points, the theorem, If four conics be drawn circumscribing the four triangles formed by four straight lines, and also passing through two fixed points, they will also all pass through a third fixed point. (2) By reciprocation, the four lines become four points, *a . b . c . d.* forming four triangles, *a b c, a b d, a d c, b d c*. The circles become conics touching the sides of the triangles and two fixed lines. Hence we get: If four conics be described, each touching the three sides of one of the triangles, and also touching two fixed straight lines, they will all touch a third fixed straight line. In each case the conics are all determinate, for there are fixed conditions to be satisfied by each conic.—T. H. L.

[56550.]—**Sawing.**—In the first place, your saw is just 1in. too narrow at the bottom according to the top, through bad sharping, and perhaps filed hollow as well, so that would make it too light altogether. It is only a useful saw for ripping or cutting small logs. I should advise you to get two new saws, and order them yourself, from Messrs. Atkin and Son, Birmingham, as I think they make about the best pit saws that can be got, and you will get the two for about £1 15s. or £2. The reason I recommend two is that you will not be able to cut different sorts of stuff with one saw, not being used to the job, as it will require a great deal of altering in the sharping to cut hard and soft woods. The saws I should recommend are the same as I get myself—that is, 6ft. 6in. long, ⅝in. space, 12in. heel, 14 gauge on face, and 15 gauge on back. As to sharping, there is no proper degrees (or angles) for holding the file, because you might sharpen for a soft nature of timber, and when you come to cut it, it would, perhaps, be harder than you expected, and then it would want altering for harder, or otherwise it may be the opposite way. The greatest art after you have a good idea of sharping, is to know the nature of timber, and that you will learn as you go on; so if you sharpen to cut an ash tree and it is a hard one, that sharping will not do to cut the elm with, as ash is very hard when it is dry; but if it is a very soft ash, it might cut a very hard elm with a little attention; but when you sharpen to cut your ash (keep the face of your saw as straight as a straightedge by running the flat side of your file lightly down the face of your saw, so that one tooth will not be higher than another, and mind that the file is properly level, so that one side will not be higher than the other), top your saw after ranging it down with not too much bevel till you have just cleared the file mark off; then gullet your saw, and mind that there is enough hook put on, or else it will be sure to hollow, and so, if there is too much. You must know the nature of your stuff, and always file enough hook on, so that if there is too much on, it can easily be hooked back a little with the file; and when you start working, if there is too much on, notice what part of the saw picks most, and knock it back a little till it goes down sweet, and if it goes down too easy, there is not enough on. In elm put a little more bevel and more hook, and set so that the saw just clears itself, and if it is inclined to hollow, put a little more hook on the side that is weakest, or a little more set on that side; and so on till you get on better. Always alter in time, as it will go further. There are different kinds of turning or felley saws, and different sizes. If you do not like advertising your address, post a private one to some post-office, and I will give you more advice.—I. M.

[56551.]—**Wheelwrighting.**—"Alabama" does not say what kind of wheels he wants to get old spokes out of naves, or if he wants to use either again. If he does not want to use naves again drive the hoops off, then split the nave and spokes will fall out. If he does not want to use the spokes again, lay the wheel face downwards, cut a notch in back of spoke 4in. or 5in. from tongue, lay a block under spoke, then a few sharp blows with adze will draw spoke out, if he wants to use spokes again lay wheel in position as directed above and use ring and wedge instead of cutting notch in spoke; use adze instead of sledge.—H. J. HUMPHREY.

[56569.]—**Boiler Query.**—I do not think it would be wise to increase the pressure of your boiler to 75lb., being all single-riveted, as applying gussets to ends would not add strength to the shell, which can only be taken as given by me—viz., 257lb. bursting pressure. Under the Board of Trade 257 must be divided by 8 to get working pressure, which would only give 32lb. Lloyds would give 43, which is ⅙, but the insurance companies would divide by 4, or even less in competition, but would not give more than 70lb. working pressure, the weakness being in the single riveting, which cannot be strengthened. The strength of the furnace may be taken as follows: Thickness multiplied by thickness multiplied by 806,300 and divided by length, multiplied by diameter = collapsing pressure, or $\frac{806,300 \times T^{2.19}}{L D}$ = 285lb., which, divided by 4, gives 71lb. safe working pressure, the length of tube being taken from first cone tube to front end, that being the longest portion unsupported. All boilers for 70lb. and over should have a gusset at back end below and two at front. Longitudinal rods are not absolutely necessary when well stayed with gussets for under 75lb.—BOSWELL.

[56573.]—**Chronic Rheumatism.**—To "B Sc., Plymouth."—In reply to "A Many Years' Subscriber" (1), it should be a coil worked by a battery, (2) Leclanché cells. (3) Niemeyer strongly recommended the continuous current in cases like yours; but the induced current discovered by Faraday and applied by Duchenne has, to my thinking, met with greater success. (4) There is nothing to hinder your electrisation in bed, although I think you will not feel any cold sensation in the exposed skin when the elastic brush is passed over it. (5) Application: Sponge the part affected with sea water, or a solution of Tidman's sea salt, and keep all the part moist during the application of the current. The pads or sponges (having handles attached and connected with wires to the P. and N. poles of the battery) must also be kept moist when in use, in order to lessen the resistance. Begin with applying both pads to the part of the skin complained of, keeping the one stationary and moving the other gently over the surface, say, for five minutes, then substitute the wire brush for one of the pads, and pass it also gently over the surface for five minutes. This will be enough per day to begin with. Increase gradually up to a 30-minute séance. Further, I would recommend Hirschman's (of Berlin) apparatus as the most suitable. The only bother is that one may have to wait (as I did) six weeks from the time of order through a surgical instrument maker until receipt. The price is from £3.—B.Sc., Plymouth.

[56578.]—**Electric Bells.**—Although it may be possible to have telephones working well when joined up in parallel circuit, and using "earth return" (similar to Fig. 2 on page 286), it is hardly possible to get the same result from a number of electric bells separated from each other by some miles of wire when joined up in the same way. The reason of this is:—A good telephone will generally respond to a current of $\frac{1}{10,000}$ of an ampère, whereas a carefully-made bell relay would require quite four hundred times that amount, or about 40 milli-ampères. Now, when a circuit is joined up similar to the sketch just mentioned, and with the stations some miles apart, the greater part of a current sent from No. 1 station passes to earth at station No. 2. Similarly, the lion's share of the remainder takes the same course at station No. 3, and so on, so that when the last station is reached, the received current is small indeed. This would probably be ample for telephonic purposes; but I should say useless for call bells or bell relays, unless they are very delicately made. I trust I have made it clear to "Electra" that it is almost impossible to get a bell circuit to work satisfactorily under the conditions he names. I am still of opinion that the "closed circuit system" is admirably adapted for such a bell circuit, but joined in series, of course, as only one battery of, say, 10 Fuller cells would be needed for the whole circuit. This is, of course, supposing that the wire is not already connected up to telephones, as I fancy his last few lines on p. 286 seem to imply. If such is the case, and "E." wants to add call bells, it is another consideration altogether, depending to a great extent on the pattern, &c., of most telephones.—H. S. BEACH.

[56580.]—**Tricycle Pedals.**—To "U. C. S.W."—Are you not "sorry you spoke," and thus spoiled the outflow of more experts on the question? This week we have yet another friend, "Lithium," falling into the same error; whilst had you not drawn attention to the fallacy, that has much amused me as I read the replies, we should have had several others doubtless making the same error. This little matter should show amateurs that very many persons write without thinking. That the information is gratuitous is acknowledged. But I would like it to be a boast of this journal, that erroneous instructions and advice are conspicuous by their absence. "U. C. S. W.," I fancy, is a new contributor—at least his initials are new to me. But he has done good service by dropping on such a simple error as the one in question. Amongst certain classes the contributed matter is ridiculed enough, without giving additional chances of doing so by being aided and abetted by impossible mechanical errors. Personally, I would like to see the reply pages filled with such answers that it would be simply impossible, consistent with truth, to cavil at the statements to be found therein.—INVICTA.

[56580.]—**Tricycle Pedals.**—I understood this query to refer to a central-geared tricycle: hence my reply last week. "C. D. R." appears to have fallen into the same error. However, our common mistake is not altogether a matter of regret, seeing that it has called forth the letter of a Cardiff correspondent, a production which strongly reminds one of the accounts travellers give of an Indian scalp-dance. Our Welsh friend seizes on "C. D. R.'s" well-intentioned, though, perhaps, mistaken suggestion, fiercely whirls it aloft (so to speak), and calls sarcastically for a diagram. Perhaps he will not be too severe on me if I venture to point out that it is not only possible to put a washer, or what will serve all the purposes of a washer, on the pedal of a crank tricycle, but a very easy thing to do, too. All that is required is a bit of steel rod of a square section—say, ½—which should be bent round while hot, and the ends brought neatly together; the pedals, of course, being first removed. Any blacksmith can do the job in a couple of minutes. I have seen washers of this description which work well enough, and the querist (Calvert) had evidently some such idea when he mentioned "spring washers." Of course I don't mean to say anything against "Invicta's" method, which is probably the best; but then amateurs usually find brazing a rather awkward job.—LITHIUM.

[56604.]—**Differential Equation.**—The equation $\frac{d^2y}{dd^2} - a\frac{dy}{d\zeta} = 0$, may occur in some geometrical problem, but it occurs in the mathematical theory of heat, where $y$ might express the temperature in a bar at a distance $x$ from the origin at a time $z$, no radiation being supposed into space from the sides or extremities of the bar. Other similar problems are likewise represented by the equation. The general solution of the equation is given in Poisson's and Fourier's treatises on the mathematical theory of heat, and also I believe in Boole's differential equations. "M.I.C.E." has given a solution of the equation, but not "the solution." A very general solution is—

$$\sqrt{\pi}\,.\,y = \int_{-\infty}^{+\infty} \epsilon^{-t^2} \phi \left\{ x + 2\sqrt{az}\,t \right\} dl,$$

containing, of course, an arbitrary function which corresponds to the constant in ordinary differential equations of one variable. It is not at first sight easy to prove the above solution, but it can be easily done by the "separation of the symbols of operation," as it is called. The solution given above is due to Laplace, and is probably the only one which is of any use in physical inquiries. If the state of the bar when $t = 0$ be given, the arbitrary function—namely, $\phi(x)$, is given, and the definite interval gives the temperature of any point of the bar at any time. Taking the simplest possible case, let $\phi(x) = ax + b$, then $y = ax + b$, throughout all time. I need scarcely say that $y = ax + b$, is a solution of the equation in question.—W. C. E.

[56605.]—**Waggon Wheels.**—"Coal Merchant's" query is difficult to answer without seeing the two waggons, but I will help him if I can. If the two sets of wheels are the same dish all he has to do is to drive the boxes out of wheels and change them, and put best set of wheels under best body. If his wheels are not the same dish, he must alter the lease of the arms to suit dish of wheels, or he will soon see his horses lose flesh.—H. J. HUMPHREY.

[56622.]—**Lightning Conductors.**—My last answer might be judiciously extended. As regards the points, they should be gilded or be of platinum. Then it would be most advantageous, if possible, to fix the bottom of the conductor to the water mains. If, however, this cannot be done, use metal earth plates in the coke. The area of these should be at least 7ft. total. Do not use insulation at supports and holdfasts. The putting up of a lightning conductor is an operation which requires much care, as a badly put up one is more dangerous than not having one at all.—J. RANCE.

[56628.]—**Heliograph.**—I am much obliged to "Volunteer Signaller" for his reply to my question; but I think he has not quite understood my difficulty. I have seen illustrations of the heliograph constructed as he describes; but I want to know how the proper angle at which to set the mirror so that the reflected ray may fall upon the distant station of the observer, is found without the aid of a sextant, an angle which is altering every moment as the sun moves onward.—ARTIBUS MAGISTER.

[56650.]—**Lead Burning.**—Mr. Davies is rather too hard, I think, on a new beginner, and Mr. D. is not quite correct about the quality of acid required, as I have seen thousands of feet burned with brown vitriol. If "New Beginner" has not the back numbers to look at, or if he wants any further information, I will write again any time. I may now inform him that the best thing for new hands at lead burning is to mind the following points:—1st. Have good clean gas, by using clean zinc free from iron, wire, &c., and free from paint. 2nd. Renew the acid and water as often as the gas begins to burn dirty and tarnish the bright lead. 3rd. Mind not to have the flame too large. 4th. Learn to burn flat work first. 5th. Start with moderately thick lead, say, 7lb. per foot, at first, and by practice he will manage 1lb. per foot lead. 6th. When he begins to burn upright nail two pieces of lead (well cleaned) on to a loose board, then he can incline the board and the lead half upright, and by degrees he can place the board quite erect. 7th. When burning upright do not have the top lap so close to the under one, and the flame and heat will go behind and heat all alike. 8th. When making the flame right size for upright or flat work, shut the air or bellows tap while you regulate the gas up to the right quantity of gas you think you need; then begin to turn the bellows tap on by degrees, just knocking it a little with a shave hook. 9th. Have a mug or pot, put plenty of clean zinc in, then try different proportions of acid and water in; you will soon learn what proportions make the most gas. Much depends on the strength of the raw acid; but if it be full strength 170 Twaddle, about one of acid to three or four water will answer best, or try acid and water at 20 Twaddle. Write again if you need more instruction, and if you or any of our kind readers can answer my inquiry made four weeks ago—viz., how to make the best nitrate of iron, without putting copperas in, for calico dyers, which stands about 78° Twaddle, kindly do so.—HENRY HOLMES.

[56651.]—**Boiler.**—I presume that the fire was damped the whole length of the furnace and the damper close shut; if such was the case, the explosion was due to an accumulation of coal gas in the furnace tubes. This would arise from the damper being close shut and only admitting a very limited quantity of air to the furnace, which would be chiefly consumed by the under side of the damped fire, very little passing through the furnace; the heat thus generated will distil some of the coals on the upper surface into coal gas, the gas will accumulate in the furnace tube because there are no currents to carry it into the chimney, and become mixed with the little air that has found its way through the furnace, making a very explosive compound, which, as soon as the stoker broke the fire, would explode. To remedy this, a portion of the grate bars at fire-bridge end of the furnace (about one quarter the length of the grate will do) should be raked clear of the fire, leaving the bars entirely open, the remainder of the fire should be damped in the usual way; the damper should also be left partially open. This will cause a current of air through the back end of the furnace, which will carry with it any gas that is generated in the damped fire up the chimney, thus preventing any accumulation and all risk of explosion.—R. W., Newcastle-on-Tyne.

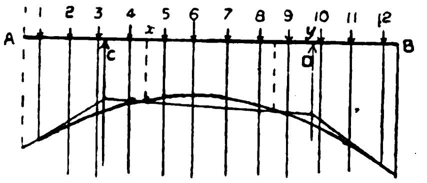
[56669.]—**Expansion of Metals.**—The increase of volume of any metal is proportional to the increase of temperature. Twisden gives the coefficients of linear expansion for 1° F. at 0·00000642 for wrought iron and 0·00001052 for brass rods; that is, the rods would increase these fractions of their original length for every increase in temperature of 1° F. Then a rod of wrought iron 36in. long heated from 32° F. to 100° F. would be—

$$36 \times 0{\cdot}00000642 \times (100 - 32) + 36$$
$$= 36{\cdot}02505616\text{in. long.}$$

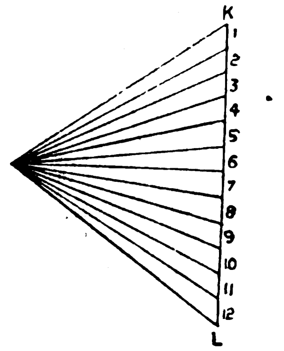
—R. W., Newcastle-on-Tyne.

[56654.]—**Portraiture.**—This is rather a difficult query to answer, because of insufficient data. for instance, querist says he uses one of Lancaster's ¼-plate landscape lenses. Now I will be bound Mr. Lancaster sells at least three different kinds of landscape or view lenses. Therefore "Camera" should state precisely what lens he uses. Presuming it to be a single lens, I should guess (what a lot of guessing indefinite queries cause) the aperture of lens without stop (other than the fixed one) would not be less than $\left(\frac{f}{32}\right)$. With such he should get a correctly-exposed negative of a group outdoors in two seconds. Then, taking ratio given in answer by "B.Sc.," 1 to 30, he would require one minute indoors, which I should consider about right. What does Mr. Bennett mean by "your negatives are under-exposed? You get the details of the dress, if a dark one, all right; but you get the faces, which are lighter, too dark in the negative, which makes them print without sufficient detail in the print"? Is there not a slip here of some sort? Since "Camera" says, "I get detail in the dress, but the features come out dark." Now this looks to me like over-exposure, since with under exposure the face would be too dense in the negative, and too white (or light) in the print; at the same time detail in the dark dress would be conspicuous by its absence. Farther on Mr. Bennett says: "It is not very easy to get good portraits with a view-lens." Quite right, Mr. B.; 'tis not very easy with any lens, but 'tis quite as easy with a view-lens as it is with a portrait-lens. A rapid rectilinear is no doubt a view-lens, and I have taken good portraits in an ordinary room with such aperture of stop $\left(\frac{f}{16}\right)$ in five seconds. Now don't say that was because it was a "rapid" lens, for rapidity depends not on any particular build of lens, but on the relation the aperture bears to the focal length; therefore, a single lens with stop $\left(\frac{f}{16}\right)$ would work quite as quick as a rapid or portrait-lens stopped down in the same ratio. "B.Sc." gave 25 seconds with a portrait-lens. Did he use the full aperture? I can get good results in two seconds in an ordinary room under the same conditions. I see "B.Sc." has omitted one very important factor in his explanation as to the why a near object takes longer to impress its image on the plate. I mean the different ratio the focal length of a lens bears to its aperture when used on a near object. For instance, take a lens of 6in. equivalent power and 1in. aperture $\left(\frac{f}{6}\right)$, use it to get a large head on a ¼-plate, and you will find that the focussing screen is about 9in. from the lens, so that our working aperture would be diminished to $\left(\frac{f}{9}\right)$ with same lens and same stop. I hope photographic querists will in future use the simple formula $\left(\frac{\text{focal length}}{\text{aperture}}\right)$ in describing their lenses, and not fuss about their being view or portrait-lenses, snap shutter, &c.—JAS. ADAMS.

[56679.]—**Supported Beam.**—The points will be best determined by the graphic method. Taking the beam as one uniformly loaded, A B represents

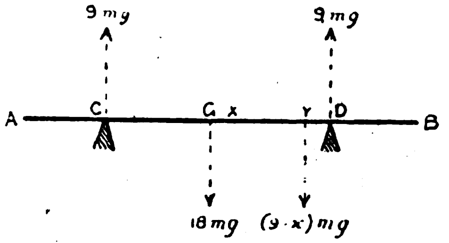


the beam resting on the supports C and D. Draw the diagram of bending moments, and the points $x$ and $y$, at which the beam has no bending moment, are the points at which it has no tendency to break.



If you wish to know the distance of $x$ and $y$ from C and D, you can measure it with the same scale as you draw the beam A B.—R. W., Newcastle-on-Tyne.

[56679.]—**Supported Beam.**—The tendency to break at any point of a beam is usually measured by what is called the "breaking couple"—i.e., the moment round the point of all the forces which act on either segment of the beam. Let A B be the beam, G its centre, C and D the points at which it is supported. Let the mass of unit length (an inch) of the beam be $m$; then it is clear that the beam is in equilibrium under the action of a force

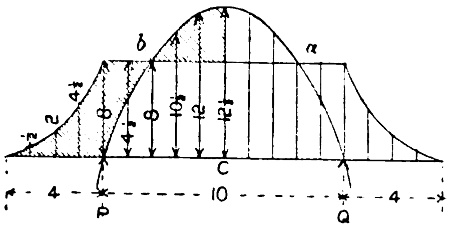


18$mg$ acting vertically downwards at G, and two upward pressures at C and D each equal to 9 $mg$. Let us find the tendency to break at any point X. Let G X = $x$. The forces which act on X B are 9$mg$ upwards at D and $(9 - x)mg$, which is X B, downwards at Y the middle point of X B. Taking moments round X, tendency to break is—

$$9mg\,.\,\text{XD} - (9 - x)mg\,.\,\text{XY}$$
$$\text{Or } 9mg\,(5 - x) - (9 - x)^2\,\frac{mg}{2}$$

$\therefore$ if there is no tendency to break $9\,(5 - x) = \frac{1}{2}\,(9 - x)^2$
Or simplifying $x^2 = 9$, $\therefore x = \pm 3$,
And the two points required are at a distance of 3in. from G, one on each side.—HIMICUS.

[56679.]—**Supported Beam.**—The bar being uniform, its weight is 18 units uniform. The weight of the parts beyond P and Q is 4. The weight between P and Q is 10. The bending moment at P and Q is weight 4 × arm 2 = 8, beyond P and Q bending moments are as the ordinates of the curve. Between P and Q there is a uniform tension in the top of the beam, and a uniform compression in the bottom of the beam, both being represented by 8. The bending moment at C for the length 10 is $\frac{10 \times 10}{8} = 12\frac{1}{2}$, between C and P, and between C and Q the bending moments are as the ordinates of the parabola, causing compression in the top and tension in the bottom, represented by the value of the ordinates, so that at the points *a* and *b* the tension in the top neutralises the compression in the top, and the compression in the bottom neutralises the tension in the bottom; that is, there are no horizontal strains at these points. But there are vertical shearing strains represented by 3 (half the weight between *a* and *b*) at each point. The ordinates in the shaded part of the diagram exactly represent the value of the horizontal strains at any point. See Professor Cotterell's "Applied Mechanics," published by Macmillan.—J. S. C.



[56681.]—**Trueing Steel Square.**—First make the stock of the square perfectly parallel; then obtain a piece of wood not less than 7in. wide and about a foot long—a piece of hard wood will be best. Get this planed up on one side, and make one edge as straight as you possibly can, for on this will depend the truth of the square. Now apply the square to this board, keeping the stock close to the straightened edge, and with a thin-edged knife make a light scratch on the planed side of the board. Turn the square upside down, and again apply it to the board. If the edge of the blade coincide with the scratch the square is true; if it does not do so, the blade must be filed down until the scratch made with one side of the blade will coincide with the scratch made with the other side, taking great care at the same time to keep the edge of the blade straight. If the blade is now made parallel, the square will be true.—R. W., Newcastle-on-Tyne.

[56682.]—**Struck by Lightning.**—"A Brand Plucked from the Burning" may be thankful he escaped with his life. His whole nervous system has had a severe shock, and anomalous symptoms such as he describes are common sequelæ of such accidents. He requires either a nerve stimulant or a nerve sedative—probably the latter; but it would be impossible to say which without a personal inspection. Probably potassii bromidum in 20-grain doses might relieve his pains; but let him beware of taking quack nostrums and narcotics, such as opium, except under professional advice, and trust as much as possible to tincture of time.—Medicinæ Doctor.

[56687.]—**Wheel Calculations.**—The wheels A and C being of the same size, no alteration of the diameters will make any difference in the velocity ratio. C will make two revolutions to one of the handle; getting one revolution from the handle and the other from the rolling of wheel B on A.—R. W., Newcastle-on-Tyne.

[56687.]—**Wheel Calculations.**—In my reply last week, I find that I was in error through misunderstanding the query. The size of the wheel B is immaterial. It is only an intermediate which derives its motion from the fixed wheel A, and communicates it to the wheel C.

$$\therefore \frac{\text{The fixed wheel A}\ 50}{\text{The wheel C}\ 50} + 1 = 2 \text{ rev. of C.}$$

—J. Jewsbury.

[56690.]—**Flux for Alumina.**—If it is desired to fuse the alumina as such, I know of no substance which will be of any use; but if something be wanted which will combine with it to form a more readily fusible compound, an alkaline carbonate would be all that is necessary.—B. B.

[56690.]—**Flux for Alumina.**—"Ex-Garrison Gunner" can dissolve pure alumina to almost any extent at the heat he mentions by adding a little at a time to ordinary borax in an open fire. The borax being volatile is gradually dissipated at this heat, leaving a very hard, transparent substance behind, which scratches glass with ease. This may be an abnormal aluminium pyro-borate; but if the product and additions be weighed, the former will be found to be minus the weight of the original borax. Besides, undeniable aluminium borate, obtained by treating pure alumina directly with pure boric acid before the blowpipe, is a white opaque, rounded mass, which no amount of ordinary heat can render transparent. In the year 1871, at Mussoorie, India, with the view of ascertaining the cause of the beautiful cerulean blue of sapphire, which "Ex-G. G." probably knows is pure alumina, I dissolved chemically prepared, perfectly white alumina, added by degrees to borax on platinum wire with the mouth blowpipe, working hours every day for a fortnight, when I obtained a pale, but distinctly and beautifully, blue transparent bead, so hard and tough that it resisted hammering on an anvil. I kept this bead for some years, but when I found no one was the least interested in the fact I threw it away, or lost it; but my experiments then convinced me that the blue colour of sapphire is due to the same cause as the cerulean blue of deep seas (over 100 fathoms), or of the miles of moist atmosphere called "the sky"—viz., to combined, or "chemical" water, which may be dissolved in ordinary water, or other menstruum. In 1879 I again "returned to the charge," and by using substances containing large proportions of this "chemical water"—namely, hydrated aluminium phosphate (pure wavellite) dissolved in hydrated boric acid before the blowpipe by a minute addition of potassium hydrate, I obtained, in about an hour's time for each, beautiful dark blue "stones," one of which I had set in a gold ring, and showed in 1880 to Professor Tyndall; no doubt he remembers the fact. By altering the proportions I obtained from the same materials brilliant green "stones," as finely coloured as the best emeralds, and a dull purple; but the latter only opaque, as it became first blue, and then green, when transparent and cool. I cannot make them so well now for want of practice; but have some tolerable ones in this exhibition, "South Central Gallery, No. 2176."—W. A. Ross.

[56697.]—**Cutting Glass Bottles.**—Soak some worsted or darning cotton in turpentine or other inflammable liquid, and wind it round where the bottle is required to be cut, then set light to it, being careful that the whole of the cotton becomes ignited, and then plunge into cold water. I have cut some very thick bottles by this method.—A. J. Wilson.

[56697.]—**Cutting Glass Bottles.**—A simple and very effective method, which I have practised for years, is to take about as much worsted as will go twice round the bottle, dip it in paraffin oil for a moment, then tie it round where it has to be broken off, take a lighted match and set the worsted on fire. As soon as it is burnt out, pour some cold water over it, and the bottle separates at once.—R. N.

[56697.]—**Cutting Glass Bottles.**—If "Sodium" will take the bottle in one hand and a hot poker (dull red) in the other, and place the end of that poker on the edge of the neck of that bottle, he will soon see a small crack. Now keep the poker about half an inch in front of the end of that crack, and it will follow the poker wherever you like to lead it. Keep two pokers going. Knocking the neck off the bottle will assist in commencing the crack, which is the only difficulty. Fill up with turpentine.—Tredagh.

[56697.]—**Cutting Glass Bottles.**—Perhaps this may suit "Sodium,"—a good plan I saw the other day, which I tried and found to answer. Take the glass bottle, which must be quite dry inside (if not it will crack where you do not want it), and hold it over a gas flame, just touching; keep turning it round until it is hot enough, you will find out in a few trials, then touch it with the point of a small brush dipped in cold water at the spot you have heated, and it will crack all round and drop off.—J. Aigburth.

[56697.]—**Cutting Glass Bottles.**—I have not heard of the method mentioned; but should think it might answer, though not with any great degree of certainty. You might try some other inflammable liquid lighter than, and not miscible with, water—e.g., ether. I have heard that by filing a groove and tying a piece of string soaked in spirit round it, and then igniting it, the object can be obtained; but this is tedious, and destructive to files. I have myself succeeded in a precisely similar case by starting a crack at the mouth (by means of the wards of a key, or a slight blow, or sudden heat), and leading it spirally down to the desired point, and then right round by means of a red-hot wire, or tang of a file, or the fused end of a piece of hard glass tube.—B. B.

[56697.]—**Cutting Glass Bottles.**—I would inform "Sodium" how I have succeeded in separating the necks from the lower parts of bottles, having done many for rough purposes. First, heat a part near the neck, and suddenly cool in water; this will start a flaw, which can be carried where you require; then, as a guide, stick a slip of paper round the bottle where you want to cut it, take a fairly-pointed poker heated, and lead the crack or flaw (which will follow a red-hot point) gradually (not directly down) towards the paper, and then continue round to meet. In gardening, to strike cuttings, old oil-flasks treated in this way and washed with hot soda-water are most useful. I have made and used great numbers, and seldom lose a cutting under one of these inverted glasses. —W. Hosken.

[56697.]—**Cutting Glass Bottles.**—I haven't tried the way the American paper gives, but should think it would answer if done properly. The following is a simpler plan, however, and I have cut off dozens of bottle-tops this way, so I can answer for its efficacy. Wind a piece of thick knitting-cotton (any absorbent kind of string will do, but I find this answers best) saturated in spirits of wine round the bottle at the point where you want it to crack off; it is not necessary to tie it, as it will stick to the bottle when wet of its own accord. Have ready a basin of water as cold as you can get it, and having set the cotton on fire, let it burn for a few minutes, holding the bottle sideways (so that only the rim, round which the cotton is wound, gets hot), and plunge it suddenly, before the cotton has burnt itself out, into the water in such a way that the surface of the cold water will just come up to the line of cotton. The glass will crack instantly, and the top will go down to the bottom of the basin. If the cotton is wound straight this makes a perfectly straight break. The rim can be afterwards filed off if considered too sharp.—R. A. R. Bennett, Walton Manor Lodge, Oxford.

[56699.]—**Condensing Engine.**—If I might offer my advice to this querist, I should say, With your present stock of information respecting steam-engines, don't have anything to do with a condensing engine—i.e., if you have any respect for your own and other people's safety or your employer's property; but rather get some good work on the steam-engine, and study that till you get the theory: the rest will come with time and practice. If you like to communicate with me, I will lend you a little book which will give you more information than could be given on a page of the "E. M."—R. A. Goodman, Stanley Mill, Marsh, Huddersfield.

[56699.]—**Condensing Engine.**—As the ostensible object of these pages is to afford information, I have very much pleasure in briefly endeavouring to make the many points clear to this querist, and (with the permission of the Editor) any further ones he may feel requisite to thoroughly understand the matter. Your present high-pressure engine delivers the exhaust into the exhaust pipe against a pressure of about 14·75lb. on the square inch, or, as we will call it, 15lb.; this is a constant back pressure against the engine which the condenser in great part removes. Now supposing that, for instance, your present engine was to be made a condensing one, what should we need to do? In the first place, we should want a suitable vessel, say, of cast iron, for our condenser itself; to the top of this we connect our exhaust pipe, instead of taking it to the outer air. Into the side, so that it projects well inside this vessel or condenser, we fit a pipe, either perforated in the part which runs across the condenser, or, still better, a rose-head or jet pointing upwards. From this pipe or jet we connect on a pipe to some body of cold water, such as a brook, or river, or canal, or even to a large reservoir. All we want is a connection so that we can draw water from an unfailing source. To the bottom of our condenser we fit our outlet, and connect it to the air-pump, a foot-valve being placed between the condenser and the pump. Our pump is arranged to be driven from the crank-shaft, and we have all the parts needed to make the engine a condensing one. Supposing we now wish to see the action of these parts, we start our engine, and we find that as the steam passes by the exhaust into the condenser it is met by the jet of cold water inside from the rose-head or jet, and is instantly condensed. Perhaps you will ask why do we get a jet of water flowing into the condenser when the water in the pond or brook is perhaps 4ft. below the level of our condenser?—simply by the vacuum we have obtained. In other words, the pressure of the air on the water in our pond is, as we have said before, nearly 15lb.; whilst in the condenser, the pressure being perhaps only equal to 2lb., leaves a pressure of 13lb. available to force water into our condenser. As the steam from the cylinder meets the jet of cold water, it is instantly condensed and falls to the bottom, from whence it is drawn off by the air-pump at each outstroke. Now, steam contains a large volume of air in solution, and this is removed by the air-pump with the injection water and the condensed steam. A stop-valve on the injection gives us the power of regulating the supply of cold water. Now, in reply to your separate questions, I would say that the vacuum is shown by a dial gauge, very much like a steam gauge; but, instead of showing pressure, shows vacuum, so that by a glance at the gauge we see when the best vacuum is gained, and it also tells us when the injection water is in sufficient quantity. This is done by gradually reducing the supply of injection water, when the gauge will show more and more vacuum until a point is reached when the best obtainable vacuum is good, and the least quantity of injection used to produce it. The vacuum being derived from the removal of the pressure of the atmosphere, is just the same in a 1-horse or 1,000-horse engine condenser. Neither does the pressure of steam enter into the question beyond the fact that the higher the steam pressure, the more injection water is needed, because the hotter the steam, the more cold water is needed to cool it. But this is only in such narrow limits that it need not trouble you. To your question on lines 8 and 9, the answer is already given. To your last, the difference between the jet and the surface condenser is this: In the jet form the water is brought into direct contact with the steam to condense it. In the surface form a large number of small tubes are used, fixed in the ends of a box or case; through these tubes cold water is driven by a pump, consequently the outer surfaces of these tubes are kept cool. The exhaust steam, instead of being sent into a condenser as in the jet form, is sent into the spaces between and around the tubes, these tubes being kept cold by the cold water passing through condenser; the steam, which is condensed steam, is drawn off with the air by an air-pump, as with a jet condenser. Thus water from the hot well (which is the cistern or tank on the delivery of the air-pump) of a jet condenser is mixed with muddy or salt water from the injection, whilst the water from the hot well of a surface condensing engine is pure water, the cooling water, which may be as dirty as may be, not coming in contact with it. The whole question is one of interest to mechanics, and I would strongly advise you to buy such a book as Dr. Lardner's "Rudimentary Treatise on the Steam Engine," price 1s.; or, better still, Mr. Michael Reynolds's book, "Stationary Engine Driving," price 4s. 6d. This latter is a modern book of great value, as a plain, concise, yet thoroughly practical handbook. The subject is one you should study, and you will, if you take the same interest in such subjects as I do, feel many hours of gratification in the perusal of such manuals.—Invicta.

[56701.] — **Pull of Martini-Henry.** — Unless the querist is a good mechanic, I would advise him to take his rifle to the armourer-sergeant, or to a gunsmith, to get the pull altered. He would do well also to remember that, although a minimum pull of 6lb. is allowed in shooting, yet it is not safe practically to go too near to that limit, because the pull of a rifle is apt to vary slightly, and it is not pleasant to be disqualified for having too light a pull. It seems to be overlooked that what is termed the "pull" of a rifle is really made up of two perfectly distinct things: 1, the pressure needed to move the trigger; 2, the distance through which the trigger moves before the cartridge is struck.—Wm. John Grey, F.C.S., hon. sec. Derwent Rifle Club, Newcastle-on-Tyne.

[56701.]—**Pull of M.H. Rifle.**—To "Inner." Take out the trigger spring and file a little off the under side of it—very little. You may make the pull as light as you wish by the above means. I may mention that this is not according to W.O. regulations. The W.O. order is to scrape a little off the bent of the tumbler with a special steel tool. It would not be easy to explain to you how the scraping is done, and if well explained, you would then even find it a most difficult job. I have altered scores of pulls by filing the spring; but you ought to get a spring-balance, such as are sold in the ironmongers for 2s., and before you alter the pull put the hook of the spring-balance on the trigger, rest the muzzle of the rifle on a table, then pull the balance, which will show you the weight of pull. Of course, you put the action in the firing position before the test. After filing the spring, test again. I write only on M.H. rifles made on strictly military plans, and only on those in use up to 1st of April, 1885. There are a number of so-called M.H. rifles made by private makers. I have seen several, and I found they differ in little details from the military one, so that my instructions may not always apply. I make the above remarks because I don't wish to mislead, nor to write about what I don't understand.—Armourer.

[56703.]—**Algebraical Problem.**—We have from the data—

$$(1)\quad \frac{n\,.\,\overline{n-1}\ldots\overline{n-r+2}\,.\,\overline{n-r+1}}{n\,.\,\overline{n-1}\ldots\overline{n-r+2}} = \frac{10}{1}.$$

$$(2)\quad \frac{n\,.\,\overline{n-1}\ldots\overline{n-r+2}\,.\,\overline{n-r+1}}{1\,.\,2\,.\,3\ldots\overline{r-1}\,.\,r.} \times \frac{1\,.\,2\,.\,3\ldots\overline{r-1}}{n\,.\,\overline{n-1}\ldots\overline{n-r+2}} + \frac{5}{3}.$$

Divide (1) by (2)—

Then $\frac{1\,.\,2\ldots\overline{r-1}\,.\,r}{1\,.\,2\ldots\overline{r-1}} = \frac{10\times 3}{5}$; or $r = 6$.

Again writing 6 for $r$ in equation (1)—

$$\frac{n\,.\,\overline{n-1}\ldots\overline{n-4}\,.\,\overline{n-5}}{n\,.\,\overline{n-1}\ldots\overline{n-4}} = \frac{10}{1};$$

hence, $n - 5 = 10$, or $n = 15$.—W. A. S.

[56703.]—**Algebraical Problem.**—No. of permutation of $n$ things taken $r$ at a time is

$$n\,(n-1)\ \ldots\ldots\ldots\ldots\ (n-r+1)$$

and taken $r - 1$ at a time—

$$n\,(n-1)\ \ldots\ldots\ldots\ldots\ (n-r+2)$$

and since these quantities are in the ratio 10 : 1 we have $n - r + 1 = 10$ ........................ (i.)

Again, No. of combinations of $n$ things taken $r$ at a time is $\frac{n\,!}{r\,!\,(n-r)\,!}$

and taken $r - 1$ at a time $\frac{n\,!}{(r-1)\,!\,(n-r+1)\,!}$

and these quantities are in the ratio 5 : 3.

$$\therefore\ \frac{(r-1)\,!\,(n-r+1)\,!}{r\,!\,(n-r)\,!} = \frac{n-r+1}{r}$$

$$= \tfrac{5}{3}\ \ldots\ldots\ldots\ldots\ (ii.)$$

From equations (i.) and (ii.) we have $n = 15$, $r = 6$. East Anglian.

[56703.]—**Algebraical Problem.**—The number of variations, or permutations, according to Todhunter, of $n$ things taken $r$ at a time is—

$$n\,(n-1)\,(n-2)\ \ldots\ldots\ldots(n-r+1).$$

The number taken $r - 1$ at a time will be the same as above, except that it will not contain the last term. Hence by the conditions of the problem this last term must = 10, and we get—

$$n - r = 9\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Again, the number of combinations of $n$ things taken $r$ at a time is—

$$\frac{n\,(n-1)\,(n-2)\ \ldots\ldots\ldots(n-r+1)}{\underline{|r}}$$

The number taken $r - 1$ at a time will have its numerator only one-tenth as great, and its denominator will be factorial $r - 1$ instead of factorial $r$. Hence we have—

$$\frac{10}{\underline{|r}} : \frac{1}{\underline{|r-1}} :: 5 : 3.$$

$$\therefore\ 30\,\underline{|r-1} = 5\,\underline{|r}$$

whence $r = 6$ and from (1) $n = 15$. The number of variations of 15 things taken 6 at a time is 3,603,600, and taking 5 at a time the number is 360,360. The number of combinations taking 6 at a time is 5,005, and taking 5 at a time 3,003. The numbers 15 and 6, therefore, completely satisfy the conditions of the problem.—Wm. John Grey, F.C.S., Analytical Chemist, Newcastle-upon-Tyne.

[56706.] — **Microscopical.** — "Ignorant's" polariscope is all right. He will not obtain colour phenomena with the prisms only. He must introduce another double refracting body upon the stage to do that. If he will put a piece of mica or a section of wood or bone, or a prepared slide of salicine, santonine, or a fish scale in balsam, he will obtain fine colour effects. If he will look in Sale Column, he will find little paper he wants advertised. —E. Holmes.

[56706.]—**Microscopical.**—Though I do not know much about the subject, yet as I have been through a similar experience to "Ignorant," and found the way to use the polariscope without any assistance, perhaps I may be able to help him. You are perfectly right in the way you put your instrument together (mine goes in just the same way), and your description of the effect is quite correct; but there is evidently "something wanting," and that something, it seems to me, is a selection of proper objects. Perhaps you may not be aware that only certain objects are affected by polarised light, and many of these in different ways. As I understand the matter, the polariscope, consisting of two prisms, breaks up the ray of light into two parts, and as one prism is rotated the varying position of the portions of the ray bring out, in some objects, effects which could not be obtained by a ray of ordinary light. These effects are of two principal kinds—those with colour and those without. Some objects, when viewed with polarised light, present the most gorgeous changes of colour, altering with the rotation of the prism; others, though less highly coloured, show a remarkable structure known as the black cross. The second class are without colour, but details of structure are very clearly shown in bright light and deep shadow, the position of the lights and shades changing with the rotation of the prism. These are just a few of the things you may look for and expect to see. Now as to objects. I would advise you to get a few of the polariscope objects of one of the good makers, and familiarise yourself with them. Mine came from Watson and Sons, and include a transverse section of walrus whisker, which shows some of the most gorgeous colours imaginable; transverse section of whalebone, which shows the black cross. Another beautiful object is platino-cyanide of magnesium. One of the finest objects of this (chemical) class I ever saw is cinconidine. Of the second class, uncoloured objects, a very good specimen is the palate of whelk; these may be had at 1s. each. You ought also to have a set of selenite slides; they are 1s. 6d. each, but are generally sold, I think, in sets of three—blue and yellow, red and green, various; but any may be had separately. By themselves they produce no effect, but placed under or over the object on the stage, they give to many of them a splendid colouring, which changes in a most beautiful manner on rotating the prism slowly. I have found them especially effective with my palate of whelk and whalebone. I think if you get some of these and try them you will find your polariscope—as I have mine—a source of almost endless enjoyment; and you can then proceed to prepare and experiment upon crystals of various chemical salts, and other objects. If you do not find the results I have led you to expect, write again, and I will try to help you all in my power.—F. W. B.

[56708.]—**Science Questions.**—A table 1 mètre by 70 centimètres has an area of ·7 mètre$^2$; it, therefore, contains 700,000mm.$^2$, or 7,000cm.$^2$, or 70dcm.$^2$. I suppose next week we will have an inquiry as to the number of sq. in. in a table 6ft. by 4ft. (2) The volume of a gas varies inversely as the pressure. Hence we have—

530 : 770 :: 1200 : 1743 mètres$^3$.

(3) The *approximate* specific gravity of the metal is obtained by dividing its weight in air by its loss of weight in water, this last being obviously the weight of an equal bulk of water. In the case given we have—

$$\text{Sp. gr.} = \frac{3{\cdot}7395}{3{\cdot}7395 - 1{\cdot}5780} = \frac{3{\cdot}7395}{2{\cdot}1615} = 1{\cdot}73.$$

In the case of the unknown liquid, we have that the weight of a bulk of water equal to the piece of metal is 2·1615grms., and that the weight of an equal bulk of the liquid is 1·4499grm. Hence—

$$\text{Sp. gr. of liquid} = \frac{1{\cdot}4499}{2{\cdot}1615} = {\cdot}67.$$

—Wm. John Grey, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[56709.]—**Lubrication.**—Very much depends on the lubricator itself, as well as the lubricant. Many lubricators simply administer the oil as drops one at a time into the steam-pipe. Once in the steam-pipe part finds its way mechanically into the cylinder, and part is taken up by the heat of the steam, and is converted into vapour. Now if we follow the steam we find that the oil in solution in the steam is gradually deposited on the various metal surfaces, so that if the h.-p. cylinder and valve be well lubricated, the l.-p. cylinder and valve, which must be of larger surface, have only the remnant of the oil in solution to lubricate them. Even supposing that the high-pressure cylinder did not either absorb or decompose the entire volume. I am well aware that endless instances could be mentioned where one lubricator does the business; but, in my opinion, this is due not to the lubricant still held by the steam, but from lubrication due to partial liquefaction. Now on an actual test a Boyle's Injector Lubricator is proved to have so fed in the oil as spray of the finest subdivision that an ample volume of lubricant was carried to the l.-p. cylinder. There are (not to be unfair) others besides Boyle's that no doubt would show an equally good result; but I have no faith in those giving drops of oil only. What is the meaning of the black glutinous residues in the valve-box and cylinder but decomposed oil? Therefore, if it be decomposed, how can it be in two places and lubricate the l.-p. cylinder. If I were specifying I should undoubtedly mention a lubricator on each cylinder. Then, again, I have found that suet (not rancid) is far better than oil or tallow, so that another point is here involved. In my opinion, from actual experience, suet is better than oil or tallow, whilst I would after suet prefer a good oil. I am, of course, giving my opinion only, but based on daily use of the three forms of lubricant in question.—Invicta.

[56710.]—**Salicylic Acid in Food and Drink.** —Perhaps the best known test for this is chloride of iron. Eat or drink some of the suspected article, and three hours later test the urine. The result will be first a precipitation of phosphate of iron, and then, on adding more of the test, if salicylic acid be present, even in so small a quantity as 25 milligrams (about one-third of a grain), note the characteristic violet tinge due to this reaction.— Percy Stanley, 119, Manchester-road, Poplar, E.

[56711.]—**Fulcrum.**—The weight of the bar acts as though it were collected at the centre of gravity of the bar; that is, in the middle. We have then 4lb. acting at the middle, and 6lb. acting 5in. off at one end of the bar; consequently, the fulcrum must be between them, and 2in. from the end, since $6 \times 2 = 4 \times 3$.—W. A. S.

[56711.]—**Fulcrum.**—As the fulcrum is 10in. long and weighs 4lb., then the centre of gravity is in the middle of it, or at 5in. from one end; and as there is 6lb. at the other end, then $\frac{6 \times 5}{4 + 6} = 3$in. —that is, 3in. from the centre of the lever; or $\frac{4 \times 5}{4 + 6} = 2$in.—that is, 2in. from the 6lb., which is the point where the lever will be at rest on fulcrum. —R. N.

[56711.] — **Fulcrum.** — The centre of gravity where the weight of the bar might be concentrated is 5in. from the end. By the principle of the lever, 4lb. × its arm = 6lb. × its arm, and the length of the arms will be inversely as the weights acting on them. Dividing the length of 5in. into 10 equal parts, 4lb. × 6 of them, or 3in. = 6lb. × 4 of them, or 2in., the fulcrum will be 3in. from the centre, and 2in. from the end of the bar. Study this and similar questions in some elementary book on mechanics.—J. S. C.

[56711.]—**Fulcrum.**—On the assumption that the bar is uniform, its weight may be considered to act at its centre; hence the problem becomes one of finding the point about which a lever 5in. long, without weight itself, but with weights of 4lb. and 6lb. at its extremities, will balance. Let $x$ be the distance of the point from the 6lb. weight, then the moment of the weight about the fulcrum is $6x$ pound-inches. Again, the distance of the fulcrum from the other end is $5 - x$ inches, and the moment of the 4lb. weight is $4(5 - x)$ pound-inches. These moments are of opposite sign, so there will be equilibrium when they are numerically equal; so we get $4(5 - x) = 6x$; whence $x = 2$. That is, the point about which the lever will balance is 2in. from the 6lb. weight.—Wm. John Grey, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[56711.]—**Fulcrum.**—This question was one of those given the Applied Mechanics Examination last month by the Science and Art Department. The bar is 10in. long and weighs 4lb. Its weight is considered to act at its centre of gravity, which is consequently 5in. from either end. Practically, therefore, the bar is reduced to a lever of the first kind, having a weight of 6lb. at one end and of 4lb. at the other, its length being assumed to be reduced to 5in. By the law of equality of moments, one weight multiplied by its distance from the fulcrum must equal the other weight multiplied by its distance from the fulcrum, and these distances are inversely as the weights, which are in the proportion of 4 to 6, or 2 to 3. Divide the 5 inches into 5 units, and divide inversely as the weights, and we get the balancing point at 2in. from the end from which the 6lb. weight is suspended.—Fred. A. Robinson.

[56711.]—**Fulcrum.**—Let $x$ = distance of fulcrum from end at which the 6lb. weight is hung. ∴ $10 - x$ = distance of the fulcrum from the other end. Then, assuming the bar to be uniform, the weight of the portion $x$ is $\frac{x}{10} \times$ 4lb., and that of the portion $10 - x$ is $\frac{10 - x}{10} \times$ 4lb. Now, since these weights may be each assumed to act from the centre of gravity of each portion, the question resolves itself into finding the balancing point of a weightless bar 10in. long, leaving suspended on one side $\frac{x}{10} \times$ 9lb. at a distance of $\frac{x}{2}$ from its fulcrum + 6lb. at a distance of $x$ from its fulcrum, and, on the other, $\frac{10 - x}{10} \times$ 4lb. at a distance of $\frac{10 - x}{2}$ from the same point. Then, as the effect of these forces at these distances must be equal—

$$\therefore \left(\frac{x}{10} \times 4\right) \frac{x}{2} + 6x = \left(\frac{10 - x}{10} \times 4\right) \frac{10 - x}{2}$$

Whence $x = 2$.—B. B.

[56718.]—**Northern Railway of France.**—The distance from Calais (Pier station) to Paris viâ Boulogne and Amiens is given in the official French time tables as 298 kilomètres, equal to 185 miles 303 yards.—R. T. L.

[56718.]—**Northern Railway of France.**—The distance from Paris to Calais (Ville) is given by the company in their timetables as 297 kilomètres—i.e., 184¼ English miles. The harbour extension is about three-quarters of a mile, so that the total distance to the pier would be 185 miles.—East Anglian.

[56721.—**Steam Motor.**—To "Invicta."—If this querist will advertise his address, I will make a communication to the necessary parties, so that he may get the information he desires. I may add that this motor seems well adapted for driving dynamo machines, and from what users seem to say is giving every satisfaction, more especially a more recent pattern, which has an improved form of inoxidisable condenser, which, in my opinion, is a decided improvement.—Invicta.

[56722.]—**Flywheel.**—I should myself recommend a disc flywheel for the speed you mention. For a pair of cylinders, 2in. bore and 4in. stroke, at 350 a minute, I should use a wheel 20in. diameter, the rim being of U section. Across the widest portion the section should be 2in. wide by 1in. deep; this whilst the minor or inner rim should be 1in. deep and 1in. wide. With the boss and disc, or arms, the weight would be about 35lb. You say what difference if boiler pressure was raised to 50lb., with the speed being the same? I should not vary the size or weight of the wheel; but if you made more or less revolutions a minute, then I should certainly alter the weight and diameter of the flywheel. 350 a minute is a high speed for engines 2in. by 4in. Is this correct?—Invicta.

[56725.]—**Western Railway of France.**—The distances from Paris to Versailles are stated in the French official time tables to be as follows:—By Rive Droit, 23 kilomètres, equal to 14 miles 514 yards; and by Rive Gauche, 18 kilomètres, or 11 miles 225 yards.—R. T. L.

[56733.]—**Problem.**—Apparently there is a misprint in this question. In line 8, 13 hours should read 3 hours. Assuming this to be the correct reading, let A. pump out $n$ gals. per minute; then, since working together, they would clear the hold in 3h. 45m., in this time A. would pump out $225n$ gals. But A. actually did pump out $200n$ gals.

$$\therefore 200n + 100 = 225n.$$

∴ A. pumps out 4 gals. per min., and B. pumps out $\frac{2}{3} \times \frac{5}{4} \times 4 = 3\frac{1}{3}$ gals. per minute. Let $x$ be number of gals. in hold at first, and $y$ number of gals. which leak in per minute. ∴ whole number of gals. pumped out when both work together is $x + 225y$.

$$\therefore (x + 225y) \div (4 + 3\tfrac{1}{3}) = 225 \quad \ldots\ldots\ldots\ldots \text{(i.)}$$

A. would empty the hold in $\frac{x}{4 - y}$ minutes. In this time B. pumps out $\frac{10x}{3(4 - y)}$ gals., and there remains $\frac{2x}{3(4-y)}$ gals.

$$\therefore \left(\frac{2x}{3(4-y)} + 200y\right) \div 4 = 200 \quad \ldots\ldots \text{(ii.)}$$

From equation (i.) and (ii.) we may determine $x$ and $y$. Thus we have—

$$y = 2,\ x = 1{,}200;\ \text{or},\ y = 5\tfrac{1}{4},\ x = 468\tfrac{3}{4}.$$

—East Anglian.

[56733.]—**Problem.**—Let $x$ = number of gallons in hold at first, $y$ = number of gallons per minute which come in at leak, and $z$ = number of gallons per minute that A. can pump. Since B. pumps $\frac{2}{3}$ as fast as A., and at each stroke throws out $\frac{5}{4}$ as much as A., ∴ B. pumps $\frac{2}{3} \times \frac{5}{4} \times z = \frac{5z}{6}$ galls. per minute. A., pumping by himself, could pump out the vessel at the rate of $(z - y)$ galls. per minute. A. would, therefore, take $\frac{x}{z - y}$ minutes to clear out the hold. B. can pump out the vessel at the rate of $\left(\frac{5z}{6} - y\right)$ gallons per minute; therefore, in $\frac{x}{z - y}$ minutes he will pump out $\frac{x\left(\frac{5y}{6} - y\right)}{z - y}$ galls., and A. would pump out what remained, or $\left\{x - \frac{x\left(\frac{5z}{6} - y\right)}{z - y}\right\}$ galls. in

$$\left\{\frac{x}{z - y} - \frac{x\left(\frac{5z}{6} - y\right)}{(z - y)^2}\right\} \text{minutes.}$$

The total time, therefore—

$$= \frac{2x}{z - y} - \frac{x\left(\frac{5z}{6} - y\right)}{(z - y)^2} = \text{13h. 20min. or 800min.}$$

Therefore (1)—

$$\frac{2x}{z - y} - \frac{x\left(\frac{5z}{6} - y\right)}{(z - y)^2} = 800.$$

If A. and B. worked together, they would pump out the vessel at the rate of $\left(z + \frac{5z}{6} - y\right) = \left(\frac{11z}{6} - y\right)$ galls. per minute; they would, therefore, empty the hold in $\frac{x}{\frac{11z}{6} - y}$ mins. = 3h. 45m., or 225 mins.

Therefore (2)— $$\frac{x}{\frac{11z}{6} - y} = 225.$$

In 225 minutes A. pumps out $225z$ galls., and B. $\frac{5z}{6} \times 225$ galls.; but $225z - \frac{5z}{6} \times 225 = 100$.

Therefore (3)— $z = \frac{8}{3}$.

Equating the values of $x$ in (1) and (2) and substituting $\frac{8}{3}$ for $z$, we get after a little reduction—

$$207y^2 - 888y = -816$$

∴ $y = 1\frac{1}{3}$ galls. per min., or 80 galls. per hour

And $x = 800$ gallons.

—J. C. Kelly.

[56734.]—**Testing Butter.**—London cream is an emulsion, made by triturating fresh butter with powdered gum-arabic, and adding milk until the right density is acquired. The ideas of London milk being calves' brains and chalk and water are exploded on account of the price of the former and the insolubility of the latter.—Basford.

[56734.]—**Testing Butter.**—The following is a useful rough-and-ready way to test the purity of butter. Take ¼oz., and dissolve it to oil in the oven, and whilst hot float a lamp wick in it; then light it; after burning some time blow it out; if pure, it will have a pleasant odour, but if mixed with animal fat you will have the characteristic pungent smell of acroleine, like an extinguished tallow candle.—W. A. S.

[56737.]—**Cutting Discs.**—No expensive machine is needed. All you want is a pair of washer cutters. These are like a pair of stout joiner's compasses; but the one leg carries a small cutting blade instead of being a mere point only. They are made so that the knife travels round in a vertical plane, so that the washers are cut with a square, not a bevelled edge.—Invicta.

[56738.]—**Wimshurst Machine.**—The granulated appearance of the sectors is produced by passing the tinfoil through prepared rollers; but Mr. Jackson and others may easily prepare any small quantity by pressing the tinfoil upon a sheet of new glass paper. The "two binding screws on the base board" are in metallic connection with the outer coatings of the Leyden jars; the removal of the wire between the binding screws breaks the outer circuit of the Leyden jars. I shall always be glad to give any further explanation, but fail to see any point open which can now be usefully touched by me; but when the winter season for electricity approaches I shall be glad to furnish through these pages all the explanations and sketches necessary to enable the amateur and others to build up similar instruments to those exhibited by me in Group 28, No. 2128. In the meantime intending makers should closely look at the parts of the machine exhibited.—James Wimshurst.

## UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

Since our last, W. J. Grey has replied to 56204.

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| 56218. | Electric Clock Dials, 89. |
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| 56231. | Dynamo, 90. |
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| 56249. | Electric Bell, 90. |
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| 56257. | Telescope Stand, 90. |
| 56260. | Wicker, 90. |
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| 56408. | Preparing China for Oil-Painting, p. 178. |
| 56413. | Green's Economiser, 178. |
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| 56422. | Enamelling. To Mr. Lancaster, 171. |
| 56425. | Brass Plate, 178. |
| 56428. | Hot-Air Valve, 178. |
| 56433. | Object-Glass, 179. |
| 56439. | Separating Potash and Magnesia, 179. |
| 56440. | Warnerising, 179. |
| 56444. | Dynamo, 179. |
| 56454. | Violoncello, 179. |

**Disinfection and Disinfectants.**—A committee of the American Public Health Association have issued a preliminary report on the subject of disinfection and disinfectants, in which it is explained that disinfection necessitates the actual destruction of any specific which gives rise to infectious diseases, and that the destruction must not be partial, but complete, if true disinfection is to be obtained. Popularly, the term disinfection is used in a much broader sense, and mere deodorisers and antiseptics are styled disinfectants—the result being much misapprehension and failure: many such agents are entirely without value for the destruction of disease germs. This applies, for example, to the valuable antiseptic sulphate of iron or copperas. Antiseptics, however, exercise a restraining influence upon the development of disease germs, and hence they have a proper place amongst the agents to be used for certain purposes when epidemic diseases are prevalent. Many so-called disinfectants are mere deodorisers, and quite valueless for their professed purpose. Chloride of lime is held by the Association to be entitled to the first place for disinfecting excreta; it is both trustworthy and rapid in its action. A solution of corrosive sublimate and permanganate of potash in soft water, in the proportion of two drachms of each salt to the gallon, is placed next, as being really effective, but slower in its action. Liquor sodæ chlorinatæ is also referred to, but it is dearer than chloride of lime, and has no special advantages over it. For clothing and bedding which cannot be washed, a temperature of 230° F. is recommended as sufficient for the destruction of all known disease germs which do not form spores. Superheated steam under pressure is, however, a safer method to rely on, and, as stated in the memorandum, a less temperature of this agent probably suffices to effect the object than is the case with a dry heat.

# QUERIES.

[56739.]—**Books.**—Would some of our readers kindly tell me what books would be required to read up for the examination (honours) held by the Science and Art Department, in the following subjects?—Theoretical Mechanics, Applied do., Sound, Light and Heat, Magnetism and Electricity, Physiography, Agriculture, Steam, and Hygiene.—Student.

[56740.]—**Psychology.**—Will any reader of the English Mechanic be good enough to tell me what parts of Bain's "Mental and Moral Science" I had better read for the London B.A. pass?—S. J. S. L.

[56741.]—**Shafting.**—To "Invicta" or Others.—Will "Invicta" kindly inform me the best method of setting out a line of shafting at right angles to an existing line of shafting, and 8ft. above it, to be driven by a quarter twist belt?—Another Millwright's Apprentice.

[56742.]—**G.W. Railway Locomotives.**—Can any correspondent give me the dimensions of the engine 1163? Also is there any difference between 1163, and the coupled narrow-gauge engines? Which class do the drivers like best? What are the principal dimensions of the broad gauge, six-wheel coupled engine, No. 2068?—Demoid.

[56743.]—**L. and N.W. Railway.**—What are the dimensions of "Bevere" express engine? Which are the most popular with the drivers, the simple or the compound engines? Where is the single engine "Cornwall" stationed, and what trains does it work?—Demoid.

[56744.]—**Softening Water.**—Can someone inform me (1) If any apparatus is procurable for softening water, 22° Clark temporary hardness with lime—say 2,000 or 3,000 gallons an hour? (2) If any such contrivance can be practically worked with ordinary care, by one not a professional chemist to insure reduction of the hardness to a minimum, avoiding the addition of a surplusage of lime? (3) The best practical test of the result?—J. T. C.

[56745.]—**North Eastern Engines.**—Can any correspondent give any information of the new N.E. express just built at Darlington and Gateshead? Are they still of Mr. Macdonell's design?—B.

[56746.]—**A Disagreeable Noise.**—Would any kind reader suggest a plan to remedy the following?—An old lady living opposite a smith's shop (distance, 40ft.; height, 14ft.) and she says that every blow on the anvil is like striking her on the head, especially when lying in bed (it is an iron bed). We padded the window with cloth, but it seems to have done very little good.—R. M.

[56747.]—**Governors.**—I have an engine 1⅝in. bore, and 3in. stroke, and I want it to run at about 200 revultions per minute. Will some reader kindly inform me how to make a pair of governors, stating the size and details for the same? Also what size of copper boiler (vertical one), and what thickness of copper to work at 20lb. pressure would do for the above engine? I should heat the boiler with gas.—A. B.

[56748.]—**Barbadoes.**—Will some of your readers give me some information about the above island, such as best and cheapest route to reach it, climate, &c.? Having to go on business shortly, which may detain me some time on the island, I am anxious to know? An early answer will oblige.—A. Kimber.

[56749.]—**Painter's Wheel Lining Tool.**—Would any of "ours" kindly inform about a painter's decorative wheel lining tool, and give a hint how to construct the same?—Bon-accord.

[56750.]—**Gold-Plating.**—I wish to make some small steel articles appear as if gold-plated, and stand polishing, but can't afford gold plating. Would any kind reader tell me any way to do this? Soldering thin sheet brass over them would do, but would be very tedious.—C. M.

[56751.]—**Portrait Drawing in Crayons.**—Will one of our obliging friends inform me how to enlarge photographs for crayon portraits? Also name the best kind of paper for the work, and oblige.—Invalide.

[56752.]—**Raising Water by Ejector.**—I have a town's supply of water at 40lb. pressure; in addition I have another supply of stream water. Can any reader inform me if an injector would lift the water out of stream by means of the town supply at 40lb.?—if so, what kind of ejector or elevator is best? How many feet would it raise the stream water, and how many gallons of town water at 10lb., would it take to raise each 1,000gal. of stream water, say 20ft.?—T. H. Bury.

[56753.]—**Horse-Power to Drive a Millstone.**—I have a pair of ordinary millstones, 4ft. diameter. Can any reader inform me what nominal horse-power is required to work such mill, to grind barytes and similar hard minerals?—T. H. Bury.

[56754.]—**Filtering Water.**—Will any reader inform me of a cheap and good filter that will easily purify stream water, so as to render it fit to use in making starch, which I am informed requires an extremely pure water?—T. H. Bury.

[56755.]—**Magnesia Firebricks.**—Within the last four months there has appeared, in either the English Mechanic, or one of the other technical journals, a paragraph on the mode of manufacture of these articles; but having omitted at the time to make a note of the paper in which it occurred, I am now quite unable to come across it again, although I have searched for it a great deal. Can any reader of "ours" kindly assist me? I should very much like to find it, or obtain other information on the subject, and as to where such manufacture is carried on.—Cosmopolitan.

[56756.]—**Electro-Plating.**—Will any of "ours" inform me of the method employed to silver Britannia metal and common pewter? Silver can be deposited on it from its ordinary cyanide solutions, but does not adhere sufficiently to allow of burnishing; ordinary quickening solutions too contain acid, is there any special quickening used for pewter?—if so, how is it made?—Elsby.

[56757.]—**Steam Expansion**—What is the velocity of steam escaping through an aperture of two superficial inches, with say a constant pressure of 60lb. to the square inch, and supposing it to be unopposed by atmospheric pressure?—James Sinclair.

[56758.]—**Friction Clutch.**—I should be obliged for a description of the friction clutches used in tricycles, drills, &c. They are not referred to in the indices of many years' back numbers. I mean the clutches that lay hold of the shaft when pedalling forward, and free themselves when pedalling backward.—Birmingham.

[56759.]—**Waterproofing Canvas.**—Will you kindly tell me what is the cheapest, simplest, and best method of making canvas waterproof? The canvas is that in which drapers' packages are made up in. Would size, varnish, or boiled oil do?—Rescisco.

[56760.]—**Accumulators.**—I have a small dynamo, which I can work from an engine in the daytime, but not at night. I want to make some accumulators for it, sufficient to light three five-c.p. lamps for about four hours. I should be glad if anyone would tell me the size and number of cells I should require. Can I use thin lead plates, and would they be best rolled up or flat? What is the best way to cover them with red-lead, and now can I tell when the battery is fully charged?—Plumbrom.

[56761.]—**Three-Cylinder Engines.**—Will any of your readers give descriptions and sketches of best three cylinder engines—Willans, Brotherhood's, and Halsey's, or give titles of books, giving full descriptions of them?—M. R.

[56762.]—**Safety Bicycle.**—I think of making a 40in. bicycle with side rods, something like the Facile. Would some kind reader tell me the length of crank-rods and general dimensions? A few hints on the best way to make adjustable bearings, either plain or ball, would be very acceptable. I have the use of slid-rest lathe, drilling machine, &c.—Low Flyer.

[56763.]—**Water Analysis.**—To Mr. Jno. Grey, F.C.S.—will you kindly give directions for estimating (quantitatively) the following in the solid matter, obtained by evaporating 70cc. of water:—Sulphate of calcium, sulphate of magnesia, carbonate of calcium, carbonate of magnesia, chloride of sodium, sulphate of potash. Textbooks do not give methods for estimating the lime and magnesia as carbonates or sulphates, but the total lime, magnesia, &c.—Z. Y. M.

[56764.]—**Tempering Carpenter's Tools.**—Will some reader inform me where I can get a good book explaining the right way for tempering carpenter's tools, and all fine-edge tools for cutting leather and wood, and also showing the way to temper all sorts of springs, or some hints?—Tool Worker.

[56765.]—**Polish for Walnut Table.**—Would some reader kindly advise me how I am to restore the French polishing on a walnut table, which has been rendered quite rough and dull by having eau-de-Cologne spilled on it?—A. R.

[56766.]—**Building.**—Would someone tell me what is the difference in price of building now, compared with 20 years ago? I am told that to build a cottage that could be built 20 years ago for £100, would now cost £130, as bricks and labour are dearer; but I should have thought that timber being cheaper and competition keener, it would have compensated for increase in wages and bricks.—M.

[56767.]—**Parrots.**—Would someone who understands different species of parrots advise me on the following? I sent to a bird dealer for a young ring-neck parrakeet, but had an adult bird sent me. He has never once made the least kind of noise, not even in his natural tone, but continually climbs round the cage trying to get out; at other times he will sit quite still sometimes for an hour, I should like to know whether there is any chance of making it talk—I have had it a fortnight.—Y. M.

[56768.]—**Ancient Lights.**—Would someone tell me how close I am allowed, by law, to build near a window overlooking, and if there is any difference between a clear window light used as a dwelling, and a semi-transparent window of a chapel?—X. Y. Z.

[56769.]—**Legal.**—A. engages B., in the presence of C., to give a course of twelve lessons to a pupil of A.'s on a fixed day, one lesson to be given in each week for a certain sum. After seven lessons B. requests A. to change the day, but this will not suit A.'s pupil. A. then writes B. a polite note to say change of day is impossible, upon which B. replies that he will not finish the remaining five lessons and incloses his account for seven. A. feels morally bound to pay B. for these seven lessons, but is B. legally entitled to anything?—W. H. S. M.

[56770.]—**Putty.**—Will one of my fellow readers who goes in for glaziering tell me how putty is made properly? I can make a feeble imitation by mixing up whiting and linseed oil, which are, I believe, the ingredients used; but the genuine article I cannot make a bit, and what I do make does not stick properly. Ought one to mix it up in one's hands? I wouldn't be a glazier if they get their hands in the mess I get mine in when I do it.—R. A. R. Bennett.

[56771.]—**Calico Dyeing.**—How can I make stannate of soda liquor and powder suitable for calico piece dyers, as it is wanted different for pieces from hanks?—H. Holmes.

[56772.]—**Varnish for Wall Papers.**—Any information for preparing the varnish used by paper-hanging manufacturers to coat their paper to make it waterproof? It does not stain the paper as ordinary varnish and is quite flexible when dry.—A. W. G.

[56773.]—**Glucose in Leather.**—To Mr. Allen.—The practice of weighting leather with glucose is now largely carried on. I have used the following process for its estimation, and should feel thankful to Mr. Allen if he would point out its defects or indicate a shorter course. 5grm. of leather shavings were taken: these were shaved from the edge of the belt by means of a razor, placed in a Soxleth's fat extractor with ether to dissolve out fat and to free from gallo-tannic acid. Afterwards the shavings were boiled in a test tube with distilled water on the water bath three separate times, and the three extracts mixed and made up to 200cc. with distilled water. A portion of this was filtered and a burette filled with it. I found that 5·2cc. of this extract reduced 50cc. of Pavy's solution (see "Commercial Organic Analysis," Vol. II. page 290). I calculate that this gives 19 per cent. of glucose.—Weaving Manager.

[56774.]—**Tests for 5in. O.G.'s.**—To Mr. Sadler or "F.R.A.S."—Would either of these observers kindly give me a few tests for a good o. g. of 5in. aperture and inform me if there is any reliable formula for ascertaining the light-grasping power of such an o. g., and if so, to whose magnitude scale does it apply? I suppose all the objects in the late Mr. Webb's book are given in Smyth's scale.—H. A.

[56775.]—**Small Gas-Engines.**—To "Invicta."—I think it would materially improve your proposition with reference to amateurs making their own gas engines, if you included all subscribers to the "E. M." (whether they be amateurs or not) who can prove they have been such for, say, twelve months, or for any length of time that you might think fit? I think we should all of us, both subscribers and publishers, reap a benefit thereby, and thereby increase the circulation of the "E. M." I have been a subscriber to the "E. M." for several years, mostly for the purpose of gleaning something about gas-engines; and ever since those papers appeared on gas-engines some time since in the "E. M.," I have been anxiously looking for the promised instructions how to make one; and as I do a little work at the lathe during my spare time, and the only available power at my disposal has to come out of my own muscles, I should take it as a great boon if either you, "J.H.", or any other subscriber could furnish us the required information. I think myself that a small power gas-engine might be made without infringing on anybody's patent right, because for my own use, if I could run an engine, say ½-h.p., at 4d. per hour for an hour or two occasionally, I should be very thankful, and should not grumble at the expense; and 4d. per hour for a ½-h.p. gas-engine is far in excess of the cost of some gas-engines, the patents of which have already expired.—Theo.

[56776.]—**Electro-Motor.**—To Mr. Bottone.—Thanks for sketch and description of laminated armature. I propose to make one 3in. diameter, and 5in. long. Will you kindly say how many pounds and what size wire I shall put on armature, and how many pounds of what size wire I shall put on fields to get best results? Fields will be of the ordinary flat form of core. Core of fields will be about 4in. wide—what length should they be where wire goes on? What h.p. should above motor give with 4 to 6 large-sized plunging bichromate cells? What do you think about making the laminations of malleable iron?—Electric Motor.

[56777.]—**Paste Blacking.**—Would any of your numerous readers favour with receipt for making really first-class paste blacking, and describe the mode of manufacture and packing?—X. X.

[56778.]—**Circle.**—A. and B. run round a circle in the following manner:—When starting, they run in contrary directions round the circle till they meet, A. then instantly reverses his direction, running the same way as B., the latter's speed being slowest, he is overtaken by A. at the starting point, each speed being uniform. Required the relative speed of A. and B.—Amicus Veritatus.

[56779.]—**Problem.**—Two straight lines of equal lengths, crossing each other at right angles, and intersecting at their centres, are traversed to and fro, the one by A., and the other by B., always keeping the same distance from each other, that is, half the length of the traverse; C. interposes half-way, and in a line between A. and B., and takes a certain route, still keeping an equal distance from A. and B., while preserving a straight line of A. C. and B. Required the nature of C.'s path.—Amicus Veritatus.

[56780.]—**Camping Stoves.**—Can any reader of the "E. M.," tell me which is the best stove for boating and camping, coal, charcoal, and wood being very dirty and cumbersome. I have found two small oil stoves answer better than the above. Would two methylated spirit stoves be better still, as I want to take up as little room, and be as light and least trouble possible, as there is not too much room in a boat; also which is the best and handiest lamp or lantern?—W. P.

[56781.]—**Telegram Codes.**—Are any such published?—and if so, where? I have heard of one by Dr. Algar. Is it a good one, and how procurable?—M. N.

[56782.]—**Marking Bone or Ivory.**—How are the names of manufacturers so neatly stamped on articles, such as toothbrush handles, &c.? What sort of punches are used? How applied—hot or cold? and how and with what are letters then filled? I am often asked to mark initials on such articles, but fear to crack them with ordinary steel punches.—M. N.

[56783.]—**Steam Brake for Locomotives.**—On the Continent, where the inclines are severe, it appears reverse working has been employed as a steam brake; but as the temperature of the gases in the smokebox is about 600° F., they would dry up the lubrication of the cylinder and rubbing surfaces. This difficulty, however, has been overcome, by first sending into the exhaust pipe a jet of water; the energy of the moving mass is thereby stored up in the boiler, instead of being uselessly expended in grinding the rails and destroying the tires of the wheels. I should feel obliged if anyone would give a short account of how this system has answered, and also the reasons why it has not been universally adopted on our railways?—David Stephen.

[56784.]—**Bicycle.**—The front-wheel bearings of my bicycle are so worn as to cause some vibration. They consist of balls running in two parallel grooves, corresponding grooves being cut in the spindle. They are adjustable vertically by two screws in each, the cranks are not detachable. Will any reader tell me how to remedy this?—Amateur Mechanic.

[56785.]—**Kites and Kite-Carriages.**—Can any reader give me any information as to (1) the best shape, proportion, and material for kites for drawing and guiding (*i.e.* tacking) a boat or carriage? (2) A correct method of obtaing best position and angle of belly-band? (3) Reason of undue oscillation of kite, and means of preventing same? (4) The successful use of kite-carriage being an accomplished fact, a reference to any account of the method employed, or any work obtainable containing articles on the practical and scientific principles of kite construction. N.B. I have examined works in a public library, under several likely headings, without success.—J. H. T.

[56786.]—**Mechanics.**—Will any of the readers please inform me how to solve this problem?—Draw a square A B C D, and suppose it to represent a cube of stone weighing 1,000lb., and resting on a stone floor (A B produced); through D suppose a forceP to act, tending to make the body slide in the direction B to A. Find the magnitude and direction of P, when it is the smallest force that will make the body slide?—Dumbuck.

[56787.]—**Drilling Rough Plate-Glass.**—Will someone give a description of a drill for rough plate-glass slabs?—Juno.

[56788.]—**Agglomerate Battery.**—I have several agglomerate cells, and after putting new zincs and re-charging with sal-ammoniac I get scarcely any current. Can one of "ours" tell me if I can do anything with the blocks or carbon to get a good result? The blocks have been in use three years, and have had two new zincs during that time. I want them for electric bell and indicator.—A. A

[56789.]—**Klinkerfues' Barometer.**—While repairing the case of one of these instruments or "avertisseurs" as they are called by the makers, the index has become disarranged, and as it does not fit on a square or furnished with any indicator of its proper position on the axis of the instrument, I shall be pleased if some of "ours" would kindly inform me how to re-adjust it. At present I see no way but placing it alongside of another similar apparatus of known accuracy and setting with it; and with this object shall be glad to have access to one in the vicinity of Liverpool or Manchester.—Klinkerfues.

[56790.]—**Limited Liability Company.**—What are the customary and legitimate duties of a managing director and manager?—Klinkerfues.

[56791.]—**Telephone.**—It would be a great boon to many readers of "ours" if some able expert would summarise the leading features claimed by the various patentees as protected. Can Bell claim the exclusive use of an iron diaphragm with any and every form of electro-magnet actuated by battery current or permanent magnet?—or does an alteration in the nature of the diaphragm (though necessarily armed with iron armature in centre) or different form of electro-magnet, free it from royalty? Do Gower, Ochorowicz, &c., pay a royalty?—Klinkerfues.

[56792.]—**Coal.**—Will some obliging and experienced electrician say if coal and anthracite are conductors of voltaic electricity, and to what extent?—Klinkerfues.

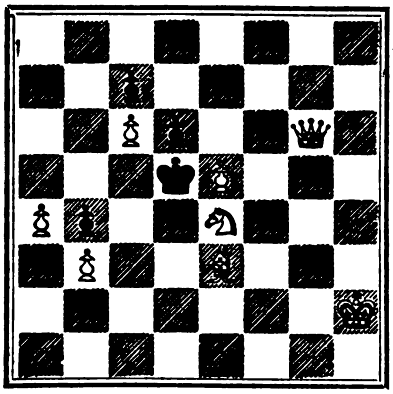
[56793.]—**Seltzogene, Leaky.**—I have one of Dr. Fevre's veritable seltzogenes for making soda water. Could anyone say what kind of cement the top is fastened on to the glass with? The top is a white metal one—are they screwed and cemented as well?—Seltzogene.

## CHESS.

All Communications for this department must be addressed to J. Pierce, Langley House, Dorking.

### PROBLEM DCCCCXLII.—An Easy Shave.

*Black.*



*White.* [8+4

White to play and mate in three moves.

### Solution to 940.

| *White.* | *Black.* |
|---|---|
| 1. K-Kt 8 | 1. K-K 2 or Q 2 (*a*) |
| 2. Kt takes P (dis ch) | 2. K moves |
| 3. B or Q mates | |
| 2. Kt-K 8 (ch), &c. | (*a*) 1. P takes P at B 4 (*b*) |
| 2. Kt-Kt 5 (ch), &c. | (*b*) 1. P takes P at B 5 |
| 2. Kt takes R P (ch), &c. | (*c*) 1. K-B 4 (*d*) |
| 2. B R 8 (ch) | (*d*) 1. P-Kt 6 (*e*) |
| 2. Kt-K 8 (ch) | (*e*) 1. Any other |

### NOTICES TO CORRESPONDENTS.

Correct solutions to 939 by V. S. Pochin (easy on account of no scope for white: plan prettily intended though full of duals), G. T. Stringfellow, Brum (pretty fair for a two mover), T. L. Robins.

To 940 by R. A. Bennett, J. E. Piper, A. W. Orr (very difficult, rich, and sound), Rev. W. Anderson (Old Romney), and A. S. Olver.

To 941 by H. Culmer, F. A. Vincent, E. S., and A. S. Olver.

Streetgate.—In 941, if 1. $\frac{\qquad}{\text{R takes Kt-P}}$ 2. B covers.

Game received from F. A. Vincent.

## ANSWERS TO CORRESPONDENTS

*** *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

### HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

*** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

### BACK NUMBERS.

We receive so many queries asking for directions how to make many instruments and appliances which have been fully described in back volumes that we have compiled a list, which we shall insert in this column at intervals, of those most frequently sent, and as the numbers are still in stock, new subscribers should consult the list before sending their questions.

Batteries: Nos. 741.
Bookbinding: Nos. 613.
Copying processes: Nos. 750, 753.
Electric machines: Nos. 628, 759, 840.
Electro-magnets: Nos. 756, 772.
Lacquers: No. 866.
Pattern Making: Nos, 938, 941, 943, 945, 948, 950, 952, 954, 955, 956, 958, 959, 962, 963, 965, 969, 973, 974, 978, 981, 986, 989, 993, 995, 998, 1,000, 1,001, 1,003 1,004, 1,008, 1,009, 1,010.
Silver-plating: No. 830.
Telephones: Nos. 695, 747, 865.
Varnishes: 478, 619, 675, 691, 723, 775.

The following are the initials, &c., of letters to hand up to Wednesday evening, June 3rd, and unacknowledged elsewhere:—

Tolley and Ticehurst.—T. Fenwick, jun.—Ellis and Co.—A. Jones.—H. Thorpe.—J. Tildesley.—British Horological Institute.—W. H. Harling.—E. P. Alexander.—C. S. Stock.—F. M. Rogers.—Dr. Edmunds.—E. A. Tindall.—Keeling and Rigley.—A. Plucknett.—B. J. Hopkins.—An Old Subscriber, Walsall.—Backwoodsman.—A. Hearn.—S. Arlidge.—Hadah.—W. B.—S. Beeching.—Ascalon.—A. H. G.—Vandusra.—G. H. Hepworth.

C. A. (Yes. Mr. Ellis Lever, of Bowdon, Cheshire, made the offer. We believe the management of the competition rests with Mr. Burt, M.P.)—E. H. (You should use a pocket battery such as that described on p. 119, No. 1,019. For directions for constructing small accumulators, see p. 28, No. 1,016.)—Undergrad. (Heat to a red; when cool, fill with sand and stop each end tightly; then bend round suitable forms. Use a wooden hammer, if necessary. We do not know of a book on that subject.)—J. S. (They can, if they like, bring an action against you; and if they have a good case, very likely will. If you have a good case, you can stop their threats by bringing an action against them; but before doing anything of that kind, consult a solicitor. If you had a partner with money, you would probably hear nothing of the threats.)—C. H. Thompson. (There are practical difficulties which, so far as we can see, it is impossible to overcome. Why not submit your ideas to a firm of engineers? If presented in a comprehensible shape, they would, no doubt, receive attention. The advantage of utilising nearly the whole of the available heat of the fuel is unquestionable; but at present you have not explained how that is to be done.)—J. Thompson. (Celluloid is, we believe, used. See the indices, however, for much information on the subject.)—Nimnim. (Try the common shellac cement, or if that won't do, marine glue.)—Onus Probandi. (What connection has your letter with the subject? Pinchbeck is an alloy of copper and zinc; but the metal referred to in the query contained gold, silver, copper, and palladium. Information about that was asked for. If you can supply it, by all means send it on.)—W. E. S. (It is specially-prepared paint, and it is frequently rubbed down with glass-paper and pumice-stone until a perfectly smooth surface is obtained. For your purpose, filter the paint through canvas, and put on in very thin coats with good brushes, letting each coat dry thoroughly hard before rubbing down. Work of the kind is usually finished with stoving copal and, so to speak, japanned in an oven.)—A Sufferer. (Frequent bathing in the hottest water that can be borne has been recommended. Some suggest the addition of bran or hay to the water.)—J. W. (Perhaps he does not intend to publish it.)—John Bayley. (The question has been frequently answered. You must fill the holes with oil—force it in, in fact. See p. 262.)—An Inquirer. (The simplest is ice and salt—two parts of pounded ice to one part of salt. If ice cannot be obtained, a cheap mixture is sulphate of soda 8 parts, hydrochloric acid 5 parts.)—M. C. Z. (Put such a question to Mr. D. Nutt, bookseller, Strand, W.C. There is not much demand for books of the kind.)—Dale. (Absolutely worthless.)—J. W. Elphic. (Probably copies; but, as you were told by the directors of the National Gallery, no opinion could be given worth having by one who had not seen them.)—T. R. Allinson. (You cannot do it. The American conscience as to copyright is a bad one. You can only secure your object by arranging with some American publisher for publication on the same day as in England.—P. Le Neve Foster. (Inserted; but Italian stamps are of no use here. Send a Post Office order.)—Edward Harrison. (We are not a sporting prophet.)—Esau. (All depilatories contain lime or arsenic, and are dangerous. Here is as harmless a one as any: Sulphate of arsenic, 1oz.; quicklime, 10oz.; starch, 14oz. Well mix into a stiff paste with water, and allow a little to remain on the skin for a few minutes.)—Leo. (Freckles may be removed by a teaspoonful of hydrochloric acid, and 1 fluid ounce of rectified spirit. Mix with 8 fluid ounces of water.)

**Every Workman** connected with the Building Trades requiring a Situation should advertise in "THE BUILDING NEWS," published every FRIDAY, price Fourpence, at 332, Strand, London, W.C.

"THE BUILDING NEWS" is the Principal Journal representing Architects and Builders, and has the largest circulation of any Professional Journal in the kingdom.

Every Workman should insist on seeing "THE BUILDING NEWS" every week at his Club or Coffee House. He will find more "Lists of Tenders" for new work in it every week than in any similar paper, and can thus judge where work is likely to be had. He is also specially invited to make use of "Intercommunication" if he wants to know anything about his trade; to write to the Editor if he has any suggestions to make, and to advertise in the paper when he wants work.

The charge for Advertisements for Situations is One Shilling for Twenty-four Words, and Sixpence for every Eight Words after.

## TERMS OF SUBSCRIPTION.

PAYABLE IN ADVANCE.

5s. 6d. for Six Months and 11s. for Twelve months, Post Free to any part of the United Kingdom. For the United States, 12s., or 3 dols. 25c. gold; to France or Belgium, 13s., or 16f. 50c.; to India (via Brindisi), 15s. 2d.; to New Zealand, the Cape, the West Indies, Canada, Nova Scotia, Natal, or any of the Australian Colonies, 13s.

The remittance should be made by Post-office order. Back numbers cannot be sent out of the United Kingdom by the ordinary newspaper post, but must be remitted for at the rate of 4d. each to cover extra postage.

Messrs. James W. Queen and Co., of 924, Chestnut-street, Philadelphia, are authorised to receive subscriptions for the United States for the ENGLISH MECHANIC, at the rate of 3 dols. 25c. gold, or Thirteen Shillings per annum, post free. The copies will be forwarded direct by mail from the publishing office in London. All subscriptions will commence with the number first issued after the receipt of the subscription. If back numbers are required to complete volumes, they must be paid for at the rate of 4d. each copy, to cover extra postage.

Vols. IV., VII., XXVI., XXVIII., XXX., XXXII., XXXIII., XXXIV., XXXV., XXXVI., XXXVII., XXXVIII., XXXIX., and XL., bound in cloth, 7s. each. Post free, 7s. 9d.

All the other bound volumes are out of print. Subscribers would do well to order volumes as soon as possible after the conclusion of each half-yearly volume in February and August, as only a limited number are bound up, and these soon run out of print. Most of our back numbers can be had singly, price 2d. each, through any bookseller or newsagent, or 2½d. each, post free from the office (except index numbers, which are 3d. each, or post free, 3½d.)

Indexes for Vols. I., VI., VII., VIII., and IX., 2d. each. Post free 2½d. each. Indexes to Vol. XI. and to subsequent vols., 3d. each, or post free, 3½d. Cases for binding, 1s. 6d. each.

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*** It must be borne in mind that no Displayed advertisements can appear in the "Sixpenny Sale Column." All advertisements must be prepaid; no reduction is made on repeated insertions; and in cases where the amount sent exceeds One Shilling, the publisher would be grateful if a P.O.O. could be sent, and not stamps. Stamps, however (preferably halfpenny stamps), may be sent where it is inconvenient to obtain P.O.O's.

The address is included as part of the advertisement, and charged for.

Advertisements *must* reach the office by 1 p.m. on Wednesday, to insure insertion in the following Friday's number.

## NOTICE TO SUBSCRIBERS.

Subscribers receiving their copies direct from the office are requested to observe that the last number of the term for which their subscription is paid will be forwarded to them in a PINK Wrapper, as an intimation that a fresh remittance is necessary, if it is desired to continue the Subscription.

**Epps's Cocoa.**—Grateful and Comforting.—"By a thorough knowledge of the natural laws which govern the operations of digestion and nutrition, and by a careful application of the fine properties of well-selected Cocoa, Mr. Epps has provided our breakfast tables with a delicately flavoured beverage which may save us many heavy doctors' bills. It is by the judicious use of such articles of diet that a constitution may be gradually built up until strong enough to resist every tendency to disease. Hundreds of subtle maladies are floating around us ready to attack wherever there is a weak point. We may escape many a fatal shaft by keeping ourselves well fortified with pure blood and a properly nourished frame."—*Civil Service Gazette.*—Made simply with boiling water or milk. Sold only in packets, labelled—"JAMES EPPS and CO., Homœopathic Chemists, London."—Also makers of Epps's Chocolate Essence

**Holloway's Ointment** is not only fitted for healing sores, wounds, and relieving external ailments, but rubbed upon the abdomen it acts as a derivative, and thus displays the utmost salutary influence in stomachic disorders, derangements of the liver, irregularities of the bowels, and other intestine inconveniences which mar man's comfort.

**J. THEOBALD AND CO.'S LATEST SPECIALITY.—THE AMATEUR'S PHOTOGRAPHIC CAMERA,** for Instantaneous Photography.

THE widespread interest created by the excellent exhibits of Photographic Apparatus at the INTERNATIONAL INVENTIONS EXHIBITION, and the ever-increasing demand for something really practical, and yet cheap, has induced us to at last bring out the

**AMATEUR'S CAMERA,**

which is the outcome of nearly two years of study and experiments. It has been easy enough to manufacture Photographic Apparatus, but a far different thing to bring out a really good article, at a price that would meet the wants and pockets of amateurs. We have now succeeded, however, but wish it to be thoroughly understood that nothing short of a sale of some thousands will enable us to make them and sell them at the price. We cannot afford to lose money, which we shall certainly do if only a few dozens are sold. Consequently, we will only undertake to execute orders that reach us within 28 days. This will give us sufficient time to see if the demand will pay, and if it does not, we shall then stop the sale. We, however, believe that the demand will be enormous: otherwise this advertisement would never have appeared. With this Camera persons can photograph their friends, pet animals, houses, scenery, &c. It is often inconvenient for one to have to dress and go to a photographer's at a certain time. All this is now done away with. Whenever you feel inclined to take a person's photograph, or have your own taken, bring out the Camera, and it is done at once. To avoid all misunderstanding, let it be understood this Camera will *really take photographs*, not simply copy them; and all chemicals, &c., are given with it. Do not confound this with other Cameras, which, although advertised at much *higher prices*, yet have no accessories, but after you get the Camera you have to spend a large sum of money for chemicals and other apparatus. This one we sell is *complete*.

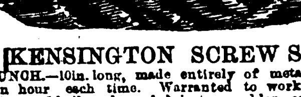
The Amateur's Photographic Camera measures 6in. square, and consists of a strong, well-made Camera, powerful Lens, Brass Fittings, Brass Cap, Focussing Tube, Dark Shutter and Slide, Focussing Glass, Packet of Dry Plates, Packet of Sensitised Papers, two Bottles of Developing Solution, Bottle Gold Solution. Box of Fixing Crystals, Cards for Mounting, Printing Frame, Elastic Bands, Glass Roller, and full instructions complete. Carriage free, 15s. This apparatus will really take perfect Photographs indoors or outdoors. For Travellers, Bicyclists who wish to carry away with them views of lovely spots they visit, for Ladies and Gentlemen, for Mechanics for taking Photographs of Models, and for a thousand and one other things, these Cameras are unrivalled. Specimen of Portrait taken, post free, six stamps.

All orders must be sent within 28 days (except from abroad), and customers will oblige by sending the Coupon below with their order.

ENGLISH MECHANIC COUPON.
Entitles holder to 1 Amateur Camera for 15s. if sent within 28 days.
(Signed) J. THEOBALD and CO.

Two will be sent, Carriage free, for 28s.

**A FISHY BARGAIN. — Enormous** demand. A splendid ten-joint Bamboo Fishing Rod, opening out to 12 feet. Packed in neat case, carriage free, 2s., two for 3s. 6d. Twenty-five yards best Derby Silk Twist. 1s. 2d.; three dozen good Hooks on Gut, 1s. 1d. Three yards best Gut, 7d. Three assorted Flies, 7d. Silver-plated Winch, 1½in., 1s. 3d.; 2in. 2s.



**THE KENSINGTON SCREW STEAM LAUNCH.**—10in. long, made entirely of metal. Will go for half an hour each time. Warranted to work perfectly. Fitted with metal boiler, brass lubricator, rudder, screw, deck and furnace, shaft, &c., complete. Carriage free. 1s. 9d. Larger and better quality, 3s. 6d., or, with cylinder, 6s. 6d. and 12s. 6d.

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**A Simple Bible Question!**

**An Easy Chance for Old and Young!**

We offer Premiums to above amount to the 217 persons correctly answering the following simple question: **WHERE IN THE BIBLE IS THE WORD "MIRTH" FIRST MENTIONED?**

No person will be entitled to participate in our rewards unless answer to above question is accompanied by an order for the GOLDEN ARGOSY, on following terms: One Year, 8s.; Six Months, 4s.; Three Months, 2s. post paid, to your address.

To the first answering correctly, on or before July 1st, we will give £50; if we receive more than one correct answer, we will give to Second, £30; Third, £20; Fourth £15; Fifth, £10; Sixth, £5; and to the next 200, each, a Standard Dictionary, containing over 900 pages, and 80,000 references. If you are not first, you may be second, third, fourth, fifth or sixth, so **YOU STAND A GOOD CHANCE FOR A LARGE PRIZE.**

In order to please all, we offer the following:

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## OUR EXCHANGE COLUMN.

*The charge for Exchange Notices is 3d. for the first 24 words, and 3d. for every succeeding 8 words.*

**Good Value Offered** (cash or instruments) for all kinds of sound or repairable Scientific Appliances.—Caplatzi, Science Depot, Chenies-street, near British Museum. Established 1862.

What offers for half horse-power **Steam Engine**, nearly new, brass cylinder, lagged in rosewood.—Apply, Willson, Coney-hill, Gloucester.

**Induction Coil**, ½in. spark; for Violin, Mandoline, or offers.—James Campbell, 60, Fisher-street, Glasgow.

**Shower Bath**, complete. Exchange to value 30s., cost double; perfect order. Quarter-plate Photographic Set, complete. Exchange to value 30s.—Fell, Market Rasen.

**Organ Pipes**, second-hand, wanted, from 3ft. F bass, to 4½in. F treble, octave and half-stopped diapason, rest clarabella or flute. Exchange—Particulars to Boswall, 177, Stanhope-street, London.

52in. **Bicycle**, Coventry "Imperial," in sound condition, half bright, with patent bell, worth £4; giving up riding. Offers wanted.—H. S., 263, Goswell-road, N.

**Lathe**, with fret saw attachment, little out of order, cost 60s. Exchange anything useful.—A. B., 48, Albion-road, Dalston, London.

**Electric Motor**, by H. Jones, not been used, cost 21s. Exchange anything useful.—A. B., 48, Albion-road, Dalston, London.

**Bench Top**, 3 inch thick, 5 by 3ft., height 2ft. 9in., will take to pieces, just cost 22s. 6d. Small parallel vice, 3in jaws, 14s. Wanted, a good Watch; approval.—Mechanic, Spen Hall, Cleckheaton.

**Bellows Camera**, ¼-plate, and two double dark slides, nearly new. What offers?—F. W. Algar, Stenard-road, Winchmore-hill, London, N.

**Mystery Gold.**—I will exchange heavy Albert for any useful article worth 5s., quite equal in appearance and wear to nine-carat gold. See Sixpenny Sale Column.—W. E. Russell, 10, Judd-street.

**Microscope**, ¼, ½, 1 inch powers, rack and pinion adjustment. Will exchange for a good Telescope, or offers.—W. Richardson, care of M. Day and Son, Dewsbury.

What offers in exchange for ½-plate **Photo Apparatus**?—For particulars, apply, A. Chambers, Dane Hill, Uckfield.

Small **Lathe**, bed 2ft., centre 8 inches, watchmaker pattern, fit for amateur, in exchange for bicycle.—P. Hurst, 15, Radnor-street, Plymouth.

Eight Vols. "**English Mechanic**," XXXIII. to XL., inclusive, clean, unbound. What offers? Drawing instruments wanted.—S., 3, Oak-terrace, Derby-road, West Croydon, S.

Screw-cutting **Lathe**, 4 to 8 inch centres, wanted; must be first-class, self-acting, sliding, and surfacing; in exchange for smaller Turning Lathes, or splendid Bicycle or Tricycle, or other valuable exchange.—Palmer, 5, Townwell Fold, Wolverhampton.

What offers for 23 parts of "**Amateur Work**," illustrated.—Address, X., Post Office, West Gorton, Manchester.

**Lathe Head**, 7in., cones for lathe wheels and lathe heads, gut, turned and bored bicycle fittings. Exchange offers to W. Smith, Bilston-road, Wolverhampton.

Wanted, collection of above 1,000 **Stamps** in exchange for Books, Scarf Pin, Electric Bell, Batteries, and other Electrical Apparatus.—H. Bunting, Didsbury.

25 c.-p. **Hand Dynamo**, E. M. pattern. Exchange for ½-plate Portrait Lens or offers.—F. G., 13, Radipole-road, Fulham-road.

Wanted, small **Mincing Machine**, perfect. Exchange "Electrician," from October 22, '81, January 13th, 1883, all clean. What offers for "Cassell's Family Magazine," Dec., '79, to Dec., '80?—Gowing, 14, Newry Faur, Holyhead.

Exchange **Fishing Rod, Lines**, &c., for Rubber Stamp Making Materials, Apparatus, &c.—Particulars, H. Yeend, Oakley Cottage, Cemetery-road, Cheltenham.

Will exchange 50in. **Bicycle**, bent handles, hollow forks, &c., cost £12, for Boat, or take £5 cash.—E. Ayres, Glade-road, Great Marlow.

"**English Mechanic**," clean, unbound, May, 1881, to present date; what offers, or cash?—J. C. Lee, 28, Sheaf-street, Heeley, Sheffield.

Twelve **Bunsen Cells** (quarts) offered in exchange for Books on Electricity, or anything useful.—J. W. G., Albert House, Haverfordwest.

Vertical **Engine**, cylinder 1½ by 1½, nearly all brass. Exchange good Portrait Lens.—John Fraser, Cottown, Glencarse, by Perth.

**Apparatus.**—All kinds, Chemical, Physical, Electrical, Photographic, exchanged for cash, or best value in other apparatus.—Send to Kemp and Co., Infirmary-street, Edinburgh.

**Micro.-Photo Objective**, by Dallmeyer, also other hoto Apparatus, for bound vols. of E. M., or offers.—Day, 56, Driffield-road, Old Ford, London.

**Speculum**, Silver-on-Glass, good definition. 9 inches diameter, 6ft. 2½in. focus; what offers?—Day, 56, Driffield-road, Old Ford, London.

What offers? 5½in. **Telescope**, O.G. about 7ft. focal.—W., 16, St. John's-road, Hoxton, N.

Edison's **Electric Pen**, Press, and Battery, cost £16. What offers?—5, Stanley-road, N.

**Watchmaker's Throw**, with tools, cost £16.—5, Stanley-road, Ball's Pond, N.

**PLANE AND TOOL MANUFACTURERS.**
(ESTABLISHED 1730).
**JOHN MOSELEY & SON,**
54 and 55, BROAD STREET, BLOOMSBURY, W.C., and
151, LEMAN STREET, WHITECHAPEL, E.
Price Lists on application. 10s. worth of Goods Carriage Free.
Wholesale, Retail, and for Exportation.

**£20 TOBACCONISTS COMMENCING.**—An Illustrated Guide (110 Pages), HOW TO COMMENCE BUSINESS RESPECTABLY, 3 stamps.—E. MYERS and CO., Cigar and Tobacco Merchants, 109, Euston-road, London. Wholesale and Export Only. Telephone No. 7541.

## THE SIXPENNY SALE COLUMN.

*Advertisements are inserted in this column at the rate of 6d. for the first 16 words, and 6d. for every succeeding 8 words.*

**Motor Castings**, materials for Electric Bells, Batteries, Galvanometers, Intensity Coils, Microphones.—King, Mendham, and Co., Bristol.

**Insulated Wire Table**, showing size, weight, resistance per foot, feet per ohm, &c., price 3d.—King, Mendham, and Co., Bristol.

**Standard Ohm**, in box, copper poles, guaranteed correct to ten thousandth of ohm, 21s.—King, Mendham, and Co., Bristol.

**Wimshurst Influence Machine.**—Sole Manufacturers of Improved Pattern. Numerous testimonials as to thorough efficiency.—King, Mendham, and Co., Bristol.

**Galvanometer Cards**, improved for tangent and ordinary combined, 2½in., 8d.; 4in., 10d.; 6in., 1s.; post free.—As above.

Write for **King, Mendham, and Co.'s** large new and reduced Price List, post free 4 stamps.

**Trouser Lengths**, 5s. each. Cheap Cloth for Ladies' Dresses, Mantles, Boys' Suits.—Hewitt, 27, Winfield Mount, Leeds. Patterns free.

**Electric Depot**, 10, Deansgate, Manchester.—Electric Breast Pins, 25s. Electric Bells, 4s. Induction Coils, 8s.—Millar, Proprietor.

**Billiards.**—Great success of Thorpe's Patent Automatic Cue Tips. Cannot fly off. Cues retipped instantly.

**Billiards.**—Excellent testimonials from Roberts, jun. champion, and other professionals. £5 per week easily earned.

**Billiards.**—District Agents wanted. Send 9 stamps for particulars and sample cue end fitted with patent.

**Billiards.**—Five Shillings for sample cue, also fitted, and 3 extra tips. Thousands already in use.

**Billiards.**—Apply to sole representative for United Kingdom.—A. W. Morgan, Lancaster Avenue, Fennel-street, Manchester.

Hard **Vulcanised Fibre** for Magnet Heads.—Mosses and Mitchell, 68a, Chiswell-street, London, E.C.

Hard **Vulcanised Fibre** for all kinds of insulation.—Mosses and Mitchell, 68a, Chiswell-street, London, E.C.

**International Inventions Exhibition**, East Avenue, Group 21, Stand 1683.—Mosses and Mitchell, 68a, Chiswell-street, London, E.C.

Tudsbury and Sons' "High Tension" **Wimshurst** Machines, with Compound Ebonite Plates. List, one stamp.—Edwinstowe, Newark.

24 **Microscopic Slides**, in box, very cheap. List sent for stamp.—Well, Dalmain-road, Forest Hill.

**Tricycle Wheels**, Bicycle Wheels, and Fittings Wonderfully cheap. Also for Safety Bicycles.—W. Gwinnett and Co., Wolverhampton.

**Lathes**, Lathes. Cheapest and best. List, 2 stamps Nothing equal at price.—Robinson, Somerset-road, Sheffield.

100 **Foreign Stamps**, including Brunswick, Ceylon Tasmania, Egypt, Greece, Luxemburg, free 7d.—Hely, Foley-street, London.

**The Kinetic Engineering Company**, 36 and 37, Brooke-street, Holborn, London. Circulars and list post free

**Dynamo Wire**, 1s. 2d. per lb. Line Wire, 29s. 6d. per mile. Pushes, 4s. per dozen.—Kinetic Company.

**Leclanche Cells**, best. No. 1, 16s.; No. 2, 19s.; No. 3, 22s. 6d. per dozen.—Kinetic Company.

**Electric Bells.**—Best quality, workmanship, appearance and value in market, 40s. per dozen.—Kinetic Engineering Company.

**Maiche Patent Battery.**—Best yet produced. Circulars and Scientific Reports post free.—Kinetic Engineering Company.

**Electrical Supplies.** Wholesale only.—Kinetic Engineering Company, 36 and 37, Brooke-street, Holborn. London, E C.

Gravet's **Slide Rule**, recommended by H.M. Government officials. Write for prices and testimonials.—Sole Agent, Farrar, Benson's-buildings, Leeds.

**Chemical Apparatus.** — Catalogue, 80pp., 500 illustrations, posted 3d.—W. Hume, Lothian-street, Edinburgh.

**Photographic Apparatus and Chemicals** for professionals and amateurs. See new illustrated catalogue, post free.—Hume, Lothian-street, Edinburgh.

Brazilian Pebble **Spectacle Glasses**, rough slabs or polished.—Richard Baker and Co., 9, Mincing-lane, London.

Brazilian **Pebbles and Crystals.**—Richard Baker and Co., 9, Mincing-lane, London.

**Mica**, otherwise Talc.—Richard Baker & Co., 9, Mincing-lane, London.

**Planing**, not exceeding 10in. by 10in. by 8in.—B. W Olroo, 18, Belinda-street, Hunslet, Leeds.

For **Model Work** (wheel-cutting in brass only); also Boring, Turning, and Screw-Cutting.—Olroo, as above.

**French Polishing**, Staining, Painting, and Varnishing. 122 Recipes or Trade Secrets, with full instructions and details, post free, 1s.—I. Tomlin, 28, Highfield-terrace, Barnsley, Yorkshire.

**Castings.**—Half horse-power Horizontal, Vertical, or Launch Engine Castings, complete, with brass work and forgings, 12s. 6d. One horse-power, 25s.—Tomlin, Highfield-terrace, Barnsley, Yorkshire.

**Castings.**—Bench Drilling Machine Castings, complete, 3s. 6d.—I. Tomlin, Highfield-terrace, Barnsley, Yorkshire.

**Castings.**—All Brass Engine Castings, horizontal or vertical, suitable for model work, 2s. 6d. set.

**New Designs and Price List** of Perfected Engines and Castings, post free.—I. Tomlin, Engineer, 28, Highfield-terrace, Barnsley, Yorkshire.

**Bottles for Chemists**, Wine and Beer Merchants, sample tubes, cases, and boxes.—Edward W. Drury, Hull.

**Optical Glass** of finest quality, crown and flint; all sizes in stock to 14 inches diameter, discs and sheet.—Buckingham, Blenheim-grove, Peckham.

Cotton-covered **Wire**, D.C. 10 to 18, 1s. 9d.; 20, 22, 24, 26, at 2s., 2s. 3d., 2s. 6d., and 3s. per lb.—C. Darvill, 8, Brent View-road, The Hyde, London, N.W.

Celebrated Kerry **Ferns**, 12 varieties, including bridge filmy, 1s. 6d. free.—FitzPerr, Rathanny, Tralee, Kerry.

Pumphrey's **Pocket Tripod**, for cyclists, professional and amateur photographers. Perfectly rigid. May be had on approval. Illustrations and testimonials free.—Pumphrey, Stanhope-street, Birmingham.

Pumphrey's **Hydrostatic Shutter** for instantaneous and timed exposures. Photographs done with it. Free, price 10s.

Pumphrey's **Camera and Lantern**. with 54 illustrations. 2 instantaneous photographs. Full instructions, 2d. post.

Eighty sets **Lantern Photographs** at reduced price. Illustrations of 20 sets post free.—Pumphrey, Stanhope-street, Birmingham.

**Engine**, horizontal double oscillating cylinders, ¼-horse, price £6, little used.—Journet, 194, Great Portland-street.

**Insulated Wire**, best quality only. Price list free. —Maw, removed to 53, St. James's, Brixton, London, S.W.

**Harmonium**, £4, walnut, full compass, rich tone, quite new, perfect, warranted. -W., 140, Carlton-road, Kentish Town.

**Brass Cylinders**, accurately turned and beautifully finished, with slide-valve, 16 screws, &c., fitted complete materials and workmanship guaranteed very best, and can be had on approval by deposit. 1in. stroke, 5s. 9d. ; 1¼, 7s. 9d. ; 2in.. 10s. 6d.—H. F. Lovegrove, Optical Works, High-street, Slough,

**Strange Fact**.—Although the cylinders (as above) have been sent on approval to various parts of the kingdom, yet up to this date (May 20th, 1885) not one has been returned.

**Dynamo Castings**, 20 candle-power, 5s., Photo. 6d., Wire, 18s. 6d. Gunmetal Wheel, 4s. Motors, &c.

**Turning, Drilling, &c.**, every kind of work done-—Staunch and Butterworth, 1, Elmfield-road, Bromley, Kent.

**Showcases for Exhibitions**, Models, Scientific Instruments, Nests of Drawers, &c., &c.—Fry and Co., Shop-fitters, 90, Borough-road, London.

**Homœopathy**.--Laurie's "Epitome of Homœopathy," 540 pages, together with solid morocco case, containing 44 medicines, complete, price £1.—T. C. F., 332, Strand, W.C.

**Printing Presses**, from 10s. to 50s., complete numerous testimonials.—Manufacturers, Adams Bros., Daventry.

**Refractors and Reflectors** for sale, a 4½in. Cooke (old Thomas), Equatorial.—G. Calver, Widford, Chelmsford.

Model **Steam Engines** made or repaired. Separate parts fitted up, boilers made to order.—Lucas and Davies, 21, Charles-street, Hatton-garden, London.

3in. centre **Lathe Heads**, several for sale, cheap new.—C. Pool, Tool Maker, 30, Hockley, Nottingham.

3½in. back-geared **Heads**, hardened double coned, steel mandrels, phosphor bronze bushes.—Pool, as above.

New Illustrated Price List of **Screws, Bolts, and** Nuts for Model Work, drawn to actual size, sent on receipt of stamp.—Morris Cohen, 132, Kirkgate, Leeds.

Valuable **Patent**, connected with railways, for sale, full particulars from J. T. Leighton, 18, Montgomery-street, Edinburgh.

Model **Engine Castings**.—Best and cheapest. See list (stamp) and compare.—Wood, Dalley-street, Broughton, Manchester.

**Front Slide Lathe**, concerning which so much correspondence in English Mechanic. Circular, 2 stamps. Front Slide Lathe, used in Britannia Works several years, slides two shafts at one time, self-acting, stop and length automatically, £30.

**Binocular Microscopes and Apparatus**, stage and stand condensers, polariscopes, and all accessories. Alterations and Repairs for the trade.—R. G. Mason (from J. Swift), 24, Park-road, Clapham, London, S.W.

To Engineers, Founders, &c.—**Block Letters and** Figures in wide, medium, and extra condensed characters, from ½in. upwards.—Jos. Leanby, Langton-road, Brixton.

**Launch Engine**, 3in. bore, feed pump, complete, vertical boiler, 1ft. 9in. diameter, 3ft. high, 19 tubes, lagged and fittings, complete, £35.—S. Smith.

**Propellers**, improved pattern, from 12in. to 30in., in stock.—S. Smith, 11, West-street, Soho, W.C.

For sale (by Singer), a three-in-hand **Tricycle**, good, clever, cost £40 ; price £10 ; also American Star Bicycle, cost £22, six guineas. Rear-steer Tricycle, £7.—Dyer, 124, Falcon-road, Clapham Junction.

More about the **Wonderful Ink** at 1d. per quart.—Jet black ! Free-flowing ! Unfading ! Non-corrosive ! Waterproof. Recipe, 7 stamps (returned if dissatisfied).—Stanley, 119, Manchester-road, Poplar.

**Lathe**, 6in., back-geared, compound slide-rest, double throw crank, V and flat bed, heavy 7 speed flywheel, £10 ; also 2 overhead motions, cheap.—Lane, 35, High-street, Peckham.

"**Hints on Egg Collecting**." Illustrated Pamphlet, 3d. Drills and Blowpipe, 1s. free.—W. Davis, Naturalist, Dartford.

**Ova, Ziczac, Pudibunda**, 4d. ; Dictæ, 6d. ; Larvæ, Dispar, 6d. Monacha, 9d. d.z. free.—W. Davis, Naturalist, Dartford.

**Gas Engine**, 3-man, Barker's Patent Universal, good as new, £28. All my extra fittings.

Patent **Band-Saw Machine**, on stand, two saws, hand or power.—10, Darby-road, Folkestone.

**Drawings of Slotting**, Oxford Frame Moulding Machines, 3in. piston, two shillings each.—Edward Dale, Sherborne, Dorset.

**Bicycle** for sale, 51in., Northern, ball bearings, nearly new, cost 12 guineas. Will take £8. Guarantee in perfect order. —Address, E. Wake, Railway-street, Percy Main, near North Shields.

Steel **Name Stamps**, 3d. per letter. Figures (set), 2s. 4d. Letters, 6s. 4d. per post.—E. F. Baldwin, Robinswood-hill, Gloucester.

**Formulas Worked Out** for winding Dynamos from 10 c.-p. to 500 c.-p., 8 stamps each.—H. Jones.

**Dynamo Castings**, Jones's patent H : 8 c.-p., 5s. ; 16, 5s. 6d. ; 20, 6s. 6d. ; 30, 7s. ; 70, 16s. a set.—H. Jones.

**Dynamos**, finished : 8 c.-p., 30s. ; 16, 36s. ; 20, 40s. ; 30, 50s. ; 70, 100s. each.—H. Jones.

**Dynamos** for house lighting. — Jones's Patent Laminated Fields and Armatures, 5, 6, and 7 lights, £6, £7, and £8 each.—H. Jones.

**Dynamo Machines Repaired**. Motors, with wire, 5s. 6d.—H. Jones, 48, High-street, Lambeth, S.E.

**Standard Ohms**.—S. Bottone has a few of these on hand. Price 2s. 6d.

**Am-meter**, indicating up to 8 ohms, 5s. Delicate Galvanometers, in glass-capped boxes, 5s.

**Wheatstone's Bridges**, 5s. each, post free.—S. Bottone, The Limes, Stanley-road, Carshalton.

**Oxygen Gas**, compressed in cylinders, handiest and safest for limelight.—Clarkson, Compressed Gas Chemist, Bartlett's-buildings, E.C.

**Oxygen Gas**, compressed into iron bottles, liquid nitrous oxide and carbonic acid.—Clarkson, Compressed Gas Chemist.

**Oxygen Gas**, compressed into iron bottles : prices on application.—Clarkson, 28, Bartlett's-buildings, Holborn, E.C.

Astronomical **Telescopes** of all kinds and Apparatus or Fittings made by A. Clarkson, 28, Bartlett's-buildings.

**Eyepieces**.—Huyghenian of any power to fit any telescope, 15s. each. Sun Diagonals, £1. Star Diagonals, 30s.

Astronomical **Telescopes**, second-hand, by best makers.—Clarkson, 28, Bartlett's-buildings, Holborn, E.C.

Must be sold.—Horizontal **Engine**, 1¼ bore, with boiler, £1 5s.—A. R. Lane, 30, Alfred-road, Handsworth, Birmingham.

First-class 6in. **Slide-Rest**, had very little wear, price 30s. Cost £5 10s.—A. H., 6, Wymering-terrace, Lavender-hill, S.W.

**Theodolite**, 4in, Troughton and Simms, price 10 guineas. 13in. Dumpy Level, 5 guineas.—S., 20, Montpelier-road, N.W.

Dollond 4in. **Telescope**, steadying rods, six powers, finder, &c. Price £25.—S., 20, Montpelier-road, N.W.

**Oils**, lubricating, or Lardine : expired patents. Send for instructions.—J. M., 6, Hamlet-street, Bootle, Liverpool.

**Printing**.—100 Bill Heads, 1s. 3d. ; 100 Business Cards, 1s. 2d. Larger quantities, special quotations.—Brooks and Co., Rotherham.

Half-plated 46in. Humber type **Tricycle**, new, Coventry make, cost £26. Will accept £14 10s., cash ; have been forbidden to ride.—A. B., 87, High-street, Sydenham, S.E.

Galileo **Telescope**, 36 inches, very powerful, astro. or terrestrial purposes, 2s. 6d., free.—Theobald, South-street, Greenwich.

**Electric Bell**, cost 16s., will sell for 9s. ; never been used.—P.O., C. King, Jeweller, Windsor.

**Steam Launches and Engines**, Boilers and Propellers for same, all sizes. State requirements.—Chennall, Eastville, Bristol.

**Launch Engines**, 6in. double and 6in. single cylinders, good, cheap.—John Middleton, 16, Hope-street, Glasgow.

**Launch Engine**, 4½in. by 5in. cylinder, link motion reversing, &c., £11.—John Middleton, 16, Hope-street, Glasgow.

**Launch Engines**. large and small, single and double, for sale.—John Middleton, 16, Hope-street, Glasgow.

**Lathes**. screw-cutting, 5in. centres, £16 ; 4in. centres, £14.—John Middleton, 16, Hope-street, Glasgow.

**Dynamo and Arc Lamp**, 2,000 c.-p., both new, 50 volts, 15 to 20 ampères, price £18.—George Tolman, Wolverhampton.

"**English Mechanic**."—Any back number, 3d. Indexes, 6d. Vols., 2s. 6d.—T. Sladen, 33, Cank-street, Leicester.

**Lawn Mower**, 11in., good condition, £2, carriage paid.—W. Harthup, Junior, Hurst-green, Sussex.

**H. Jones and Co.** for Polishes, Varnishes, Stains, Glues, &c., &c., &c. Virgin Cork, 16s. 6d. per cwt., any quantity. Methylated Spirit, 3s. 1d. gallon.

**Stylographic Pens**, 2s. 1d. free ; usual price, 5s. ; warranted.—H. Jones and Co., Viaduct-street, London, E.

First-class 3in. centre screw-cutting **Lathe**, cheap.—Particulars of A. Halls, Howard-street, Yarmouth.

Two new **Vice Pins** and solid boxes, suit 5in. vices, 10s. each.—Halls, Howard-street, Yarmouth.

**Piles**.—Worst cases cured first application. Indian Ointment, sent ten stamps.—Thomas Palmer, St. Helen's, Auckland, Durham.

**Devonshire Cream** (delicious) by improved centrifugal process. ½lb., free, 1s. 6d.—G. Bull, Manor Farm, Martock, Somerset.

**Fresh Butter** of superior quality from the cream, as above. 2½lb., free, 3s. 6d.

Genuine **Syrup Recipe**.—Coughs, Colds, Consumptive tendencies, 18 stamps ; poor person, 7.—Beta, Y. M. C. A., Bradford, Yorkshire.

**Telegraphy**.—Learners' sets, sounder, and key, and battery, P.O. Pattern 30s.—Sledge, Wyatt, and Co., Clapham.

**Telegraphy**.—Learners' Sets. S.N. instrument and Battery, 30s., free on receipt of cash.—S. W. and Co.

**Telegraphy**. — Sounder and key, full size (P.O. pattern), on mahogany boards, 30s. set.—S. W. and Co.

**Telegraphy**.—Telegraphic Clerks should purchase a set for home practice.—Sledge, Wyatt, and Co., Clapham.

**Telegraphy**.—SLEDGE, WYATT, and CO. (late of L. Clark, Muirhead, and Co., of Westminster), 95, Wirtemburg-street, Clapham.

**Sixpenny Telegrams**.—Before entering the Telegraph service have home practice with your own instruments.

**Telegraphy**.—Every set warranted complete, and sent free on receipt of P.O.—Sledge, Wyatt, and Co., Clapham.

**Sledge, Wyatt and Co.**, Electrical Engineers, are making these sets expressly for students of telegraphy.

**Incandescent Lamps**.—A few Woodhouse and Rawson, 50 volt, never used, at 2s. each.—Sledge, Wyatt, and Co.

**Quotations** forwarded to Amateurs for all electric work.—Sledge, Wyatt, and Co., 95, Wirtemburg-street, Clapham.

Vols. VI., VII., "**English Mechanic**," monthly parts, good. Highest offer.—G. Wessley, Waterloo-road, Aldershot.

**Mica Cut** for all purposes.—G. C. JOHNSON, 87, New Oxford-street, W.C.

An **Altazimuth** for sale.—For description and price apply, W., Bradninch Vicarage, Cullompton.

**Vermilion**, best, 2s. 4d. lb.—PINNELL BROTHERS, 214, Whitechapel-road, London, E.

**Pyrotechny**.—Complete and valuable plant, the property of the well known author "Practicus," offered at very moderate cost.—Apply to J. Bacon, Coldash, Newbury.

**Medical Coil**, large size, by Dale, new, owner has no use for it, bargain, 25s.—Apply, G. Martin, 100, Russell-road, Wimbledon, Surrey.

50in. Coventry Machinist "**Roadster**," good condition, new suspension saddle, 75s.—A. Pledger, Ely.

**Assay Balance**, Oertling, short beam, new, cheap.—As below.

Dollond **Telescope**, 3in., three eyepieces, new.

**Lathe**, 3in., screw-cutting, slide-rest, cheap.

**Microscope**, Bulloch's Biological, two eyepieces, condenser, swinging substage.—H. P., East Howle, Ferry-hill.

**Mystery Gold**.—Warranted equal in appearance and wear to nine-carat gold. See opinions of press.

**Mystery Gold** is causing a great revolution in the jewellery trade. See articles in daily newspapers.

**Mystery Gold**.—I am now supplying heavy Alberts (ladies' or gents') at 3s. 6d. each, post free.

**Mystery Gold**.—Notice.—I do not sell these Alberts as gold, but a most wonderful imitation.

**Mystery Gold**.—For Albert, send Postal Order to W. E. Russell, 10, Judd-street, London, W.C.

Green's Patent **Lawn Mower**, 20-inch cut, throw-out gear, as new, £4.—East, Market Rasen.

**Ward's Division Plate**, new series, registered, 7 rows, for bicycle makers.—Olga Villa, Hurlingham-lane, Fulham.

**No more Bad Work**.—Possessors of Lathes should have one above wonderfully cheap tool, free, 13 stamps.

**100ft. Glass**, cut to size, 12s. 6d. Pamphlet on Polariscope, three stamps.—Holmes, 149, Essex-road.

**Burmese Gong**, brought from the Naga Hills, Upper Assam.—W. Griffiths, 22, Annandale-road, Greenwich, S.E.

**Conjuring**.—Rare chance for buyers. Clearing out stock ; also fit-up. Write for list.—Postmaster, Emsworth, Hants.

**Mesmerism**.—Full manuscript instructions, 2s. Raphael's Manuscript. Private instructions for students. Thirty pages, 4s.—Postmaster, Emsworth.

**Ventriloquism**.—Rare Bargains.—Two new knee figures, 15s. Two second-hand ditto larger, 20s.—Postmaster, Emsworth.

**Ventriloquism**.—Four new figures, splendid movements.—Judge, Man, Woman, Policeman. Cost £5, sacrifice 70s. —Postmaster, Emsworth.

**Ventriloquism**.—Little Girl sits or stands, 16s. Nigger throws back head when laughing, 16s.—Postmaster, Emsworth.

**Chiromancy**.—Character read at a glance. Chart, with explanation, 7d.—H. Dyke, 21, North-street, Taunton.

A handsome **Aquarium**, 20 by 12 by 13 deep, with slate bottom, outlet pipe, decorated gold and black, perfectly watertight, 20s.—Smith, 72, Halliwell-road, Bolton.

Amateurs' second-hand **Photographic Apparatus** bought, exchanged, or sold.—Kemp and Co., Infirmary-street, Edinburgh.

Second-hand **Cameras**, Lenses, Stands, and complete photographic outfits. Send for special list.—Kemp, see above.

Induction and **Shocking Coils**, Cells. Amateurs supplied with parts for making bell sets, 12s. 6d.—See above.

**Chemical**. Physical, and Electrical Outfits for Schools and Science teachers ; Static Apparatus greatly reduced. —See above.

If you want cheap and good **Scientific Apparatus** send to Kemp and Co. stating your requirements.

Splendid double-action **Slide-Valve Cylinders** (brass), with steel screws and valve regulating adjustment, inch stroke, 6s.

These **Cylinders** are of highest quality only, and best metal ; others at considerately lower prices.

**Parts Fitted up** at cheap rates. Castings, with all parts turned, from 8s.—J. Spencer, Modeller, 1, Whittaker-street, Burnley.

5 by 4 bellows **Camera and view lens**, 25s. ; quarter-plate portrait lens, Horne Thornthwaite, 21s.—99, City-road.

Also **Model Yacht** ("May Fly"), mahogany built, 4ft. long, 40s. Small Slide Valve Marine Engine, 17s. 6d.

**Lathe Tool Holders**, 3s. ; Tools, 4d. : much handier than solid tools.—S. Brechin, Mareham-le-Fen, Boston.

**Bicycle**, 54in., superior make, Æolus balls throughout, Harrington's Enamel, and plated ; splendid machine.—Jno. Alcock, 66, High-street, Northwich, Cheshire.

**Uranotype Paper**, 6d. sheet. Cyanotype Paper 4d. sheet ; list free.—Humphreys, 44, Cornwallis-road, Holloway, London.

Order your **Photographic Apparatus** of the maker ; Drawings worked to, and ideas worked out.—Cusworth.

**Amateurs Assisted** in Photographic Apparatus, parts supplied ; write for Quotations.—Cusworth, 38, Ellington-street, Barnsbury, London.

**Wrought Iron Coils**, any shape and length. Stocks and Dies, Whitworth or Gas ; Weather Vane, new patent, shows direction of wind indoors ; Wheels, Machine Moulded, Spur, Bevel, Mortise, or Helical, in iron or steel.—F. M. Rogers, 21, Finsbury-pavement.

Small **Arc Lamps**, work with small dynamo, 100 c.p., carriage free, 6s.—Habgood.

**Wheatstone's Bridges**, accurate, 3s. 6d., carriage free.—W. Habgood, Hazlebrook, Buccleuch-road, West Dulwich, London, S.E.

**Engine and Boiler**, 2½ H.-P. horizontal, tubular upright, in thorough condition ; price £30.—G. H., 36, Hayle's-street, St. George's-road, S.E.

**Lathe**, 5in. screw-cutting gap bed, foot or steam, overhead motion, complete, price £18.—G. H., 36, Hayle's-street, St. George's-road, S.E.

**Universal Trade** and Amateur Supply.—Lecture requisites ; light, heat, air, water, geology, engineering, chemistry, photography, &c. Wholesale and export.—Caplatzi.

**Model Engines**, Boats, Boilers, Gauges, Cylinders Screws, and Bolts ; Fittings, new, second-hand ; cheapness unequalled ; ¼ to 2h.p.

**Fairs, Public Shows**.—Electric and Weighing Machines, Camera Obscuras, Polyramas, Lung Testers, large Telescopes, Mechanical Models ; great attractions.

**Photography**.—Large quantities of Wet and Dry Plate Apparatus, Lenses, Instantographs, Copying Cameras, Tents, Stands, Focussing Glasses, Printing Materials ; cheapest in London.

Catalogue, 2d. **Caplatzi**, Science Depot, Hire and Exchange, Chenies-street, Tottenham-court-road. See 15 years' advertisements.

**Lenses**, to form Negative Astro. Eyepieces of power, ¼ inch, 4s. Ditto Pancratic Astro., 2s. 6d.—Wm. Nicholl, Roslea, Clones.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
*FRIDAY, JUNE* 12, 1885.

## TOOLS AND CUTTER BARS.—III.

OF cutter bars a great number have appeared, each claiming some superiority over its compeers. Some are made to hold special tools, as, for instance, gouges and chisels for wood, and Holtzapffel brought out an effective one for this purpose many years ago which answered perfectly, but had the one drawback of some loose parts liable to get lost. It is, perhaps, impossible without such loose pieces to make one bar take variously-sized gouges or chisels, nor is it difficult, on the other hand, to design such a bar if these loose parts are not objected to. I have one, the maker of which I do not now recollect, but I have a vague notion it was by Booth, of Dublin, which is so similar to Haydon's that I think it probably suggested to him the form which he ultimately adopted. I have drawn it in Fig. 28, A B. In this there is a loose piece to render it serviceable for the cutters of square section for metal work, and without this piece it will hold a gouge, but not very well unless it is of one special curvature. Round or square bar cutters are equally securely held in the rectangular nick on bar and its loose inner piece. The apparent drawback for which probably it was rejected by "D. H. G." is the projection of the sling, owing in a great measure to the intermediate loose part. Unless the tool is thrust up so as to stand above the level of the shank of the bar the sling will come against the work. Even this, however, depends on the distance between the line of centres and top of slide-rest, and I have myself used the bar with the same cutters that fit one of Haydon's. I have chiefly found the sling in the way during the process of grinding.

It was probably supposed that the sling alone would not hold the cutters with sufficient firmness, and therefore the loose tail piece was added to extend the length of the nick in which the cutter lies. Haydon's bar, however, proves that this piece is not necessary, as the cutters do not slip or yield in the least if the bar is properly made.

The Smith and Coventry bar (Fig. 29) already spoken of, is made right and left, and in pointing as I have done to the faulty construction of the round tool, which, when ground, presents a plan elliptical in shape, with edge varying in sharpness, it would be very absurd of me to condemn a bar which is every day doing its appointed work in the large and important shops of the inventor, and in many others. But in writing on the theory of edge tools and on the practical application of such theory, it is impossible to avoid speaking of a defect even when it may not appear of very great importance. Because a razor with nearly flat sides will do to shave with, it does not follow that it is to be recommended if one with hollow sides is to be had. In a paper, moreover, like the present, I have no interest in commending one bar and finding fault with another; the only object being to give the reader a few hints about the why and wherefore of their struction. If, then, anyone should prefer an elliptic tool to one with distinct double edges, or a Tangye bar to a Haydon, I see no reason why he should not gratify his taste. If I were to recommend anything it would be the purchase of two or three bars by different makers, each of which would, in all probability, be used as occasion might require. Fig. 30 represents another bar of Smith and Coventry's, in which the tool of a special section of steel is secured in a slot in the bolt by which it is held, aided by a notch in the washer above it. A single nut secures the cutter in exact position. The tool swivels round so as to form a right and left or a straightforward one. This, again, is no doubt a good bar, and very useful for all sorts of work, but it is plain that the upper face is at a determinate angle, which is calculated as the best average for general purposes. Perfect accuracy is, therefore, unattainable, and if in any case a different angle would be preferable, it cannot be obtained. The only possible alteration, therefore, that can be made in the cutting edges must be got by altering the amount of clearance, and this, for reasons already stated, is very limited indeed.

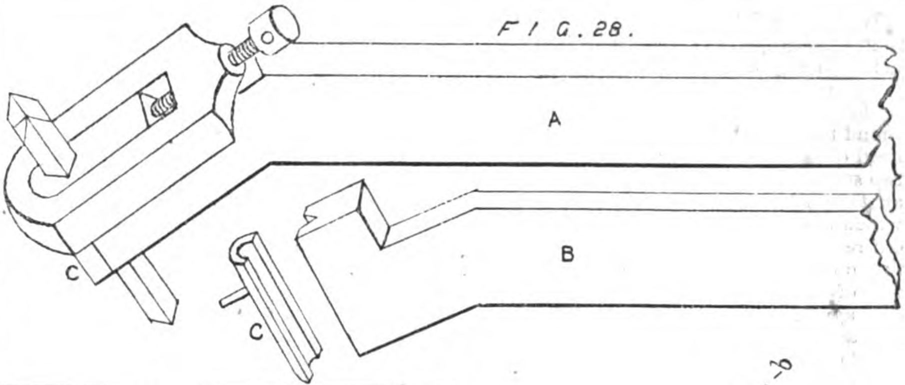


FIG. 28.

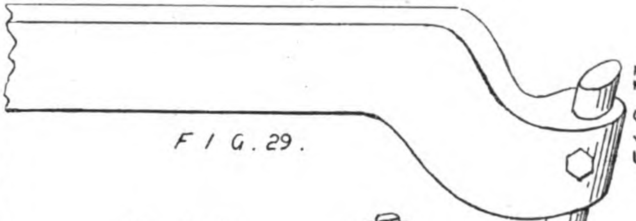


FIG. 29.

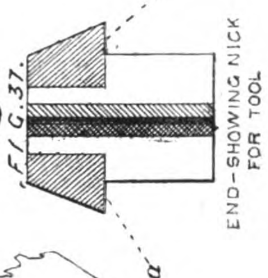


FIG. 37.

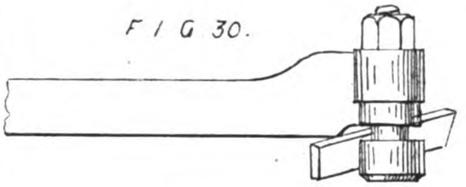


FIG. 30.

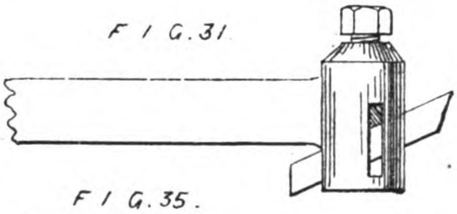


FIG. 31.

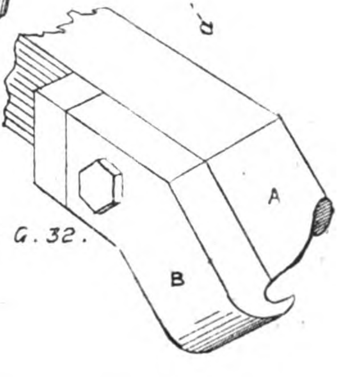


FIG. 32.

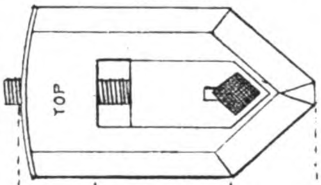


FIG. 35.

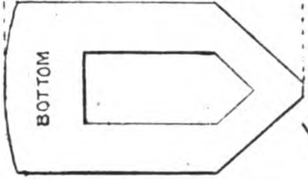


FIG. 36.

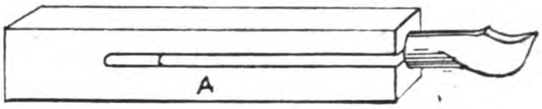
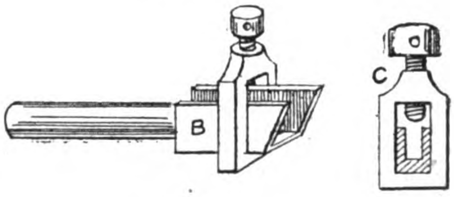


FIG. 33.



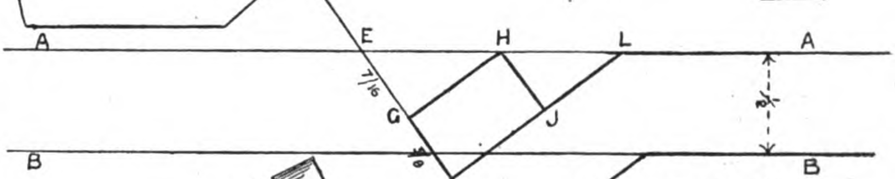


FIG. 34.

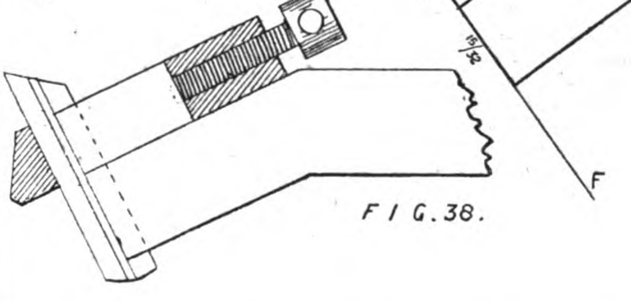


FIG. 38.

In one of Tangye's bars, derived apparently from the last, the tool is similarly held (see Fig. 31), and is, therefore, subject to the same defect. In this case, instead of a loose bolt allowing the tool to swivel round to right or left, there are slots in the head of the bar, and a pinching screw on the top secures the cutter. Here there is added another limit to the horizontal angle at which the tool can be placed; but as the entire bar can be laid in any desired position on the table of the rest, this limit is not of much practical importance. This bar, again, has the advantage of few parts, and no loose one liable to get lost. The front or clearance angle of this and the previous one can be easily ground while the tool is in the bar, as will be described in speaking of Haydon's.

My good friend "J. K. P." has sent me a bar the like of which I had not hitherto set eyes on. It appears made solely to hold a large gouge of given curvature. It is a massive affair, weighing exactly 2lb., and the tool is secured by a side clamping piece, attached by a guide pin and set screw. It must hold the gouge at a considerable rake, and, at a guess, I should imagine it to turn Elizabethan twist balusters in a large self-acting lathe — only revolving cutters would do it better. Here it is, at any rate, Fig. 32 A. B.*

Mere straight holders for round or square bar hardly come under the technical name of cutter bars; but I give a sketch of one designed by W. S. Brown, of Halesworth, because it may happen to supply a hint which may prove of value in this direction (Fig. 33.) This is a bar of steel drilled and then sawn lengthwise. The round shank of the tool slides spring-tight into this hole, and is clamped securely as soon as the pressure of the screws in the tool holder of the slide rest acts upon it. In addition to the tools with round shanks there is a little separate holder B, with its small sling for clamping short cutters. The tool receptacle is represented too large; it should be more like C to take the small cutters used in the ornamental slide-rest. The advantage of such a tool bar is not great. The tools have to be filed and shaped much as solid ones are formed, and there is little gained by being able to revolve them upon their axes, the effect of which is merely to give more or less side rake. The split bar is better as the nucleus of an inside cutter bar, and has indeed been so used, as will presently be explained when we have done with those for external work.

What is now well known as the Haydon bar remains to be described, and for simplicity of detail and undeniable correctness in principle it has not, so far as I know, been surpassed. Some supposed copies were, however, at one time sold, which, from their inaccuracy, tended to bring this bar into disrepute. Mr. Haydon, on first offering it to the notice of mechanics and amateurs, stated plainly that it was a modification of another, and was intended simply to carry out in practice the theory of cutting tools published by Prof. Willis in the first volume of Holtzapffel's valuable work. The professor had himself devised a holder similar to that for the slide-rest; but not suitable for the purpose except as an experimental one. Having thoroughly studied the subject of tool edges and the special requirements of a bar which would present cutters at a proper angle to the work, and enable them to be rigidly held, Mr. Haydon eventually adopted the bent bar and sling, modifying it so far as appeared necessary, and not forgetting that it should be within the powers of an amateur or any workman of moderate skill to construct. In this work there is really no difficulty whatever, as the rough forging can be made by any blacksmith, from a wooden pattern and zinc template; and a little care in the use of a file—if a planer is not available—will soon bring the job to a successful termination. The great thing is to go to work methodically, and not at haphazard, nor by rule of thumb, and the way thereto is as follows:—Measure the height of the lathe centres above the top plate of the slide-rest on which the bar is to lie when in use, because upon this will depend certain measurements, and it varies in different lathes. In small lathes it will probably be from ½in. to ⅝in., and in larger lathes from ⅝in. to ⅞in., or even more. Draw a line A B, Fig. 34, to represent the height of lathe centres, and a second parallel to it to represent that of the tool-plate, at the distance from the first, thus ascertained. These lines will give the thickness of the shank of the bar, and the upper one will also represent the limit of height at which the point of the cutter will stand.

The next measurements have for their object the regulation of the height of the tool-point above the sling, and also the thickness of the same, as well as the angular position of the tool. The latter consideration comes first in order, as it does in importance. The tool is to stand at 55° from the horizontal. Draw, therefore E J at that angle, cutting the two lines previously drawn. Then set off upon it the following dimensions, which vary according to the thickness of the bar, or rather according to the distance measured between the centre line and top of rest—in other words, the distance between the two parallel lines.

I give these dimensions from Mr. Haydon's own notes, but I see that in a drawing, also I believe by him, they vary somewhat. "If," says the writer, "the distance in question does not exceed ½in., set off E G $\frac{7}{16}$, and square off G H to represent the top of the sling and head (on which it lies). Then make G K ⅜ for depth of head and sling, and square off to L, to give the top of the cranked part. Draw H J at right angles to G H. Next measure from K $\frac{15}{32}$, and square off to bottom line of bar. These dimensions will allow the cutter to stand up ¼in. to ⅜in. above the top of sling and head." The measurement $\frac{15}{32}$ is evidently within a very small fraction the ½in. thickness of the bar, and is so in the rough; but after filing on the top of the bend the bed on which the sling is to rest, it will reduce the thickness probably $\frac{1}{32}$, leaving the finished bar of the dimensions given.

When the distance between the height of centre and top of slide-rest exceeds ½in., say $\frac{9}{16}$ to $\frac{11}{16}$, make the first set-off ½in., giving an elevation of ⅝ from level of sling to point of cutter, enabling a suitable tool to part an inch bar right through, and meeting most of the requirements of ordinary work. For an inch bar (where the aforesaid distance is of that amount) the measurements given are $\frac{11}{16}$, ¾, and 1in. This is a very large strong bar, suitable for lathes with steam power. A bar may be propped up by *parallel* strips of iron under the shank for occasional use on a lathe with higher centres, or for the purpose of lowering the tool in the sling to make it less liable to hitch in. The point of the tool, observe, must still be on the level of centres; but, the bar having been raised, the point will be below the top of such bar and below the point of flexure, and will give if a hitch occurs.

If a tool point is above what is called the point of flexure of a bar (or solid tool), and there should chance to be a hitch, the edge will draw in and get broken, or perhaps bend and spoil the work. But if it is below this point it will bend the tool or bar and clear itself. Hence it is always advantageous to keep the point low as regards the shank of the tool or cutter bar. In fine work I have frequently put a slip of iron under the shank and lowered the tool in its sling to the same extent. I am not myself mathematician enough to determine the point of flexure in a Haydon bar; but I apprehend that it is at some spot below its upper surface, and the tool point ought, I think, as a rule, to stand just below this. It is, however, better to lay such block or strip below the shank than to alter the bar, which is so easy to plan on the simple rule given, and specially devised by Mr. Haydon. He, however, foresaw a certain amount of difficulty in making bars for sale, owing to the variety of lathes manufactured, no standard apparently being accepted by makers as to the proper height of the tool slide in reference to the centre line. By means of parallel slips, however, either to be attached under the bar by a couple of screws, or merely laid upon the table of the rest, this difficulty may be overcome and stock bars manufactured and kept for sale. American lathes have in many cases available means for raising the tool plate of the slide rest, and in this case no packing is needed.

We now come to the sling which must not be like that of Fig. 28—round on the end. Made thus, it will not go into corners. Its form will be readily gathered from Figs. 35, 36, 37, and from the sections of it, *in situ* in Fig. 38. The bottom, Fig. 36, is to be filed quite flat, and then the edges are to be bevelled upwards (see also Fig. 37, which shews the shoulders filed on each side of the head on which the sling rests). In the bar (Fig. 28) these do not exist, and the sling is far less steady. The steel for the head—this being preferable to iron—should, says Mr. Haydon, be shear steel, faggoted on a suitable mandrel. There should be no unnecessary length in the slot where it fits the bar. The angle in the bar and sling (for reception of the cutter) should be got out quite square, and that in the bar further sawn or filed down for about $\frac{1}{16}$, as seen in Fig. 35, to insure the firm bedding of the cutter. If the angle in the sling is less than a right angle, the cutter acting as a wedge may burst it open. The end of the clamping screw should not be pointed nor the bar recessed. It should be turned quite flat to set squarely and truly against the head. The front of the sling is to be filed off at such angle as to allow it to go into a square corner when in place on its bar. If $\frac{1}{16}$, or even $\frac{1}{32}$, is left on the upper face on each side of the slot, it will suffice; because the bottom will be of full width and strength, and will bear any strain likely to come upon it, unless the angle is filed out to a degree less than a right angle.

(*To be continued.*)

## THE INTERNATIONAL INVENTIONS EXHIBITION.—VI.

### Manufacture of Textile Fabrics.

ALTHOUGH the manufacture of textile fabrics has been developed to its present high state of perfection in this country, and has contributed enormously to the commerce and wealth of the United Kingdom, it is well known that not one of the many branches into which it is divided is indigenous to these islands. The chief fibres which form the raw materials of the textile industries are cotton, flax, wool, mohair, alpaca, and silk; but from present appearances it would seem that another must be added in the shape of asbestos, a material which, known and utilised by the ancients, has latterly made enormous strides, and is steadily forcing its way into use for a variety of purposes. India was probably the home of the cotton industry, as China unquestionably was the first country in which silk was utilised in the production of a textile fabric. Flax and its uses were certainly known to the ancient Egyptians, and they were probably also highly skilled in the manipulation of wool, for while the poorer classes were invariably clothed in woollen garments, such as they were, the rich employed both cotton and wool, and the priests wore linen, woollen materials being deemed unclean, as they were liable to the attacks of insects. The dead, too, were wrapped in linen cloth, and its indestructibility by time or the ravages of the moth has left indubitable evidence that the ancient Egyptians must have been very skilful weavers. Sheep's wool, goat and camel hair, silk, and fibres of the pinna, flax, hemp, cotton, together with asbestos, and threads or wires of gold and silver, were all utilised by the ancient weavers; but the oldest known remains are those found in the Swiss Lake dwellings, supposed to belong to the Stone Age, which clearly prove that at so early a time the inhabitants of the earth had learned how to twist fibres into cords and to plait them into cloth. Weaving was certainly carried on by the ancient Greeks and Romans as a branch of trade, and from them the art gradually spread throughout Europe. Matthew Paris mentions that the ribs of people throughout the world were kept warm by the fleeces of English wool; and Edward III., observing the wealth which his neighbours were gaining by their encouragement of weavers, invited a number of Flemings and Frenchmen to come and settle in this country, which they did, and there and then established industries that have steadily progressed for five centuries. The Crusaders, too, brought back with them a knowledge of some of the Eastern arts, amongst which was probably that of damask-weaving, and before long a number of skilled craftsmen were settled in different parts, for weaving had been carried on in a coarse fashion by the natives, and they were not slow in comprehending the processes of the more skilful workers from the Netherlands. These artisans employed looms which were little more than developments of those used by the Egyptians, and it was not until the power of the steam-engine began to be recognised that the modern machines had a chance of being invented, for the simple reason that there were no tools to make them. The principles underlying the construction of cotton machinery were, however, thoroughly understood before Watt demonstrated the importance of the improvements he had made in the steam-engine, for in 1738 John Kay had invented the fly-shuttle, Robert Kay the drop box in 1760, Arkwright the water frame, and Hargreaves the spinning jenny in 1770, while Crompton combined those last-named inventions and produced the "mule" spinning frame in 1779. The machines were mostly driven by water power; but in 1785 the first steam-engine for working a cotton mill was erected by Boulton and Watt for Messrs. Robinsons, of Popplewick, Notts. From that time progress was comparatively rapid; tools were produced to the demand of the machine makers, and at the Great Exhibition of 1851 the United Kingdom astonished the world by the perfection of her machinery for manufacturing textile fabrics. No great changes in principle have been introduced since then; but there have been many improvements in details, which, combined with superior materials and workmanship, have given greater production with increased life of the machines. Although looms are much the same as they were a quarter of a century ago, so far as principle and general construction are concerned, they are being continually improved in details, the competition amongst makers materially helping in the progress. In the present exhibition Group IX. is a very inadequate representation of the manufacture of textile fabrics; but it will afford the general public an opportunity of seeing some of the wonderful machines which are now employed in the industry, though none of the branches is shown in anything like completeness, except it be asbestos weaving. A good exhibit of cotton working machines is to be found at the stand of Mr. S. Brooks, of West Gorton, Manchester; but even in his case it is not exactly feasible, or, perhaps, we should say, economical, to work some of the machines, e.g., an improved drawing frame. However, there is a ring spinning frame for twist yarn, and another for weft, a wet doubling frame, and a dry ditto, which represent the latest improvements in these important items of a cotton mill plant. A winding frame (Hill and Brown's patent) is a valuable improvement, as it dispenses with bobbins and winds the yarns on paper tubes up to any desired dimension, from ¼in. to 2in. thick (or wide) up to as much as 18in. in diameter. A very ingenious invention in this exhibit is the "Ferguslie" balling machine, which winds 190 yards of crochet cotton on each of twelve balls simultaneously, and when driven at its normal speed does the work at the rate of 250 yards per minute. Here it would be as well to mention that the machines in this group are driven at a lower speed than usual, and that several are shown operating on "endless" fabrics, whereas in real work the fabric would, of course, be wound on receiving rollers. Where so many apparatus of diverse kinds are driven by one engine, it is impossible to impart to each its normal working speed, and a mean has to be selected suitable for purposes of exhibition. One of the most interesting stands in the group, at the north end of the West Gallery, is the collection of machines illustrating in a practical manner the art of spinning asbestos as practised by Bell and Son, of Southwark-street, S.E. The machines are of the type well known in connection with cotton manufacture, but modified to suit the peculiar material. They consist of a carder, a slubbing frame, a throstle frame, a doubler, and a loom, with specimens of the raw material from different sources, and examples showing its condition after passing through the various preliminary processes. The visitor will experience one great advantage at this stand, for at all reasonable hours one of the members of the firm is in attendance ready to explain anything that may be desired in connection with this comparatively new manufacture, for until 1879 asbestos was generally mixed with cotton to form it into a sliver for spinning. In that year, however, Bell and Son discovered a means of spinning asbestos without the addition of any other fibre, and now a wide field of usefulness is opening for their products. A rough classification divides the asbestos manufacture into textile fabrics, paper and millboard, paint and cement, the first-named class comprising a great variety of useful products. Asbestos cloth, for instance, is found invaluable in Maignen's Filtre Rapide, while a sort of asbestos paper or felt will be found an excellent substitute for paper underneath carpets. Asbestos cordage and yarn, engine packing (especially the new combinations of asbestos with indiarubber and wires of soft metal), washers, and paint, are all notable introductions of the last six years or less, while asbestos lubricants, particularly "asbestoline," a combination of fine asbestos with other lubricating substances, are rapidly winning their way into favour amongst engineers, from their economy and perfect action. The United Asbestos Company, Limited, also exhibit at their stand the process of making "packing" by means of a braiding machine, a noisy, albeit ingenious, contrivance, which might have been omitted with advantage from this exhibition, especially as it is shown at several stands, Treloar and Sons, for instance, having one making coir plait, which is afterwards worked up into the familiar mats in view of the visitors. Other noisy machines are the looms, specimens of which are shown by G. Hodgson, of Bradford, working Bradford stuffs; by H. Livesey, Blackburn, weaving shirtings; and by some other exhibitors, notably Hacking and Co., of Bury, Lancashire, who exhibit their looms with four-shuttle motion for weaving checks, and an improved loom weaving trouserings. The McNary Machines Co., Lombard-street, E.C., show a straight and a circular weaving machine for the manufacture of various fabrics in wool, cotton, hemp, jute, &c. The circular machine is especially deserving of notice, as it works up hats, caps, and bags without seams. An Irish handloom is shown at work by Howell and James, of Regent-street, W., with samples of damask table linen in several stages of manufacture, and Mr. J. Etchells, of Macclesfield, exhibits a Davenport and Crossley's cross border Jacquard weaving silk handkerchiefs, &c., which requires no changing of cards, the latter being folded down as they pass through the machine in readiness to be taken up again when their turn comes. W. T. Glover and Co. exhibit at their stand James's patent doubling machine for cord and banding, which puts a twist into two, three, four, or any number of folds, either slack or tight, and deals with different sizes at the same time. The machine, for instance, has three heads, each with four spindles or bobbin holders, which are removable if a two-strand cord is required. If an end breaks, a weight inside the spindle at once stops the machine, so that one attendant can look after a large number of machines. Each head works independently, and can be altered in a moment to left or right hand twist. Several useful inventions are shown at this stand which have no special connection with the manufacture of textile fabrics—*e.g.*, Riley's piston ring, which is cut first and turned afterwards, thus securing a perfect circle,—Bell's patent rope pulley friction brake, &c. Close by is a novel device by Prof. Hele-Shaw, of the University College, Bristol, which has certainly nothing to do with textile fabrics, but which will attract much attention from mechanics and engineers. It is a sphere and roller mechanism for transmitting power, and is undoubtedly ingenious. A heavy sphere of iron is so placed between two solid pulleys and supported by others that it transmits the motion by rubbing friction in any desired direction, or in several directions at the same time, for every pulley or roller which is brought into contact with it may have its shaft at a different angle. Carding machines and card-grinding machines are shown at several stands, and Gauntlett and Co., of Trowbridge, exhibit their special machines for opening and carding hair by passing it between two revolving cylinders carrying spikes. Dickinson and Sons, of Blackburn, have at their stand a slasher sizing machine with beam press motion; and Mr. J. King, of Manchester, shows his improvements in doubling or twisting yarn in the shape of a machine which puts two twists in the thread for each revolution of the spindle. J. Farmer and Sons, of Salford, have an important exhibit, in which is a four-bowl calender, which gives as desired a chasing, glazing, or swizzing finish, an embossing finish by substituting an engraved roller for the friction bowl, and also the moiré finish. The bottom bowl is of cast iron with wrought centre, the next of paper or cotton, the third of chilled iron fitted for heating by steam or gas, and the top of paper or cotton. The machine shown is driven direct by two inclined cylinders attached to the A frame. Farmer and Lalanco's patent bleaching, washing, chloring, soaping, &c., machine is exhibited in the shape of a three-cistern size having six rollers. These hollow rollers are of copper, perforated and corrugated over their whole surface, and are connected in couples to rotary pumps, which draw the water or liquor through the cloth and cleanse it thoroughly from starch or matter used in the printing processes. When albuminous matter has been used beaters are employed, which make from six to eight blows per inch on the cloth, and effectually loosen the most glutinous particles. This principle of drawing the liquor through the cloth is found to work well with the thickest cloths, and the routine will be understood when we mention that for a print works a five-cistern machine would be used—the first being for fixing, the second for washing, the third and fourth for soaping, and the fifth for washing. In connection with this stand we notice a large-size model of Farmer's plant for treating sewage and town refuse, the most important feature in which is the patent twin cylinder apparatus for drying excrementitious matter. Five of these are, we understand, already at work in Birmingham, and it is intended to erect four others, and so deal with the whole refuse of that town by this certainly sanitary and, we believe, economical method, for the manure is valuable, and the ashes and ground clinker are utilised for making mortar and cement. Mather and Platt, of Salford, exhibit a continuous bleaching machine for use in the Thompson process. In this apparatus the cloth dips into a solution of bleaching powder of 1° Twaddle, and passes between squeezing rollers into a chamber containing carbonic acid. Here it is compelled to make a comparatively long stay, as it passes from the bottom to the top over a number of rollers. Emerging between rubber lips (to prevent diffusion of gases as much as possible) it is washed in a beater, and is pressed between two rollers, one nickel plated, the other covered with rubber. The rationale of the process is that the carbonic acid combines with the lime of the bleaching powder, and oxygen is given off in a state to effect the decolouration of the fibre. A gauge in the shape of a hollow glass ball floating in a beaker shows the workman at a glance whether he has sufficient carbonic acid in the closed chamber, as the sphere is adjusted to float on carbonic acid gas but to sink in air. The machine will bleach from 50 to 100 yards per minute. Mather and Platt also exhibit their open soaping and washing machine, in which the cloth passes over perforated copper cylinders, and is beaten by flaps of india-rubber attached to revolving cylinders. The object is to drive the water through the fabric, and so discharge the thickening materials used in printing it without any rubbing action. Another machine shown by Mather and Platt is a sampling machine for calico printers, to enable them to form a rapid judgment of the effect of various colours. The engraved copper rollers are readily adjusted with sufficient accuracy in a few seconds. and the requisite colour ink-troughs having been put into the machine, the pattern can be obtained printed in different colours in pieces about the size of a handkerchief in a very few minutes. Many of these patterns, it will be remembered, require five or six different rollers to complete them, and there is consequently a wide range of effects to be produced by the employment of various colours for different parts. The labour of setting the ordinary machines is practically prohibitive of much exhaustive experiment, but the ease and rapidity with which the sampling machine works render it a boon to calico printers. There are a variety of textile products exhibited which will attract the attention of many visitors; but even in this comparatively small group there is much to interest and instruct those who will examine what is set before them.

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* It was made to hold a large gouge for turning the naves of cartwheels in India.

## ON THE COLOUR-CORRECTION OF ACHROMATIC TELESCOPES.[*]

By Wm. Harkness.

ALTHOUGH much has been written on the theory of the achromatic telescope, I am not aware that any attempt has been hitherto made to treat the colour-correction rigorously as a function of the wave-length of the light; and on that account, much obscurity, and some positive error, has crept into the textbooks on the subject.

The theory given in the following pages is based upon fundamental equations, which neglect the thickness of the lenses, as has always been done heretofore, and which suffice to give the refractive indexes to scarcely more than four places of decimals. All the subsequent operations on these equations are rigorously accurate; and it would have been useless to attempt greater precision in the refractive indexes while the thickness of the lenses is neglected. As achromatic telescopic objectives are usually composed of two lenses, rarely of three, and hardly ever of a greater number, it has been thought sufficient to write the equations in the form applicable to triple objectives; but no difficulty will be experienced in extending them to a greater number of lenses when necessary.

Our fundamental equations are—

$$\frac{1}{f} = (\mu - 1)\left\{\frac{1}{r} + \frac{1}{\rho}\right\} \quad \ldots\ldots\ldots\ldots(1)$$

$$\mu = a + b\gamma^2 + c\gamma^4 \quad \ldots\ldots\ldots\ldots(2)$$

in which—

$f$ = the principal focal distance of any lens.
$\mu$ = the refractive index of the lens.
$r$ = the radius of curvature of the first surface of the lens.
$\rho$ = the radius of curvature of the second surface of the lens.
$\lambda$ = the wave-length of the light.
$\gamma = 1 \div \lambda$.
$a\,b\,c$ = certain coefficients, determined from not less than three properly situated values of $\mu$.

Equation (2) is Cauchy's dispersion formula. Now put—

$$\frac{1}{r} + \frac{1}{\rho} = A \quad \ldots\ldots\ldots\ldots(3)$$

and suppose a series of lenses, such that—

$$\frac{1}{f_1} = (\mu_1 - 1)A_1;\ \frac{1}{f_2} = (\mu_2 - 1)A_2;\ \frac{1}{f_3} = (\mu_3 - 1)A_3 \quad \ldots\ldots\ldots\ldots(4)$$

These lenses being very thin, let them be placed in contact with each other; and let the equivalent focal distance of the whole combination be $f$. Then by a well-known optical theorem—

$$\frac{1}{f} = (\mu_1 - 1)A_1 + (\mu_2 - 1)A_2 + (\mu_3 - 1)A_3 \ldots(5)$$

Substituting the values of $\mu_1$, $\mu_2$, $\mu_3$, from equation (2), putting

$$\left.\begin{aligned} C &= A_1(a_1 - 1) + A_2(a_2 - 1) + A_3(a_3 - 1) \\ D &= A_1 b_1 + A_2 b_2 + A_3 b_3 \\ E &= A_1 c_1 + A_2 c_2 + A_3 c_3 \end{aligned}\right\} \ldots(6)$$

and arranging the terms according to the powers of $\gamma$, we have

$$f = \frac{1}{C + D\gamma^2 + E\gamma^4} \quad \ldots\ldots\ldots\ldots(7)$$

This equation expresses the relation between the focal distance of the combination and the wave-length of the light. It shows that when white light enters an objective, there will generally be an infinite number of foci situated one behind the other, and all contained between the two values of $f$, which correspond to the limiting values of $\gamma$.

For our purpose, however, it will be more convenient to consider $f$ as the ordinate, and $\gamma$ as the abscissa of a curve which we will designate as the focal curve. To investigate its properties we differentiate with respect to $f$ and $\gamma$, and obtain—

$$\frac{df}{d\gamma} = -2\gamma f^2(D + 2E\gamma^2) \quad \ldots\ldots\ldots\ldots(8)$$

Putting the left hand member of this expression equal to zero, we find—

$$\gamma^2 = -\frac{D}{2E} \quad \ldots\ldots\ldots\ldots(9)$$

Differentiating (8) a second time—

$$\frac{d^2f}{d\gamma^2} = 2f^3\gamma^2(2D + 4E\gamma^2)^2 - f^2(2D + 12E\gamma^2) \ldots\ldots\ldots\ldots(10)$$

Substituting the value of $\gamma^2$ from (9), this becomes—

$$\frac{d^2f}{d\gamma^2} = 4Df^2 \quad \ldots\ldots\ldots\ldots(11)$$

which shows that so long as D remains positive, the curve is convex towards the objective, and the value of $\gamma$ given by eqn. (9) corresponds to the minimum focal distance.

An achromatic objective, or more accurately and with greater precision, a corrected objective, is one in which all rays of the kind for which the correction is made are brought to as nearly as possible the same focus. For example, if an objective is corrected for visual purposes, then the rays which produce the greatest effect upon the human eye must all be brought as nearly as possible to the same focus; or, if the objective is corrected for photographic purposes, then the rays which act most energetically upon silver bromo-iodide must all be brought as nearly as possible to the same focus. This condition will evidently be fulfilled when the rays in question have the minimum focal distance; or, in other words, when they satisfy eqn. (9). Thus it appears that this equation determines the correction of the objective, and for that reason it will be called the achromatic equation, and the particular value of $\gamma$ which satisfies it will be designated as $\gamma_0$.

To find the relative values of $A_1$, $A_2$, $A_3$, in a corrected objective, we substitute in (9) the values of D and E from (6). The resulting expression for the middle lens is—

$$-A_2 = A_1\frac{(b_1 + 2c_1\gamma_0^2) + A_3(b_3 + 2c_3\gamma_0^2)}{(b_2 + 2c_2\gamma_0^2)} \ldots(12)$$

which shows that this lens must be of the opposite kind from the other two—that is, if the first and third lenses are convex, the middle one must be concave, or *vice versâ*.

To find the equivalent focal distance of the whole combination for the ray $\lambda_0$, (9) gives—

$$D = -2E\gamma_0^2 \quad \ldots\ldots\ldots\ldots(13)$$

Substituting this in (7)

$$f_0 = \frac{1}{C - E\gamma_0^4} \ldots\ldots\ldots\ldots(14)$$

Replacing C and E by their values from (6)

$$f_0 = \frac{1}{A_1(a_1 - c_1\gamma_0^4 - 1) + A_2(a_2 - c_2\gamma_0^4 - 1) + A_3(a_3 - c_3\gamma_0^4 - 1)} \ldots\ldots(15)$$

Substituting the value of $A_2$ from (12), and putting

$$\left.\begin{aligned} n &= \frac{A_3}{A_1} \\ L &= (a_1 - 1)(b_2 + 2c_2\gamma_0^2) - (a_2 - 1)(b_1 + 2c_1\gamma_0^2) + \gamma_0^4(b_1c_2 - b_2c_1) \\ M &= (a_3 - 1)(b_2 + 2c_2\gamma_0^2) - (a_2 - 1)(b_3 + 2c_3\gamma_0^2) + \gamma_0^4(b_3c_2 - b_2c_3) \end{aligned}\right\} \ldots(16)$$

We obtain finally

$$f = \frac{b_2 + 2c_2\gamma_0^2}{A_1(L + nM)} \ldots\ldots\ldots\ldots(17)$$

The ordinate of the focal curve for the ray $\lambda_1$ is the difference between the focal lengths of the objective for the rays $\lambda_0$ and $\lambda_1$. To find it we have—

$$\frac{1}{f_0} - \frac{1}{f_1} = (C + D\gamma_0^2 + E\gamma_0^4) - (C + D\gamma_1^2 + E\gamma_1^4) = D(\gamma_0^2 - \gamma_1^2) + E(\gamma_0^4 - \gamma_1^4) \ldots\ (18)$$

But—

$$\frac{1}{f_0} - \frac{1}{f_1} = \frac{f_1 - f_0}{f_0 f_1} \ldots\ldots\ldots\ldots(19)$$

and putting $f_1 - f_0 = \triangle f_1$, this becomes

$$\triangle f_1 = f_0 f_1\left\{\frac{1}{f_0} - \frac{1}{f_1}\right\} \ldots\ldots\ldots\ldots(20)$$

Substituting for the quantity within the brackets, its value from (18), and replacing D and E by their equivalents from (6)—

$$\triangle f_1 = f_0 f_1\left[(A_1b_1 + A_2b_2 + A_3b_3)(\gamma_0^2 - \gamma_1^2) + (A_1c_1 + A_2c_2 + A_3c_3)(\gamma_0^4 - \gamma_1^4)\right] \ldots(21)$$

Substituting the values of $A_2$ and $A_3 \div A_1$ from (12) and (16), and putting

$$\left.\begin{aligned} N &= b_1c_2 - b_2c_1 \\ P &= b_3c_2 - b_2c_3 \end{aligned}\right\} \ldots\ldots\ldots\ldots(22)$$

we obtain the important expression—

$$\triangle f_1 = A_1 f_0 f_1(\gamma_0^2 - \gamma_1^2)^2\frac{N + nP}{b_2 + 2c_2\gamma_0^2} \ldots(23)$$

If a star is viewed through a carefully-focussed achromatic telescope, and if the surface in the focus of the eyepiece is designated as the focal plane, then of the infinite number of images which eqn. (7) shows will be formed; some will be situated before, and some behind, the focal plane, but only one will coincide exactly with it. The cones of rays which form the images situated before and behind the focal plane will necessarily have a sensible diameter at their intersection with that plane, and their combined effects will be to produce a fringe of coloured light around the image of the star, as seen through the eyepiece. This fringe is the secondary spectrum, and its magnitude for light of any given wave-length will evidently depend upon the value of $\triangle f_1$. Hence, to destroy the secondary spectrum, $\triangle f_1$ must be made equal to zero.

Eqn. (23) shows that this will be the case for a triple objective when—

$$N + nP = 0 \ldots\ldots\ldots\ldots(24)$$

or, for a double objective, when—

$$N = 0 \ldots\ldots\ldots\ldots(25)$$

As yet no materials have been discovered whose physical properties are such as to satisfy these conditions. We therefore proceed to investigate what form an objective constructed of any given materials must have in order to render the secondary spectrum a minimum.

Substituting in (23) the value of $A_1$ from (17), we find—

$$\triangle f_1 = f_1(\gamma_0^2 - \gamma_1^2)^2\frac{(N + nP)}{(L + nM)} \ldots\ldots\ldots\ldots(26)$$

In the right-hand member of this equation, $n$ is the only quantity which depends upon the form of the objective. Considering it as variable, and differentiating, we obtain—

$$\frac{d(\triangle f_1)}{dn} = f_1(\gamma_0^2 - \gamma_1^2)^2\frac{PL - MN}{(L + nM)^2} \ldots(27)$$

To make $\triangle f_1$ a minimum, such a value must be attributed to $n$ as will reduce the right-hand member of (27) to zero. This condition gives at once $n = \infty$; which will be the case when $r$ and $\rho$ are both infinite, as is evident from equations (16) and (3). The objective is then reduced to two lenses and a piece of very thin plano-parallel glass. As the latter cannot appreciably affect the colour correction, it may be dismissed from further consideration; and thus it appears that from any three pieces of glass suitable for making an objective, but not fulfilling the conditions necessary for the complete destruction of the secondary spectrum, it will always be possible to select two pieces from which a double objective can be made that will be superior to any triple objective made from all three of the pieces.

The focal curve being tangent to the focal plane at the point corresponding to the wave-length $\lambda_0$, if we assume the spherical aberration to be perfectly corrected for light of all degrees of refrangibility, then the image of a star formed upon the focal plane by light of wave-length $\lambda_1$ will be a point, and the linear semidiameter of the image of the same star formed by light of wave-light $\lambda_1$, will be the semidiameter of the cone of rays of the wave-length at the point where it cuts the focal plane. Therefore, we have—

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[*] From the *American Journal of Science*. Art. XXX., No. 105, September, 1879.

$$f_1 : a :: \triangle f_1 : s_0^{ii} \quad \text{.................} \quad (28)$$

in which $a$ is the semi-aperture of the objective, and $s_0^{ii}$ is the required semidiameter of the cone of rays of wave-length $\lambda_1$. Combining (28) with (26), we find—

$$s_0^{ii} = a\,(\gamma_0^2 - \gamma_1^2)^2\,\frac{N + nP}{L + nM} \quad \text{........} \quad (29)$$

This is the expression for a triple objective. In the case of a double one, $n$ becomes zero, and (29) reduces to

$$S_0^{ii} = a\,(\gamma_0^2 - \gamma_1^2)^2 \cdot \frac{N}{L} \quad \text{..........} \quad (30)$$

which shows that in a double objective properly connected for any given purpose the linear semidiameter of the secondary spectrum is absolutely independent both of the focal length of the combination and of the curves of its lenses; and depends solely upon the aperture of the combination and the physical properties of the materials composing it.

If a telescope armed with an achromatic eyepiece is carefully focussed upon a star, and then the image of the star is viewed through a prism held before the eyepiece, it will be seen that the eye does not adjust the focal plane tangent to the focal curve; but places it somewhat further from the objective in such wise that the plane cuts the curve in two points, which we will designate as $\gamma_m$ and $\gamma_n$. For these points we must have—

$$\frac{1}{C + D\,\gamma_m^2 + E\,\gamma_m^4} = \frac{1}{C + D\,\gamma_n^2 + E\,\gamma_n^4} \quad \text{..} \quad (31)$$

which gives

$$-\frac{D}{E} = \gamma_m^2 + \gamma_n^2 \quad \text{............} \quad (32)$$

But by (9) we have—

$$\gamma_0^2 = -\frac{D}{2E} \quad \text{............} \quad (33)$$

Combining this with (32), we find—

$$\gamma_0^2 = \tfrac{1}{2}(\gamma_m^2 + \gamma_n^2) \quad \text{........} \quad (34)$$

which gives the relation between $\gamma_0$ and any pair of points at which the focal plane may cut the focal curve.

We have next to consider how the value of $\gamma_m$ can be found, and for that purpose a method partly arithmetical and partly graphical seems most convenient. The data required are the values of $\triangle f$ for a number of different values of $\gamma$, and the relative intensity of the light at each of these values of $\gamma$. The values of $\triangle f$ must be computed by equation (26), and the relative intensity of the light may either be determined experimentally, or taken from published tables. For visual intensity, the table given by Fraunhofer may be employed; and for photographic intensity the curves published by Captain Abney contain all that is required. For the sake of definiteness, let us suppose that the valve of $\gamma_m$ is to be determined for an objective corrected for visual purposes. We begin by laying down an axis of abscissas and graduating it into a scale of wave-lengths. Here, however, it must be observed that the brightness of any part of a spectrum depends not only upon the inherent brightness of the light at that point, but also upon the degree of dispersion employed. As Fraunhofer's determinations of the relative brightness of different parts of the spectrum were made with a flint glass prism having a refractive index of 1·63 for the ray D; and as such an instrument produces much greater dispersion at the violet end of the spectrum than at the red end, it follows that our scale of wave-lengths must be not a scale of equal parts, but such a scale as existed in the spectrum employed by Fraunhofer. The wave-length of the brightest ray is approximately 5,688, and through that point in the scale and at right angles to the axis of abscissas, the axis of ordinates must be drawn. Then from the computed values of $\triangle f$ a sufficient number of points must be laid down to determine the focal curve, and that curve must be drawn. At the points whose wave-lengths correspond to the principal Fraunhofer's lines, lines must be drawn through the focal curve, parallel to the axis of ordinates, the length of each line being proportional to the relative brightness of the spectrum at the point where it is situated, and the centre of each line coinciding accurately with the focal curve. Through the extremities of these lines a closed curve must be drawn. The figure thus obtained will be termed the illumination diagram, because it exhibits the amount and distribution of the light at the focus of the objective. The eye will necessarily place the focal plane in the position where this light will produce the greatest effect on the retina, which is equivalent to saying that the focal plane must pass through the centre of gravity of the diagram. Hence, to find the position of the focal plane, we have only to cut out the diagram (which should be drawn upon rather stiff paper) and balance it upon a knife edge, held parallel to the axis of abscissas. The reciprocals of the wave-lengths of the points of intersection of the knife-edge with the focal curve will then be the values of $\gamma_m$ and $\gamma_n$.

The method just explained may be employed to determine the difference between the positions of the principal focus of the same telescope when used for different purposes. For example, if it were required to find the interval between the visual and photographic foci of a telescope, two illumination diagrams would be drawn—one for the visual, and the other for the photographic rays—and the difference between the positions of the foci plane in the two diagrams would be the required difference of foci.

As the magnitude of the secondary spectrum of a star is measured by the semi-diameter (at the point where it intersects the focal plane) of the cone of rays having the maximum focal distance, it follows that in an objective corrected for visual purposes, the secondary spectrum is diminished by the fact that the eye places the focal plane somewhat further from the objective than the apex of the focal curve. To find the amount of this diminution we remark that for light of wave-lengths corresponding to the points where the focal plane cuts the focal curve, the semi-diameter of the cone of rays is zero, while for light of any other wave-length, the semi-diameter of the cone of rays at the point where it intersects the focal plane, is proportional to the distance between that plane and the point of the focal curve corresponding to the wave-length of the light. Hence the effect of moving the focal plane into a position further from the objective than the apex of the focal curve will be to diminish $s_0^{ii}$ by a constant which is numerically equal to the value of $s_0^{ii}$ for light whose wave-length is that of the point at which the focal plane intersects the focal curve. Modifying equation (30) in accordance with these principles, it becomes—

$$s_m^{ii} = a\,[(\gamma_0^2 - \gamma_1^2)^2 - (\gamma_0^2 - \gamma_m^2)^2]\,\frac{N}{L} \quad \text{....} \quad (35)$$

in which $\gamma_m$ is the reciprocal of the wave-length corresponding to either of the two points in which the focal plane cuts the focal curve; and $s_m^{ii}$ is the semi-diameter at the point where it cuts the focal plane of the cone of rays whose wave-length is $\lambda_1$.

The exact nature of the colour correction of a telescope can be determined by placing the focal plane in a number of different positions, and observing the corresponding values of $\gamma_m$ and $\gamma_n$. These values being substituted in equation (34), several independent values of $\gamma_0$ can be deduced, the mean of which will probably be very near the truth. The conclusions reached in the preceding pages may be summed up as follows:—

1st. From any three pieces of glass suitable for making a corrected objective, but not fulfilling the conditions necessary for the complete destruction of the secondary spectrum, it will always be possible to select two pieces, from which a double objective can be made that will be superior to any triple objective made from all three of the pieces.

2nd. The colour correction of an objective is completely defined by stating the wave-length of the light for which it gives the minimum focal distance.

3rd. An objective is properly corrected for any given purpose when its minimum focal distance corresponds to rays of the wave-length, which is most efficient for that purpose. For example, in an objective corrected for visual purposes, the rays which seem brightest to the human eye should have the minimum focal distance, while in an objective intended for photographic purposes the rays which act most intensely upon silver bromo-iodide should have the minimum focal distance.

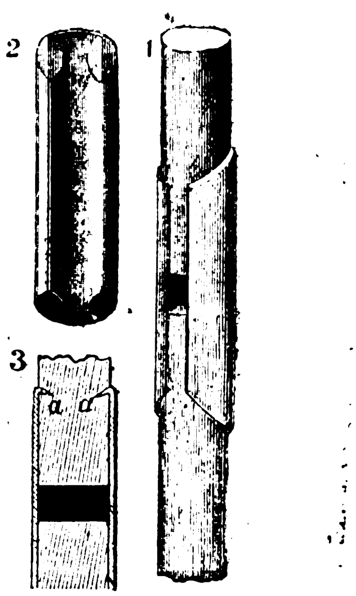
4th. In double achromatic objectives the secondary spectrum (or, in other words, the diameter at its intersection with the focal plane of the cone of rays having the maximum focal distance), is absolutely independent both of the focal length of the combination and of the curves of its lenses, and depends solely upon the aperture of the combination and the physical properties of the materials composing it.

5th. When the focal curve of an objective is known and the relative intensity for the purpose for which the objective is corrected of light of every wave-length is also known, then the exact position which the focal plane should occupy can readily be calculated.

6th. It may be remarked incidentally that in an objective corrected for photographic purposes, the interval between the maximum and minimum focal distances is less than in one corrected for visual purposes. Hence a photographic objective has less secondary spectrum, and is better adapted to spectroscopic work than a visual objective.

## LATHE BELT FASTENER.

THE invention herewith illustrated, lately patented in the United States by Mr. Lewis W. Herrick, of Edmore, Mich., belongs to that class of belt fasteners formed of a piece of sheet metal having inwardly projecting teeth on its ends, which are forced into the ends of the belt by dies. The fastening clip, Fig. 2, is made in tubular form, with one side left open to allow of the insertion of the belt. The ends of the clip are inclined from the closed side toward the open side, and the edges of these portions are bent toward the centre of the clip to form penetrating projections, *a*. The purpose of rounding the edges is to allow the ends of the belt while being inserted or withdrawn to slightly spring the projections apart, to allow of the easy entrance or withdrawal of the belt ends without the use of tools of any kind. When the end of the belt is being inserted, it will first bear against the outer rounded part of the projections, then ride up the incline until it strikes against the closed side of the clip. It will be seen that both ends are so secured that any strain put on the belt will only tend to force the ends of the belt further up the inclined projections. There will be no tendency of the belt ends to come out of the open side of the clip, and the strain will not tend to force the sides of the clip apart.—*Scientific American.*



## ELECTROLYSIS IN THE GRAPHIC ARTS.[*]

### Heliogravure.

OF all the modern methods of producing printable plates, heliogravure stands undoubtedly pre-eminent. It has many advantages over copperplate engraving, and none of its disadvantages. For heliographic reproductions the original must be extremely sharp, either a carefully-executed drawing in India ink, or a good black and otherwise perfect print of any other device. A reversed photographic negative upon glass four-fifths or three-fourths of the original size is first made. The reduction renders the lines still sharper and more delicate than in the original. A gelatine solution, to which is added sugar, lampblack, alcohol, ammonia, and creosote is then prepared, and with it a sheet of photographic paper is coated, and laid upon a plate glass carefully levelled. As soon as the gelatine mixture has set, the coated sheets are hung upon cords, and after drying, are kept in a perfectly dry room. The quantity of the pigment is proportional to the character of the original to be reproduced, one-tenth of it being the maximum, one-fortieth the minimum, the former for fine and delicate drawings in line manner, the latter for other work. The prepared pigment paper is sensitised in a bichromate of potash bath, 1—15, and laid face down upon a carefully-cleaned plate-glass, and dried in a strong current of air. Immediately before using it the paper is detached from the glass. The exposure under the reversed glass negative is made in an ordinary printing frame, the time adjudged by a Vogel photometer. After printing, the pigment paper is taken to the dark room, and in a cold-water bath transferred to a silvered copper-plate, picture side down. Removed from that bath, the paper is squeezed and dried with blotting paper. After five minutes another cold-water bath is used to wash the bichromate from the non-exposed parts. In half-an-hour it is taken up, well rinsed, and subjected to a warm water bath of 30° to 35° C. to dissolve the gelatine not acted upon, that is to develop the gelatine relief upon the silvered copper plate. After a short time the water penetrates the pores of the paper, dissolved black gelatine oozes from the film indicating the beginning of the development; in about 30 minutes the paper is detached, floats upon the surface of the bath, or can be lifted up with ease. The rest of the gelatine is dissolved in a few minutes, and the relief, a copy of the original, appears gradually upon the copper-plate. The development is continued in another bath of warm distilled water, till all remaining fog or dirt is totally removed from the interstices of the relief, and the picture stands out clear and distinct upon the plate. Finally, it is well rinsed with water and dried spontaneously.

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[*] By Major Volkner, in *Correspondenz* (from the *Photographic Times*).

To make this relief plate conductive, powdered graphite is spread over it with tampon and a soft brush; afterwards it is placed on the kathode of a Deniell trough apparatus, and a zinc anode used to accelerate the precipitation of copper. In an hour or less the heliographic relief plate is sufficiently covered, the plate is taken up, cleaned and rinsed, and again placed in the trough. To promote the force of chemical action, caused by the electric current, an iron anode is inserted. After twenty to twenty-four days the plate will be of the desired thickness, and is, therefore, then taken from the trough, rinsed with water, and dried; the edges are filed off, and the patrix removed from the matrix. Both plates are well washed. Adhering parts of the gelatine relief are carefully removed.

If the plane of the gelatine relief has been perfectly clean, and free from any tone, the intaglio plate is also smooth, lustrous, and printable. Matt spots are wiped off with oiled flannel and rottenstone; tone and impurities are scraped and burnished; other defects, which but rarely occur, are retouched with needle and graver.

The first impressions made from heliogravure plates are always rough, and retouching them should not be undertaken till a number of prints have been made. They are in every way equal to engraved copper-plates, and with them there is a great, almost incredible, saving of time. Heliogravure plates, maps of the Austrian Empire, made in fifteen years, would have taken generations to engrave. Before large editions are printed galvanoplastic reliefs are taken from the intaglio plate. From them new copies can be made, in case the original should suffer in course of time.

### Steel-facing.

An important substitute for multiplying copperplates by galvanoplasty is to face them with steel. It is used for plates like objects of art, which never require correction. When a copper-plate is placed on the cathode, suspended in a solution of sesquichloride of iron, and subjected to the action of the galvanic current, it will in a short time be covered with a delicate and lustrous cuticle of iron, hard as steel. There is no difference seen in the prints taken from plain copper or steel-faced plates. The iron gives the plate an extraordinary durability, and many thousands of prints can be made from it. In case the steel cuticle has been unsound, it can be easily taken off and renewed. The plate is laid in sulphuric acid, diluted so much that it will not attack copper; but it loosens the steel, which blisters and comes off in scales. The plate is again washed before another steel-facing. The process is carried on in a peculiar dark trough, with a three-cell zinc-carbon battery; the electrodes are placed vertically. The suitable iron solution is made by the current. One part of chloride of ammonium is dissolved in ten parts of water, and in it are placed iron plates, as kathode and anode. When the circuit is closed a chemical action takes place, the chlorine of the chloride of ammonium unites with the iron of the anode, forming sesquichloride, which remains dissolved in the bath. Within one or two days the bath assumes a greenish colour, its surface turns red, owing to the formation of hydrate of oxide of iron from contact with air, and metallic mirror appears on the kathode. The bath is then sufficiently saturated, and in place of the iron kathode the copper plate to be steeled is inserted. The plate must, of course, be absolutely clean, and is therefore washed in caustic potash, rinsed, and any possibly adhering alkali neutralised with sulphuric acid, washed again and dried. Scamoni, of St. Petersburg, makes very durable plates by first precipitating nickel upon the silvered relief, and then allowing the copper to build up till the desired thickness is reached. His bath is: 45 parts water; 5 sulphate of nickel; and 1 to 1½ of chloride of ammonium.

### Photo-Chemigraphy.

A plate of zinc or any other metal is coated with a mixture of gum arabic, water, grape sugar, bichromate of potassium, and a few drops of ammonia, and exposed to light under a glass positive. After exposure the plate is removed to the dark room, and etched with a strong solution of perchloride of iron. Strong lines are attacked first and etched deeply, the thin and delicate parts afterwards. The process lasts but five minutes, and after cleaning it may be printed from at once. To give the plate more durability it is copper-plated and eventually steel-faced. The copper-plating of zinc cannot be done by electrotypes of the sulphate of copper: the free sulphuric acid will attack the zinc. Instead of it sub-cyanide of copper CuCy (Kupfercyamur) is used. When cyanide of potassium is added in excess to sulphate of copper, the copper electrotype Cu Cy is formed $CuSo_4 + 2KCy = CuCy + K_2SO_4 + Cy$. Sulphite of sodium added previously to the cyanide of potassium changes the cyanide into prussic acid, the sulphite of sodium into sulphate: $Cy_2 + Na_2SO_3 + H_2O = 2HCy + Na_2SO_4$. Ammonia added to the solution forms, with the prussic acid, cyanide of ammonium $NH_4Cy$. Two solutions are made, (1) 140 p. sulphate of copper, 840 p. water; (2) 140 to 200 p. cyanide of potassium, 1,000 p. of water, with the addition of sulphite of sodium and ammonia. The solutions are then mixed. The zinc plate to be copper-faced is placed on the kathode. The current is generated by two zinc-carbon elements.

### Galvano-caustics.

The electro-negative substance of the electrotype f.i., the acid of salt, or the chlorine of a chloride unites chemically with the anode, forming a soluble combination which etches the electrode. Chrom-gelatine paper is exposed under a transparency, inked with roller, and developed; the negative picture is transferred upon a copper-plate, which makes the picture metallic-lustrous. The covered parts resist etching. The sulphuric acid liberated by electrotypes combines with the copper; it etches the plate.

### In Galvanography and Stilography

the plate is coated with the fatty matter coloured with ochre or lamp-black. A drawing is made upon it with the graving tool, the plates are made conductive by graphite, and by placing them in the trough apparatus a relief is made from that on intaglio plate.

### Nature-Printing.

Natural objects like parts of plants, or laces and other open fabrics, are pressed in guttapercha or lead, and galvano-plastic matrices made from them. If f.i. lace be the object to be reproduced, it is pasted with gum upon a steel plate, a sheet of lead placed upon it, and subjected to a high pressure. Relief or intaglio plates are made this way; the former answering well for typographic printing.

### Type-Printing.

Stereotypes are now substituted by galvano-plastic copper precipitates. The form is impressed in guttapercha, the copy graphited, and, moistened with alcohol, laid in the galvano-plastic apparatus. When the copper is sufficiently thick, the plate is taken up, the reversed side and edges planed off, and backed with ordinary type-metal. Woodcuts similarly treated give galvano-plastic copies from which 70,000 to 80,000 prints can be made.

### Plain Copper-plates.

At the time when copper engravings were used exclusively in the Institute, the plates were made by the galvano.plastic process. with the aid of a twelve-cell, zinc-silver battery (system Smee). Now such plates are only made for the patrices in heliogravure. (The last daguerreotype plates in the American market were also galvanoplastic.)—TRANS.

### Magneto-electric and Dynamo-electric Machines.

Improvements introduced in the mechanical arts in modern times have also been introduced for the generation of the electric current in electrolytic operations. Magneto-electric and dynamo-electric machines have been substituted for the hydro-electric cell, by which the liberation of injurious gases and interruption of the work is entirely avoided, and more uniform and accurate work obtained. Machines for continuous currents are preferred with wire twists of considerable diameter, and wire of but little resistance, so as to generate a current great in quantity but of little intensity.

Whatever has been accomplished in the graphic arts by electrolysis justifies the prediction that there is a great future for this process. With the aid of the electric current the genius of man will continue to modify and to improve even those wonderful productions of our own times.

## THE THEORY OF THE INDICATOR: ERRORS IN INDICATOR DIAGRAMS.

AT a recent meeting of the Institution of Civil Engineers Prof. O. Reynolds, F.R.S., read a paper on "The Theory of the Indicator, and the Errors in Indicator Diagrams." The object of this paper was to define the causes and extent of the disturbances in indicator diagrams. The theory, as given, had been taught for several years in Owens College; but the publication had been deferred to enable an extensive series of experiments to be made. These experiments had now been carried out by Mr. A. W. Brightmore, Stud. Inst. C.E., late Berkeley Fellow in Owens College. In the first place it was shown that there were five principal causes of disturbance—namely, the inertia of the piston of the indicator and its attached weights; the friction of the pencil on the paper, and its attached mechanism; varying action of the spring; inertia of the drum; friction of the drum. The effect of the inertia of the pencil and its attached mechanism presented a mathematical problem, by the solution of which it was shown that there were two disturbances from this cause; one, a general enlargement of the mean indicated pressure, depending on the weight of the moving parts of the indicator, the stiffness of the spring, and the square of the speed. The other disturbance was a vibration of the pencil. Every indicator piston vibrated when disturbed, so that the period of vibration depended on the stiffness of the spring. The error which these oscillations caused in the area of the diagram depended on their magnitude, and, to a greater extent, on the smallness of the number in a revolution. But the evil of these oscillations was not so much an effect on the area as in the disfigurement and the confusion they produced in the diagram. So long as there were 30 of these oscillations in a cycle, the necessary fluid friction of the indicator piston would so far reduce them as to render a fair diagram possible, but when the number was as low as ten it was all the pencil could do to prevent them upsetting the diagram. The friction arising from the pressure of the pencil always acted to oppose the motion of the pencil, and therefore rendered it too large during expansion and exhaust, and too small during compression and admission, and thus the general effect was to increase the size of the diagram. This friction consisted of that of the pencil on the paper; and that of the mechanism, caused by sustaining the pressure of the pencil. The effect of the friction of the pencil was greatly reduced by the motion of the paper. The magnitude of these effects taken together on the area of the diagram depended on the construction of the instrument and on pencil-pressure. From numerous experiments it would appear possible to make a difference of as much as 5 per cent. in a locomotive in mid-gear by pencil-friction. The conclusions, as regarded the motion of the pencil, were that the general effect of inertia and friction were both to increase the size of the diagram; that so long as the speeds were such that the number of vibrations of the pencil during a revolution of the engine was not greater than 15, the effect of inertia was less than 1 per cent., but that if the number was greater than 30 oscillations would show themselves unless the pencil-friction was increased. They might, by this, be kept down till the number of vibrations was equal to 15, but not further, and then the necessary friction would affect the area of the diagram about 5 per cent. For the diagrams to be sensibly accurate and free from oscillation the speeds must not be greater than would make the number of vibrations equal to 30. These speeds were given in the paper for Richards' indicators. The effect of the inertia of the drum with an elastic cord was shown to be a nearly uniform elongation of the diagram. The result of the varying stiffness of the drum spring was a nearly uniform contraction. With Richards' indicator these two latter disturbances neutralised each other at a speed of 150 revolutions per minute. At other speeds the effects were apparent in the length of the diagram; but except when the expansion was great and the connecting rod short, they did not affect the indicated pressure. The friction of the drum with an elastic cord caused the cord to be longer during the forward stroke than during the backward stroke, so that the diagram was distorted and shortened, the drum being uniformly behind its proper position during the forward stroke, and before its position during the backward stroke. This distortion diminished the area of the diagram according to the rate of expansion and the length and elasticity of the cord used. This was definitely expressed by a formula. This disturbance, the influence of which was very great in cases of high expansion, large engines, and ordinary cords, appeared to have been unnoticed. The circumstances on which it depended were the elasticity of the cord and the friction of the drum, and the question was how far these existed in the ordinary indicators. It might be said that the diagrams which led to the discovery of this effect were taken with an indicator which had been in constant use for several years. It was in apparently perfect condition, and the diagrams did not differ essentially from those which had been previously taken. The cord was one which had been supplied by the maker. The manner of the discovery was described: For years the author had pursued in the class the method of testing the vibrations of the indicator pencil by projecting them on to the crank-circle, and he had noticed that the first oscillation fell short, and shorter in the back diagram than in the front. The cause of this was not obvious, and it was partly with a view to determine this cause that Mr. Brightmore's investigation was commenced. A slight error in the reducing rod, which had a fixed centre and a slot in which a stud in the slide-block worked, was altered. This, however, did not get rid of the effect. A new cord was substituted for the old one, and the effect was found to be much enhanced, the new cord being more elastic than the old one. This reduced it to the stretching of the cord, but it was only after carefully working out the effect of the inertia of the drum, and it was seen this was to lengthen the first oscillation at the back end, that the friction was examined. The indicator was taken to pieces, cleaned, and oiled: then the effect was much reduced. Several new wires and cords were used, and eventually steel wire was adopted as the best. The test supplied by the oscillations could only be applied to diagrams taken at high speeds, and the test furnished by the influence upon area was vague. What was wanted was an independent means of determining the simultaneous positions of the drum and the engine-piston. As the best method of meeting this it was decided to arrange an electric circuit through the pencil to the drum, with sufficient electromotive force to prick the paper, making the engine-piston close this circuit at eleven definite equidistant points in the motion backwards and forwards. This was successfully carried out, and the stretching of the cord during the backward and forward strokes was definitely ascertained. Taking the smallest results obtained with a cord, it appeared from these experiments that the least difference of stretching was to make this difference in inches 5 per cent. of the length of the cord in feet. Examples of this effect in diminishing the mean indicated pressure were given. Thus, in a locomotive cutting off at one-quarter it was 8 per cent.; in a condensing engine having 3·5ft. stroke, cutting off at one-tenth, 20 per cent.; and the same compounded, 10 per cent. These would seem to be the smallest results that could have occurred in ordinary practice. The conclusion, however, that hitherto the normal indicated power from engines had been from 10 to 20 per cent. too small must wait for verification. Yet there were not wanting independent evidences of such an effect. In diagrams taken from engines at high speeds the admission line would not but for this effect be vertical. It would show a certain amount of detail, and the first oscillation would not have a sharp top. Moreover, it was commonly found that the expansion line, allowing for clearance, was above the true expansion line for the steam. This apparent rise in the curve of expansion was exactly what would result if the apparent cut-off was too early, and this was the result of the effect that had been considered. The author had tried several diagrams, and found that after correction the expansion line came out very close to the true curve. In making these comparisons the explanation of another feature of diagrams became apparent. When the two diagrams were traced on the same card there was sometimes a want of symmetry about them, and in this case the cut-off was shorter on the back than on the front diagram. This the author attributed to the friction of the drum when the cord for the back diagram was longer than that for the front. When this was the case the relative lengths of the cord were about 1 to 1·8. These observations were illustrated in a diagram from "Richards' Indicator." To test this diagram, a tracing was taken, and reversed so that the front diagram was superimposed on the back. It was observed that the diagrams were of different lengths, and the difference was about the same as the difference in cut-off; that notwithstanding the apparent cut-off in the back diagram was to that in the front in the ratio of 2 and 3, the expansion line of the back diagram was the same shape as that in the front; and that if the diagrams were restored, supposing the lengths of the cords used to have been 5ft. and 9ft., the diagrams became exactly similar, and, allowing 2 per cent. clearance, the expansion line came to be the true expansion line for that cut-off. The mean pressure was 14 per cent. larger than from the original diagram. Such instances as these seemed to sufficiently establish a case against the blind faith which appeared to be at present placed in the accuracy of the indicator diagrams. But, in conclusion, the author stated that he should be very disappointed if anything in this investigation should have the effect of diminishing reliance on the indicator itself. He would have the instrument treated fairly, and instead of being the object of unthinking worship he would have it the object of careful study and experimental investigation, so that the limits of its wonderful perfection might be known exactly, and that reliance placed on it which sprang from knowledge.

## THE GREENWICH VISITATION.

On Saturday last the members of the Board of Visitors and others assembled at the Royal Observatory, Greenwich, to receive the report of the Astronomer-Royal for the past year. Despite the inclemency of the weather no fewer than 200 gentlemen were present, among them being Professor Huxley, President of the Royal Society; Sir G. Airy, Lord Rayleigh, Mr. E. Dunkin, President of the Royal Astronomical Society, and Colonel Hozier. It appears from the report that the dome for the Lassell reflector has been completed during the year; so, too, has the instrument used during the eclipse of the moon on October 4. It being suspected that some personal equation might exist dependent on the apparent direction of motion of the object observed, a reversion prism has been adapted to the collimators and the transit-circle, so that the apparent movement might be reversed—i.e., instead of the object always passing through the field from right to left it passes from left to right. The observations of the collimators show no evidence of personal equation depending on the direction of measurement, but in order to eliminate any such errors should they exist, half the observations are taken with the direction of movement reversed. A comparison of the observations of transits shows a marked difference between the observations taken in the ordinary manner and with the direction of motion reversed; but as this is only the case for some observers, the Astronomer-Royal thinks it probable that they have not yet become accustomed to the reversion. In order the better to investigate this difference of personal equation the Astronomer-Royal, in concert with Mr. Simms, has arranged an instrument by which various details can be satisfactorily entered into in a manner otherwise impossible. On the publication of Professor Pickering's "Harvard Photometry" all stars which he had noted as brighter than the sixth magnitude and which had not been recently observed at Greenwich were inserted in the working catalogue, in order that the next Greenwich catalogue might contain all stars down to the sixth magnitude which have not been observed at Greenwich since 1860. The annual catalogue for 1884 contains about 1,370 stars, or 166 less than that for 1883. Notwithstanding the gradual increase in the number of observations the reductions are kept in an advanced state. The sidereal standard clock—the real time-keeper of the country—goes very satisfactorily. The public clock at the Observatory entrance and the other mean-time clocks were put forward 12 hours on January 1, so as to show Greenwich civil time, starting at midnight and reckoning from 0h. to 24h., which would correspond with the universal time recommended by the Washington Conference. The change from astronomical to civil reckoning has also been made in all the internal work of the Observatory, and has been carried out without any difficulty. Greenwich civil time is found to be more convenient on the whole for the purposes of this Observatory, but its introduction into the printed astronomical observations has been deferred to allow time for a general agreement among astronomers to be arrived at. It is proposed, however, to adopt the civil day without further delay in the printed magnetical results, thus reverting to the practice previous to 1848, and making the time-reckoning harmonise with that used in the meteorological results, the reckoning from 0h. to 24h. being for the future adopted in both cases.

In regard to the equatoreals, all are, and have been, in perfect working order, with the exception of the Lassell reflector, which has required a number of repairs and alterations, and even now difficulty is experienced from want of stability of the optical axis of the large mirror, which requires continuous readjustment as the telescope is moved. With the various equatoreals, 30 occultations (16 during the lunar eclipse of October 4th) and 57 phenomena of Jupiter's satellites have been observed. Comet (c) 1884 was observed on four nights, and some measures of double stars and of the satellites of Saturn have been made. The observations for determining the rate of approach or recession of stars are considerably in excess of the numbers in former years, no fewer than 641 measures having been made. During the year photographs have been taken on 173 days, the sun's disc being free from spots on only two days. The magnetic registers give evidence of five days of great magnetic disturbance, and 20 days of lesser disturbance, for which tracings of the registers will be published. Pressure of work has retarded the trial of the new photographic apparatus mentioned in the last report; but the apparatus has now been erected provisionally, in order to obtain a series of records to compare with those of the apparatus now in use before the latter is discontinued. The Thames temperature observations are taken regularly at the Deptford Cattle Market, and printed with the Greenwich meteorological observations in the Registrar-General's weekly report. The mean temperature for 1884 was 50·7°—i.e., 1·4 above the average of the last 43 years. The maximum temperature was 94·1° on August 11th; the minimum 24·5° on November 25th. The greatest, mean, and least daily motion of the air were 891, 286, and 78 miles—the first on January 23rd, the last on February 8th. The greatest pressure of the wind on a square foot was 22·7lb. on January 23, there being no other case in which the pressure exceeded 20lb. The rainfall was 18·0in. per square foot—i.e., about 7in. below the average of the last 40 years. The number of hours of bright sunshine recorded by Campbell's instrument was 1,115, or about 100 below the average of the last seven years. In connection with the establishment of hourly time-signals at the Start or Lizard, which was long advocated by Sir G. B. Airy, the Committee of Lloyd's have informed the Astronomer Royal that they would undertake the maintenance of hourly time signals at any of their signal stations provided the Government would supply the necessary apparatus. After consultation with Captain Wharton, it has been thought better that, before taking further steps, some preliminary trials should be made of a collapsible cone as an hourly time-signal, facilities for doing which exist at Devonport. There seems a probability of this long-advocated project being at last carried out. The errors of the Westminster clock have been under 1sec. on 50 per cent. of the days of observation, and over 4sec. on only 4 per cent. The Astronomer Royal points out that there has been an extension in the work of the various departments during the year, and relies on the record of work done as the best testimony to the zealous spirit with which his subordinates have laboured to sustain the credit of the establishment.

The report concludes by pointing out the necessity for a larger telescope; and it is mentioned that over 20 observatories and even persons have larger telescopes than the 12¾in. at Greenwich. For such an instrument as the Astronomer Royal suggests—viz., a 28in.—about £3,500, it is believed, would be required.

## MIND AND MOTION.

The Rede Lecture delivered last week in the Senate House, at Cambridge, by Mr. G. J. Romanes, M.A., F.R.S., was entitled "Mind and Motion." After giving some account of the teaching of Hobbes, who laid it down, on the one hand, that all our knowledge of the external world is but a knowledge of motion, and, on the other, that all our acquisitions of knowledge and other acts of mind imply some kind of "motion, agitation, or alteration, which worketh in the brain," Mr. Romanes pointed out, as regards the internal world, that physiology has proved that molecular movements of nervous matter are concerned in all the processes of reflex action, sensation, perception, instinct, emotion, thought, and volition. The lecturer detailed the discoveries which of late years have been made by physiology concerning the rate at which these movements travel along nerves, the period of molecular vibrations in nerve centres, the time required for processes of thought, and the quantitative relations between brain-action and mind-action. When physiological instruments fail to take cognisance of these relations, we gain much additional insight touching the movements of nervous matter by attending to the thoughts and feelings of our own minds, for these are so many indices of what is going on in our brains. Proceeding to contemplate the mind, considered thus as a physiological instrument of the greatest delicacy, he argued that the association of ideas is but an obverse expression of the fact that when once a wave of molecular disturbance passes through any line of nerve structure, it leaves behind it a change in the structure, such that it is afterwards more easy for a similar wave when started from the same point to pursue the same course. Such being the intimate relation between brain-action and mind-action, it has become the scientifically orthodox teaching that the two stand to one another in the relation of cause to effect. He pointed out that the doctrine of conscious automatism is logically the only possible outcome of the theory that nervous changes are the causes of bodily changes, and, therefore, it cannot be fought on grounds of physiology. If we persist in regarding the relation between brain and thought exclusively from a physiological point of view, we must of necessity be materialists. But it does not follow from this that the theory of materialism is true; and other considerations of an extra-physiological kind conclusively prove that the theory is false. We have, first, the general fact that all our knowledge of motion, and so of matter, is merely a knowledge of the modifications of mind. Therefore, so far as we are concerned, mind is necessarily prior to everything else. Thus the theory of materialism assumes that one thing is produced by another thing, in spite of an obvious demonstration that the alleged effect is necessarily prior to its cause. But further, "motion produceth nothing but motion," says Hebbes, and yet he immediately proceeds to assume that in the case of the brain it produces, not only motion, but mind. Materialism has to meet the unanswerable question—How is it that in the machinery of the brain motion produces this something which is not motion? Science has now definitely proved the correlation of all the forces, and this means that if any kind of motion could produce anything else that is not motion, it would be producing what science would be bound to regard as in the strictest sense of the word a miracle; causation from brain to mind is in the strictest sense of the word a physical impossibility. *Mutatis mutandis* the theory of spiritualism—which supposes causation to proceed from mind to body—is, he held, but little less unphilosophical than the opposite theory of materialism. For just as it follows from the conservation of energy that motion can produce nothing but motion, so it equally follows that motion can be produced by nothing but motion. Is there, then, any third hypothesis in which we may hope to find intellectual rest? If we unite the elements both of spiritualism and of materialism, we obtain a product which satisfies every fact of feeling on the one hand, and of observation on the other. We have only to suppose that the antithesis between mind and motion, subject and object, is itself phenomenal or apparent, not absolute or real; that the seeming quality is relative to our modes of apprehension; and, therefore, that any change taking place in the mind and any corresponding change taking place in the brain are not really two changes, but one change. There is thus supposed to be only one stream of causation in which both motion and mind are simultaneously concerned; motion is supposed to be producing nothing but motion, mind-changes nothing but mind-changes. Both producing both simultaneously, neither could be what it is without the other, because without the other neither could be the cause which in fact it is. The use of mind to animals is thus explained, for intelligent volition is shown to be a true cause of bodily movement, seeing that the cerebration which it involves would not otherwise be possible. This monistic theory thus serves to terminate the otherwise interminable controversy on the freedom of the will; for the theory shows it to be merely a matter of terminology whether we speak of the mind or of the brain as the cause of bodily movement. That particular kind of physical activity which takes place in the brain could not take place without the occurrence of volition, and *vice versâ*. All the requirements alike of the determinist and of the free-will hypotheses are thus satisfied by a synthesis which comprises them both in one. Mr. Romanes afterwards reviewed the opinions of the late Professor Clifford upon this subject, and concluded by observing that if it were true that the voice of science must of necessity speak the language of agnosticism, at least let them see to it that the language was pure; let them not tolerate any barbarisms introduced from the side of aggressive dogma. So would they find that this new grammar of thought did not admit of any constructions radically opposed to more venerable ways of thinking, and that the often-quoted words of its earliest formulator applied with special force to its latest dialects—that if a little knowledge of physiology and a little knowledge of psychology incline men to atheism, a deeper knowledge of both, and still more a deeper thought upon their relations to one another, could only lead men back to some form of religion, which, if it be more vague, will also be more worthy than that of earlier days.

## THE NEW TELESCOPE OF THE PARIS OBSERVATORY FOR STELLAR PHOTOGRAPHY.[*]

THIS new instrument is composed of two telescopes inclosed together in a single metallic tube, in form of a parallelopiped, and separated in their entire length by a thin partition.

One of the object-glasses, 9½in. aperture, and 11ft. 9⅝in. focal length, is used for visual observation, and serves as finder; the other o.g., 13⅜in. aperture, corrected for the actinic focus, is used for the photography: the optical axes of these two telescopes being parallel, the centres of their fields coincide. The instrument is mounted equatorially, and has clockwork movement going for three hours without being rewound, and has very fine independent back movements.

The photo. o.g. is the largest that has been yet made, and is of a simple achromatic system; though it is of a relatively short focus, it can cover with neatness, and without the use of a stop, the large field of 3° diam.

Although the instrument is not yet quite finished, the Messrs. Henry have obtained a proof on the 23rd April last, with an exposure of one hour, representing a surface of the sky of 5° square, and one can count in the photo. 2,790 stars ranging from the 5th mag. to the 14th mag.; those on the edges of the plate being quite as clearly defined as those in the centre of it. Traces of stars of even the 15th mag. may be found on the plate, but too feeble for reproduction on the sensitive paper; they would certainly be obtained by a longer exposure.

The stars of the 14th mag. present themselves on the plate with a diam. of $\frac{1}{20}$ of a millimètre. The construction of such a chart obtained in one hour would, by the ordinary methods, require at least several months of close work.

The following are the necessary *minimum* exposures, but to obtain plates for good paper prints triple the time is required.

| | | | | |
|---|---|---|---|---|
| Stars | 1st | Mag. | | 0·005s. |
| " | 2 | " | | 0·013 |
| " | 3 | " | | 0·03 |
| " | 4 | " | | 0·08 |
| " | 5 | " | | 0·2 |
| " | 6 | " | last visible to the naked eye | 0·5 |
| " | 7 | " | | 1·3 |
| " | 8 | " | | 3·0 |
| " | 9 | " | | 8·0 |
| " | 10 | " | medium magnitude of asteroids | 20·0 |
| " | 11 | " | | 50.0 |
| " | 12 | " | | 2m. |
| " | 13 | " | | 5 |
| " | 14 | " | | 13 |
| " | 15 | " | | 33 |
| " | 16 | " | 1h. | 23 |

It can be seen by this table that the difference of exposure varies between the first and last mag. from 1 to 1,000,000; between two consecutive magnitudes the relation is 2·512.

The plates used were the gelatino-bromide of Monckoven, prepared by M. Bernaert of Ghent. The construction of the mechanical portion of the instrument was intrusted to M. Gautier, and the o.g. was made by MM. Paul and Prosper Henry themselves.

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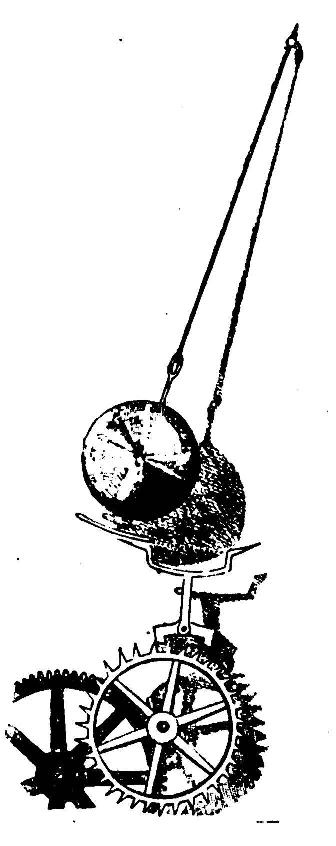
[*] Translation from Report by MM. PAUL AND PROSPER HENRY, Astronomes-Adjoints de l'Observatoire de Paris.

## HART'S PENDULUM ESCAPEMENT.

A RATHER novel form of pendulum escapement has been recently patented by Mr. Hart, of Kirksville, Missouri, and is shown in the annexed engraving. The improvement claimed consists simply in applying power through a lever escapement to a pendulum. The pendulum, being detached, meets with less resistance after receiving an impulse, and hence is more accurate for time. The power being applied at or below the ball instead of so far above and so near its place of suspension, much less power is required to keep it in motion, or to run the clock. Less power being required, there is, naturally, less wear; and a reduction in springs, weights, and material may be made throughout. Weaker or thinner springs being sufficient, there is less liability of their breaking. The dial of the clock is brought down where it can be easily seen, and no ladder is required in winding. In tower clocks the pendulum may be made of any desired length, and run up into the steeple out of the way. An accurate compensation may be had by extending a rod from the bottom of the ball up, for the support of the pendulum.



# SCIENTIFIC SOCIETIES.

## WESTERN MICROSCOPICAL CLUB.

THE members of the Western Microscopical Club met last week at the house of Dr. Foulerton, F.G.S., 44, Pembridge-villas, Bayswater. The subject for the evening was "A Demonstration in Micro-Photography." The host, who acted as demonstrator, called attention to the great progress which had recently been made in photography, with special reference to the gelatino-bromide dry plates. The essential constituent of these is a bromide of silver, on the molecules of which, themselves no doubt in a continual state of rhythmical movement, certain of the waves of light, synchronous in their action, produce a chemical change, probably the formation of a sub-bromide; but this change, which takes place during the exposure of the plate in the camera, is wholly invisible until acted on by a developer. The composition and action of developers, whether pyrogallic acid with an alkali and a bromide, or the ferrous oxalate, were then dwelt upon. They were oxidisers, which began by attacking the very small amount of sub-bromide produced on the film by the action of light, and resulted in the deposition of silver along with other changes. Whilst this was taking place more bromide was being changed into sub-bromide, with a further deposition of silver, and this was continued until, in the opinion of the operator, a sufficient amount of silver had been deposited to produce a picture in which the lights and shadows were of course reversed, most silver being deposited where the action of the light in the camera had been strongest, corresponding to those parts of the object which were most transparent. After the full effect of the developer had been obtained there still remained on the film a quantity of bromide of silver which had not been acted upon, and which, if allowed to remain, would, on exposure to light, completely destroy the picture, and which had therefore to be removed by hyposulphite of soda, an operation which is called "fixing." The image on the ground glass of the camera of the object on the stage of the microscope produced by the lenses was then dwelt upon. The time required for exposure of the sensitive film according to the degree of enlargement; the distance behind the objective on which the image should be formed; the advantages of artificial light over daylight, and other questions of a practical nature were then alluded to, particularly the best kind of non-actinic light to enable the operator to carry on his manipulations without injury to the most sensitive plates. It was shown that no light which was practically of any use to see by was absolutely non-actinic for any length of time, but that, with reasonable care, a very considerable amount of light, practically harmless, could be got by using a candle surrounded by two or three folds of "Golden Fabric." No light, however, was to be trusted without first testing it, and the method of doing so was pointed out. The lecturer then proceeded to give a practical demonstration of the observations he had made by taking a microphotograph of a rock section with an inch objective (without an eyepiece). A paraffin lamp and condenser were used for illumination. The image was formed at about 2ft. behind the object. An exposure of two minutes was given; development was effected by pyrogallic acid, ammonia, and bromide of potassium, and the image fixed with hyposulphite of soda. The operation lasted about ten minutes, was completely satisfactory, and was watched with much interest by the members present, more particularly the gradual development of the image from a faint beginning till it was fully and clearly out. Then followed its seemingly wanton destruction and obscuration by fog, which is necessary in order to secure sufficient density after the subsequent operation of fixing, in which the image again becomes clear and distinct. The process of obtaining a lantern transparency was then explained and practically demonstrated. Numerous lantern transparencies, both of microscopical objects and of landscapes, were exhibited by the lecturer, with some Dallastype specimens, in which the photos.

are transferred to a block and printed with the letterpress. Mr. J. Harris Leall, F.G.S., and Messrs. How sent a fine collection of photos. of rock sections and crystals for a lantern display. Dr. T. S. Cobbold contributed some photos. of special interest. Some specimens of human liver, kidneys, &c., were sent to him from Alexandria by Dr. Kartulis. These sections were crowded with the eggs of the dreaded fluke, the *Bilharzia hæmatobia*. Very successful photographs of these were prepared by Mr. Charters White, M.R.C.S. Photos. of diatoms, fungi, test-scales, &c., taken by Mr. Herbert Jackson, with powers as high as the twenty-fifth of an inch, elicited much interest. Microscopes were contributed by Dr. H. Snow and Dr. J. Chippendale, the latter exhibiting an interesting section of fœtal lung. Mr. G. Karop showed a beautiful section of the iris of the human eye. Mr. A. W. Stokes, F.C.S. (Public Analyst to Paddington, &c.), was unanimously re-elected hon. secretary, from whom any information as to the new session to commence in October next may be obtained.

ROYAL MICROSCOPICAL SOCIETY.— ERRATA.—In the report of this Society, page 299, last paragraph but one, for "fishplates," read testplates; for "size. of the arc," read sine of the arc; and for "the bottom could be," read the latter could be.

# SCIENTIFIC NEWS.

IN his report for 1884 Admiral Mouchez, Director of the Paris Observatory, refers to the bad situation of that establishment for doing high-class astronomical work, and sketches a scheme for removing the principal instruments to a site where greater steadiness in their mounting can be obtained, and where they will be free from the inconveniences of the present surroundings. M. Bigourdan has carried on his work in connection with double stars, small planets, comets, and nebulæ, determining with greater exactitude the positions of several and discovering no fewer than fifteen new nebulæ. The great Eastern equatorial has been utilised by MM. Henry in observing the satellites of the large planets and the ring of Saturn. M. Loewy and M. Périgaud have been using the equatorial coudé in observing comets and the newer small planets, and M. Obrecht has obtained a number of photometric observations of the satellites of Jupiter with the same instrument. We have previously referred to the photographic star charting of MM. Henry, and an article in another column gives further particulars. The great telescope of 29in. is still unmounted, and the council of the Paris Observatory do not appear to be inclined to accept the suggestion to mount it at the observatory of Algiers—an exceptionally favourable position.

It seems that the dome of the Bischoffsheim observatory, Nice, is the largest thing of the kind. It is a revolving dome, it should be remembered, and is said to weigh nearly 94 tons; but it is easily moved by turning a small wheel, and can be completely revolved in four minutes. As mentioned on p. 275, the dome is to float in a trough rim, and it has, we believe, been determined to try a solution of chloride of magnesium as the liquid, as that does not freeze until the temperature falls many degrees below zero. The telescope will have an object-glass of 30in.

The small planet discovered by M. Borrelly on March 6, No. 246, has been named Asporina.

The conversazione of the Institution of Civil Engineers was held on Friday evening last at the International Inventions Exhibition. The attendants at the stands had an evening's respite, and the public were not admitted after six.

The annual general meeting of the Marine Biological Association will be held to-day, June 12, at five o'clock, in the rooms of the Linnean Society, Burlington House. Prof. Huxley will preside. The sum now subscribed for the Plymouth laboratory amounts to nearly £8,000; of this sum £2,000 was recently contributed to the association by the Fishmongers' Company. The Earl of Derby has recently joined the association and subscribed £100. The Clothworkers' and the Mercers' Companies have contributed handsomely to the association, and it is to be hoped that other companies will follow the example of the Clothworkers, and contribute to this national enterprise.

Prof. Huxley has promised to retain his office as president of the Royal Society at least until St. Andrew's Day, when, owing to the state of his health, he will resign, and indulge in what is called complete rest.

The Swiney Lectures on Geology will be delivered in the Natural History Museum, South Kensington, on Mondays, Wednesdays, and Fridays, at 4 p.m., commencing next Monday, June 15. The course consists of twelve lectures, and Dr. R. H. Traquair, F.R.S., F.G.S., will take for his subject "Birds and Mammals" especially in relation to their fossil forms. Admission to the course is free.

Mr. Nicholas Whitley communicates to the *Journal* of the Royal Institute of Cornwall for May a paper entitled "Traces of a Great Flood in Cornwall," in which he arrives at the conclusion that the flood which deposited the stream-tin in the valley was post-glacial.

Mr. C. V. Boys, demonstrator in the Physical Laboratory at South Kensington, sends us a copy of the syllabus of the course of practical instruction in physics at the Normal School of Science, South Kensington. This syllabus contains clear and concise directions for making a variety of simple apparatus for experiments in physical science. The tools needed are few and inexpensive, and a lathe is not required. The price of the syllabus is 3d. It is sold at South Kensington Museum, and by Chapman and Hall, the agents to the department.

The Council of the Society of Arts have awarded the Albert Medal to Henry Doulton, in recognition of the impulse given by him to the production of artistic pottery in this country.

The coversazione of the Society of Arts will be held at the International Inventions Exhibition, on Friday, July 3rd.

Prof. Verneuil is the President-elect of the French Association for the Advancement of Science for the meeting which will be held this year at Grenoble on the 13th of August.

Mr. F. A. Gower, the inventor of the Gower telephone, is making a series of experiments in aërial navigation or ballooning under the "cognisance" of the Government. He has made Hythe the centre of his operations, whence he recently started a pilot balloon containing about 2,300ft. of gas, with automatic arrangements for giving out ballast and gas. This balloon made a descent near Dieppe, having made a rapid passage of 72 miles in a straight direction. On Monday last week another pilot balloon, with a capacity of 4,300ft., was started, and immediately followed by Mr. Gower in a larger balloon, containing 23,000ft. of gas. His object was to watch the action of the pilot; but the smaller machine made such rapid progress that it got out of his observation and came down in the vicinity of Paris. Meanwhile Mr. Gower, who ascended about noon, made the French coast at Boulogne at 2.15, and then taking a northerly curve travelled overland to Calais, where he made a smooth descent at 4 p.m. On Wednesday Mr. Gower made an ascent with Captain Lane and Mr. Dale; but owing to the wind drifting them to the North Sea they were compelled to descend, and landed in the Isle of Sheppey. Experiments will be made on all favourable opportunities.

Dr. Hickson, who has been studying animal morphology for nearly four years at Oxford, under Prof. Moseley, has started on a voyage of biological exploration in the island of Celebes. His special object is to study the development and life-history of the Alcyonarian corals; but he hopes also to explore the interior of the island, the fauna of which is at present almost entirely unknown.

The Stokes-Watson spark apparatus for showing the combustion of metals under the microscope by the passage of the electric spark through them, made by Messrs. Watson and Sons, of High Holborn, from the design suggested by Professor Stokes, was exhibited by Messrs. Watson at the conversazione of the Royal Society, Burlington House, on the 6th May, and again by them on Friday, the 5th June, at the Royal Institution. It is a most interesting apparatus, the different metals in combustion showing most beautiful colours, and as the apparatus can be added to any ordinary microscope, no doubt it will become very popular.

Senor Ugaz calls attention in the Lima *Cronica Médica* to the vesicating property of the inner bark of the walnut tree. He soaks it in vinegar for fifteen minutes or so, and applies it to the part on which a blister is required. He has found it useful as a remedy for lupus, but he dusted the blister with calomel.

The size of the Atlantic waves has been carefully measured for the Washington Hydrographic Bureau. In height the waves usually average about 30ft., but in rough weather they attain from 40 to 48ft. During storms they are often from 500 to 600ft. long, and last ten or eleven seconds, while the longest yet known measured half a mile, and did not spend itself for 23 seconds.

The Royal Dublin Society have resolved to hold an International Exhibition of Arts and Industries at Ballsbridge in 1887.

An exhibition of domestic gas appliances has been opened at the Parkes Museum, the apparatus being supplied by Mr. Fletcher, of Warrington. The exhibition will be open until the 27th inst., from 10 a.m. to 7 p.m., and on Mondays, Wednesdays, and Saturdays until 9 p.m.

Mr. Walker (Walker, Parker, and Co., Bagillt) having read the lecture on "Dust" delivered by Prof. Oliver J. Lodge at the Montreal meeting of the British Association, was struck with the results of the experimental passage of electric sparks through dust and smoke-laden atmospheres, and conceived the idea of applying the principle to the condensation of lead "fume" at the smelting works. Experimental trials gave results so satisfactory, that two large Wimshurst machines, with discs 5ft. in diameter, are to be employed for dealing with the "fume" at the Bagillt works.

A memorial statue of Charles Darwin, designed by Mr. Boehm, R.A., was unveiled on the 9th inst. by Prof. Huxley, in the great hall of the Natural History Museum, in the presence of the Prince of Wales and a large assembly, including many of the most prominent scientific men of the day. The Prince of Wales received the statue on behalf of the trustees of the Museum.

# USEFUL AND SCIENTIFIC NOTES.

**New Expanding Mandrel.**—Messrs. H. B. Barlow and Co., of Manchester, have introduced a new mandrel, in which they have worked out several improvements upon the Harrison expanding mandrel manufactured by this firm for some years past. In the new mandrel, pulleys or heavy wheels can be turned upon it without any back centring, and one great advantage is that it brings the work very much closer up to the face-place than in the old mandrel. The body of the mandrel consists of a steel forging, flanged with a taper nose, bored up, in which a bolt works. The split dies, which are bevelled at each end, work upon the taper nose, and the mandrel is expanded by simply turning an ordinary hexagon-headed bolt and released by turning this bolt in the opposite direction.

THE Great Northern Railway are lighting one of their trains with E.P.S. accumulators, placed in each coach. The cells are charged by a dynamo driven from the axles, and an E.P.S. magnetic switch closes the circuit when the electro-motive force of dynamo rises above that of the cells. The Electrical Power Storage Company have lately supplied accumulators for use on the Lancashire and Yorkshire Railway, as well as the Great Eastern Railway.

FIRST-CLASS carriages are not much required on some German lines. The statistics have always shown that they are little used. On one of the State Railway systems in the year to March 31st, 1883, only three passengers in a thousand travelled first-class, so that most of the trains must have no first-class passengers at all.

THE *Allgemeine Brauer-und-Hopfen Zeitung* gives the following as being the most recent statistics with regard to the tax upon spirits in Europe:—The tax yields a revenue of £18,725,850 in Russia, of £15,581,290 in Great Britain, of £14,508,000 in the United States, of £10,603,660 in France, of £2,334,640 in North Germany, of £1,890,450 in Holland, of £1,062,400 in Austria-Hungary, and of £681,200 in Belgium. This is equivalent to 9s. per head of the population in Holland, 8s. 6d. in Great Britain, 6s. in the United States, 5s. 6d. in France, 4s. 6d. in Russia, 2s. 4d. in Belgium, 1s. 3d. in North Germany, and 7d. in Austria-Hungary; while the consumption per head of alcohol is given as 2½ gallons in Denmark, 2 gallons in North Germany, 1½ gallon in Russia, rather less than 1½ gallon in Austria-Hungary, 1¼ gallon in Belgium, 1⅛ gallon in France and Holland, 1 gallon in Sweden, two-thirds of a gallon in Great Britain, and rather less than two-thirds of a gallon in the United States.

# LETTERS TO THE EDITOR.

*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

*All Cheques and Post-office Orders to be made payable to* J. Passmore Edwards.

*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

## THE SUSPECTED VARIABLE STARS HEIS 121 PERSEI—π′ ORIONIS—B. 147 MONOCEROTIS — 60 LEONIS — SOME FINE RED STARS—TWO PROBABLY VARIABLE STARS.

[24339.]—Heis 121 Persei.—This star is No. 106 in Gore's Catalogue of Suspected Variable Stars, and in the Harvard Photometric *Observations*, No. 729. The star has been suspected of variation, from the fact that Peirce found its magnitude 5·8, and Heis 6·0, while the D. M. makes it 7·7. There is a most important note in the second part of Vol. XIV. Harvard College *Observations* on this star. It would seem that both Heis and Peirce really observed D. M. 49° 1155, which is a bright 6·0.

π′ Orionis.—The following note appears in the same vol. of Harvard College *Observations*: "W. H. Gage thinks the period is 28 ± days," and the reference *Observatory* VII. 132. I have not been able to verify the reference, but it is probably an account of the seventh meeting of the session 1883—84 of the Liverpool Astronomical Society. Mr. Gage then stated that "observation could alone determine whether 28 days, or a semi-period of 26·5, is the better of the two." He there finally deduces—

P. 54·73 weighted.
Mean period 54·50.

The star is undoubtedly variable, but the observations are perplexing. Probably the comparison stars are variable. Mr. W. E. Jackson, of Constantinople—a most careful observer—has furnished me with the following observations. Comparison star $\pi^3$ = 3·90.

| Date. | h. m. | $\pi^1$ | $\pi^5$ |
|---|---|---|---|
| 1884. Nov. 25, | 9 20 | 3·57 | 4·04 |
| 26, | 7 37 | 3·71 | 4·03 |
| 28, | 7 30 | 3·83 | 4·12 |
| 29, | 9 20 | 3·90 | 4·19 |
| Dec. 7, | 6 15 | 3·60 | 4·20 |
| 7, | 7 40 | 3·82 | 4·0 |
| 8, | 7 35 | 3·64 | 3·78 |
| | 9 5 | 3·57 | 3·79 |
| 9, | 7 44 | 3·45 | 3·79 |
| | 8 33 | 3 69 | 3·76 |
| 10, | 4 12 | 3·84 | 4·04 |
| 11, | 6 20 | 3·63 | 3·81 |
| | 9 0 | 3·64 | 3·80 |
| 12, | 6 28 | 3·76 | 3·90 |
| | 9 14 | 3·79 | 3·90 |
| 14, | 5 55 | 3 90 | 3·90 |
| | 8 5 | 3·89 | 3 89 |
| 15, | 7 19 | 3·41 | 3·90 |
| | 8 3 | 3.79 | 3·90 |
| 16, | 8 23 | 3 56 | 3·90 |
| 17, | 5 53 | 3·63 | 4·14 |
| | 7 58 | 3·63 | 3·90 |
| 23, | 9 33 | 3·57 | 3·90 |
| 27, | 10 3 | 3·8 | 3 80 |
| 1885. Jan. 5, | 7 54 | 3·74 | 3·90 |
| | 9 58 | 4·01 | 3 99 |
| 6, | 8 49 | 3·76 | 3·86 |
| 12, | 7 47 | 3·63 | 3 96 |
| | 9 51 | 3·63 | 4·01 |
| 15, | 8 58 | 3·75 | 4·05 |
| 16, | 6 16 | 3·62 | 3·81 |
| Feb. 18, | 8 54 | 3·66 | |
| 20, | 7 9 | 3·70 | |
| | 8 31 | 3·64 | |
| 21, | 7 54 | 3·85 | |
| March 8, | 7 49 | 3·81 | |
| 9, | 6 44 | 3·90 | |
| 10, | 6 39 | 3 60 | |

The observations range
From 3·76 to 4·20 for $\pi^5$ and
From 3 41 to 4·01 for $\pi^1$,
or for $\pi^5$ they vary 0·44 and for $\pi^1$ 0 60.

B. 147 Monocerotis—Gore 186.—Pickering points out that Birmingham has confused this star with a bright star H. P. 1189. The difference between the two in R. A. is 10 minutes, which seems unaccountable. On Feb. 27, 1855, while reobserving Birmingham's objects, I found B. 147, 6½ reddish, and discovered another red star, ± 1m. 26s. *f.* and 7′ ± south, of the same colour. The magnitude of this star was 8½. The following observations of B. 147 were made at the Dunsink Observatory:—

| | | | | |
|---|---|---|---|---|
| 1876. | Feb. | 5 | 6·5 | deep yellow |
| | | 19 | 7·0 | deep yellow |
| 1879. | Jan. | 3 | 7·2 | orange |
| | | 16 | 7·5 | orange |

60 Leonis.—This star has not, as far as I am aware, ever been suspected of variation. It must, however, be variable in colour, unless the observation of Schmidt, mentioned by Birmingham, be really of some other star. The reference is *Astr. Nach.* 1902, and the colour red. Franks found it greenish. During the re-observation of Birmingham's red stars with the 9in. equatorial reflector I found it yellowish white 1885, March 6, and pure white May 7. It seems probable that there must be a mistake somewhere. It is a little curious that 61 Leonis is a fine orange star. The places of the two stars as taken from the Havard Photometry are

61 10 55·7 − 1·50
60 10 55·9 + 20·49.

But it seems almost impossible that so great an error as 21° could have been made.

Since February last more than 100 of Birmingham's red stars have been reobserved. It may be well to give the finest of those observed up to the present time.

h. m. s.
B. 135 6 3 26 + 26·2 1885, Feb. 5, 8·0, very fine red.
B. 148 6 28 18 + 38·32 1885, Feb. 5, Feb. 9, Feb. 20, very fine red, 6·0 mag.
B. 165 7 1 7 − 7·22 1885, Feb. 27, 8½, remarkably fine red.
B. 166 7 2 27 − 11·44 1885, Feb. 27, 8·0, very fine red.
B. 209 8 46 30 + 19 46 1885, Feb. 17, 9·0, remarkably fine red.
B. 248 10 45 47 − 20·36 1885, March 6, 7½, blood red, certainly the finest I have seen.
B. 250 10 54 39 − 17·40 1885, March 6, crimson, but not deep.
B. 277 12 19 7 + 1·26 1885, March 6, magnificent red, 8·7, May 12, 8·8, magnificent red.
B. 328 14 18 47 + 26·15 1885, May 1, 8½, very fine red; mag. 12, 8·3, very fine red.
B. 448 18 28 9 + 36·50 1885, May 1, crimson, very fine, 8·0; May 12, magnificent red.
B. 458 18 38 40 + 36·50 1885, May 1, crimson, 8 0; mag. 12, fine red.

The star B. 448 is one of the finest in the heavens. It can be easily found by sweeping 22 minutes preceding δ Lyræ, and 10′ to the north. To see it to perfection it should be observed on a perfectly dark night.

Probably the star B. 431 is variable. Its place is 18h. 7m. 50 + 22 48. This star, which is 7·5 in the D. M., was observed by Birmingham as 8·0, pale red, Oct. 12, 1876. It was swept up independently last night, June 2, with the 9in., and was noted 6½ mag. reddish.

Search was made last night for the red star B. 437, 18 16 33 + 25·0. This star was observed by Secchi as "bellisima stella, rossa." It was not observed by Birmingham. It is identified with LL 33896, mag. 6·5, Bessel 435, 8 mag.

No red star was found in the place by me. The star D.M. 24·3395°, which Birmingham believes to be the same as Secchi's star, was observed as 7½, and white. The following are the Dunsink observations:—1875, Aug. 3, 8·0, yellowish white. 1879, June 19, 7·7, no colour. 1880, June 14, 7 5, no colour.

The date of Secchi's observation is July 16, 1868, and the description "most beautiful red star 7 mag. with columnar spectrum." Birmingham points out that the place, according to Secchi, would be for 1880.

18 15 5 + 25·2° ±.

This seems to suggest that the star LL 33896 is not identical with Secchi's star. If Secchi's place be correct, the star must have disappeared.

**T. E. Espin.**

Liverpool Astronomical Society's Observatory, West Kirby, June 2.

## PARTIALLY GRAPHIC METHOD OF COMPUTING OCCULTATIONS OF STARS BY THE MOON.

[24340.]—The mode of computation which I have recently advocated in your columns is capable of being facilitated by one or two abbrevations to which I should be glad to call the attention of amateurs. They have been suggested to me by Mr. Charles L. Woodside, of Boston, U.S.A.

And, first, the American nautical ephemeris confers a benefit on amateurs who will use the partially-graphic method, by inserting in the "elements of occultations," which correspond to those which occupy from pp. 402—434 in the *Nautical Almanac*, a column which shows the *Greenwich hour angle at the mean time of conjunction in R.A. of the moon and star.* This enables us to exhibit in *three* lines of figures what otherwise requires eight—i.e., when the *Nautical Almanac* alone is available.

Secondly, tables are being constructed and about to be published, wherein the values of $\frac{100}{P \rho \cos. l}$ and $P \rho \sin. l$ are shown for all values of the moon's parallax, and each semi-degree of *geocentric* latitude. These will reduce almost to a minimum the mathematical part of the process.

Thirdly, by inserting the local meantime of conjunction in the diagram at the point where the meridian crosses the centre of ellipse of projection of the star's declination, and then ranging the intervals of hours and minutes along the ellipse, and the moon's path as before, the times of beginning and ending are exhibited at once. This, however, seems to possess less advantage in point of accuracy than the plan I first suggested.

**James Pearson, M.A., F.R.A.S.**

Fleetwood, June 5.

## THE ORIGIN OF COMETS.

[24341.]—I quite agree with the substance of the remarks made in your columns by "W. C. E." and Mr. Denning (letters 24274 and 24313 respectively) upon the origin of comets. In the ordinary way, no doubt, the particles of any mass, however closely packed, would, for reasons stated by these two gentlemen, eventually resolve themselves into an elliptic ring encircling the sun. But, nevertheless, although this statement may be generally true, although it is probable—nay, certain, that an ellipse of particles would be ultimately assumed, a ring, such as some of the meteoric rings with which we are acquainted, could not be formed. This was my meaning when I stated before the Liverpool Astronomical Society that a ring could not be formed by planetary eruption. I did not mean to infer that a *ring-shaped* formation could not be generated, but simply that a ring like the November meteor-system is, to all intents and purposes, an impossibility.

In the first place, it is to be observed (granting, for the present, the hypothesis of planetary eruption) that the original mass would have to be ejected from the parent planet on the instant. Allow only an hour to pass while a mass sufficiently large is being cast forth, and we find that not only has the planet advanced some thousands of miles along its orbit, but its rotation will have carried the point of eruption perhaps some 30° or 40° from its former position with respect to its own centre. Now, how in this case could a ring result? I look upon it as impossible that a quantity of matter sufficient to form, say, the November meteor-system could have been ejected in one hour only; but I also look upon it as impossible that it could have taken anything like that time; for, given an hour as the time occupied, it is clear that instead of a ring, properly so-called, the particles would spread out here in perihelion to something more nearly resembling a portion of a disc.

But even if we strain a point for the sake of making the case as favourable as possible for the eruption theory, and assume that the mass *was* cast forth instantly, how far have we advanced? One thing is certain, and that is that the particles on the side nearest the sun would get round him first. Hence the influence necessary for the formation of a regularly-shaped ring structure is assured; but there are certain perturbations to be considered, and everyone of these would assuredly make a difference in perihelion distance. Whether the particles were retarded or accelerated they would diverge from their paths and spread out over the plane of the ecliptic; and this effect, in the case of the November meteors, would have its maximum result just at the point where we are best situated for observing it —viz., where it crosses the earth's orbit. And I fancy that before the mass could lengthen out to some 3,000,000,000 of miles and more the breadth would cover a rather wider space than it now covers. There is also a further difficulty (which, however, I cannot pause to discuss, as it is rather complex), that a body cast forth from any of the planets will combine its own velocity with that of the generating body.

On the other hand, none of these difficulties appear in the views I have been led to maintain. We have, according to my views, a mass of particles, or nebulous matter, drawn into the sun's domain by his attraction; therefore, granting the mass to be sufficiently large, it will so lengthen out as it nears the sun that it may have a length of millions of miles, and in this case we should have a much more conveniently-shaped mass than before upon which to apply the considerations so ably brought forward by "W. C. E." and Mr. Denning. All that is required is that the chaotic matter near the sun should have been much more dense in former ages than at present, and I take it that this is a matter which admits of no question. The considerations upon which I take my stand are these: In the early ages of the solar system the sun must have been surrounded by a dense nebulous envelope, extending outwards, perhaps, for millions of miles. Any body, therefore, travelling towards him would experience some resistance in consequence, and if this resistance were sufficient to transform its orbit from a parabola, or hyperbola, into a closed curve, the captured body would belong to the sun's family thenceforward for ever.

I think I can claim for my theory that, besides being of greater simplicity, it enables us to look upon the comets as relations, and not as vagabonds; their present subordinate position being due to the circumstance that the planets are older, and must have already been possessed of some considerable influence in the solar system when the comets were captured.

With regard to "W. C. E.'s" opinion that we cannot absolutely negative the eruption theory, I can only say that there are many things astronomical which I should not care to try to negative, but of whose absurdity astronomers are pretty well assured. The grand old theory, for example, that the moon is made of green cheese is absolutely unassailable by direct proof; nevertheless, I do not suppose that most people would have much difficulty in making out that the probabilities are the other way. If we cannot meet the eruption theory with a direct negative, it is quite and equally certain that Mr. Proctor cannot support it with a direct affirmative. The question is solely one of probability, as, indeed, are most scientific theories; and I consider my own ideas on the origin of comets as slightly more natural than those of Mr. Proctor, albeit I hold them so lightly that I am prepared to cast them aside directly their insufficiency is shown.

Nor can I quite accept Mr. Denning's opinion that we ought to collect more material before we attempt to theorise. It seems to me that theory and observation ought to go together, for both must receive an impetus by the companionship. Wherever they have gone together hitherto the results have been of the best, and I am sure that Mr. Denning will agree with me when I say that of all the greatest theories yet made the principal evidence came after those theories were propounded; as, for instance, in the systems of Copernicus, Newton, and Herschel. I opine that if the last-named astronomer had waited for more materials before commencing to put together what he had we should know very little more about the structure of the sidereal system now than people knew then.

**J. R. Sutton.**

## ASTRONOMICAL.

[24342.]—In my last letter (No. 24224) of the "E. M.," line 9, for "diminished," read "increase"; line 11 from bottom, for "130°," read "103°."

I feel much indebted to Mr. Sadler for giving correct measures of positions and distances in his letter 24270. His surprise at my not seeing some comparatively easy *comites* while I could see others far more difficult, was no less a puzzle for me after having read his letter.

Looking over the whole matter, I came to the conclusion that there must be some defect in the adjustment of the mirrors. To make sure of it, I dismounted the telescope, placed the mirrors in again, and adjusted by daylight. At night I perfected the adjustment on Arcturus, using a power of 550, until the expanded disc was reduced regularly to an intensely brilliant spot. I then focussed it exactly on a 6th-mag. star. I must say here, that I have long ago given up the rack-focussing system, and replaced it by a fine movement, analogous to the one given to the best class of microscopes. I can, therefore, focus my telescope with great exactness. I then looked at 25 Can. Ven., and at once I saw the *comes* under the ring, and recorded its position-angle about 150°. I then turned on 42 Com. Ber., but there was no longer that slight elongation towards 140° I had seen so often during this season. It was, therefore, evident that a flare had deceived me, and covered the *comes* of 25 Can. Ven. I promised myself to watch more carefully over the adjustment of the mirrors, especially as my telescope must be taken in and out at every observation. The liability of getting easily out of order is the only complaint I can make against my telescope. If a permanent adjustment could be obtained for reflectors it would be a great boon. The measures of B 1880 appended to 64 Pegasi, belong to 72 Pegasi. For 64, read "Just seen at intervals." In an observation of May 9, 1884, of B. A. C. 3992, I see inserted the measures of B, which show that I must have seen the *comes* about that place; otherwise I would have recorded my own at position, according to my habit of doing so. Would Mr. Sadler kindly look over the following stars?—May 27, 1875, Gled. 430, P = 260° ±, wide with 600. There seems to be a greater difference between the mag. of the components, xiih. 58m. + 21° 50′, P = 230°; 0·3″ at 7, 8, ashy, suspected double, $\gamma$ Coro. Bor., P = 140° ±, power 735, and also with power 370. In looking over my previous observations I read the following under the date of June 28, 1882:—"I feel almost certain of an elongation of $\gamma$ Cor. between 110° and 120°." Can any one say whether the *comes* was near that place at that time, and its distance? May 28, B 612. This is the N. of two stars in finder. There seems to be a very slight elongation about 15°. Power 550. B. gives 54·4°; 0·19″; 6·6, 1878·438, and calls it very difficult. I know such stars are theoretically far beyond my means, still I find them a very good exercise for training the eye. B 619, seen at once, 350° ±. It is very close $\mu^2$ Boötis, 115° ± easy, May 30, Gled. 465, 30° ±. It is excessively close. De. 0·34″, Gled. 466, with power 370, an elongation towards 25° ±; but it is excessively close, closer than preceding one, De. oblong, not observed since 1865·33. Gled. 467, 260° ± $\xi$ Boötis, 275 ± Gled. 469, 310° ± 0·64″, Gled. 470, 205° ± easy. May 30, Gled. 494, AB, 170° ±. Very close. Elongation very slight. Power 550.

I tender also my thanks to Mr. K. T. Tarrant for giving the calculated position of 42 Com. Ber. If it is not too much trouble, may I ask him what are the elements of that star for this year, and the way he obtains his results?

**C. M. G.**

## INTRODUCTORY — ANOTHER HOME-MADE TELESCOPE—GRINDING AND POLISHING FLATS — SILVERING SPECULA—GLASS DISCS—AUSTRALIAN SCIENTIFIC AND MECHANICAL ASSOCIATION.

[24343.]—Having been a subscriber to "Ours" since 1876, and having largely profited by the information on various subjects interesting to me, so generously given by your many correspondents, I think it is only right that I should join their number, if only to thank those who have thus given valuable assistance, each in his own special subject, so fully and so freely to all. Large as is the circulation of the English Mechanic (as evidenced by the many and distant places from which its contributors write), it well deserves to be even larger still, for the benefits conferred on and derived by its numerous readers grow in a still larger ratio than even the increase in its circulation. It supplies a want in the scientific and mechanical world that no other paper could meet so well. And first, let me specially thank Mr. Wassell for his valuable and exhaustive series of articles (still in progress) on "Grinding and Polishing Glass Specula." If those articles prove of the same service to others as they have to me, great will be the increase in the number of first-class specula, and I hope of first-class amateur astronomers too. Mr. Wassell's method of figuring and testing is certain in its results, and his explanation of that method, as detailed in your pages, is beyond all praise. I began by building his machine strictly according to his plan (except that I made it to fit on the bed of my lathe, and drove it by a cord from a pulley on the crank shaft, thereby making easy the driving of the machine, and leaving both hands free). I made the grinding tool and testing aparatus exactly as described by him, and by carefully following his instructions (so far as they were then published), I succeeded in making a thoroughly good 6½in. mirror—without rings—good to the edge, and sharp and clear in definition. True, I have expended exactly 150 hours in grinding and polishing the face of that mirror (apart from the various subsidiary processes), but much of this time was spent in gaining experience and acquiring that manual dexterity which would now be instinctive; and, besides, I would not be satisfied with the figure until it was fairly correct according to Mr. Wassell's method of testing and measuring at the centre of curvature. I have mounted it on a simple equatorial stand, and so far (as tried on the moon and Jupiter) the result is very gratifying; but the weather has not been good enough for critical testing. Mr. Brashear's letters, too, were of great assistance. My second attempt at grinding flats was fairly successful, as judged by the colour test. I did not, however, adopt the method of grinding described by Mr. B. I made no tools, but took three glass discs of best French plate, and ground one against the other (judgmatically, of course) with 30-minute emery, until the inequalities disappeared; then took a fourth disc, the same size; covered it with hard pitch, grooved it, and flattened it alternately with two of the ground discs. The third—that is, the one for the time being about to be polished—must not be used to figure the pitch on which it is to be worked. As the polishing proceeds the discs may be tested in regular order, one against the other, and the error in figure judged by the colour test, and corrected accordingly. I believe that by this method good work may be produced, and it is very convenient for the amateur. I used Mr. Brashear's method of silvering, as given in No. 794; result, a bright film, but will not adhere firmly to the glass. When the reserve silver is added, I fail to get the "clear yellowish brown liquid." The addition of the reserve silver causes the liquid to become turbid, and if still more be added (as directed) a thick flocculent precipitate is formed. The deposit in this case will be a greyish mud instead of silver, so I stop adding silver when the precipitate begins to form, with the result first mentioned. Will Mr. Brashear kindly advise?

I am so pleased with the 6½in. speculum that I intend to make a larger one so soon as I can get the glass, which will have to be ordered from England. Will any correspondent oblige by saying where glass discs, varying in size from 6in. up to 12in., may be obtained, and at what price one or more of each size can be packed and delivered by, say, "Orient Parcels Post?" I know that the reply to this may be called an "answer to advertisements"; but in support of my request, I would point, for instance, to Mr. Haren's letter (23812). He there tells us where, and at what price, diffraction gratings may be obtained—very valuable information to the amateur astronomer—and of which I shall gladly avail myself so soon as I can successfully finish a mirror worthy of such an adjunct. Similarly, the information above sought for would be very useful to many on this side of the world besides myself.

And now I would ask leave to address more especially my fellow readers of "Ours" in these Colonies. I am very anxious to see established an Australian Scientific and Mechanical Association, to be composed of all Australian readers, who are engaged in the study and practice of the sciences and arts treated of in these pages. In this city alone, containing over a quarter of a million of inhabitants (not to speak of any other), there must be at least the nucleus of such a society, which, when formed, might in many ways be made of great advantage to its individual members, and I would be very glad to meet with, or hear from, any one willing to assist in its formation. There are many subjects on which I would like to write, but my letter is growing too long.

I will only now add that if there be any information which I can give, or attain for your readers, I will do so willingly, if they communicate their wishes through our pages.

**Robert W. Wigmore.**

36, Collins-street West, Melbourne, Victoria.

## EYEPIECES.

[24344.]—I see on page 300 a statement that in the Galilean telescope "the only effect of that eyepiece is to render them more nearly parallel; or, perhaps, it would be more rigidly correct to say, less convergent."

I don't object to the statement taken in conjunction with the context, which is written for a purpose, and, perhaps, shows that more clearly as it stands; but for the sake of beginners who might be misled, I want to state that the function of every eyepiece, or combination of lenses next the eyes, is to render the rays *divergent* when they strike the eye—divergent from a point, say, 5in. to 15in. from that eye—and that, no matter what telescope, microscope, or simple magnifier we use, this *must* be the final state of things.

In the Galilean eyepiece the concave not only renders the rays "less convergent," but so much less that the convergence left is negative—that is divergence. In the ordinary astro-eyepiece or magnifying glass the lens, lessens not convergence but divergence, till it reaches the proper amount.

So few works on optics draw decent diagrams for beginners, that, perhaps, the above may help them; or, if you think worth while, I will draw out a few clearly for the commoner instruments with sufficient letterpress to explain the examples.

**Bow.**

## GEOCENTRIC CO-ORDINATES OF A PLACE, AND PEARSON'S PARTIALLY GRAPHIC METHOD OF COMPUTING OCCULTATIONS AND ECLIPSES.—THE NEW TIME.

[24345.]—In all calculations involving the geocentric co-ordinates of a place, it is a matter of considerable embarrassment to amateurs to find them, unless supplied with tables for that purpose, which are generally published only in costly works, and, therefore, not, perhaps, within the reach of all.

Believing Mr. Pearson's partially graphic method to be practical, accurate, and expeditious, and easily understood by any person of ordinary intelligence, I think all my brother amateurs should avail themselves of its use, and in order that those not having tables may not be prevented from adopting it. I have calculated a table by which the co-ordinates $\rho$ cos. $l$ and $\rho$ sin. $l$ may be easily found. A single example will suffice to show its application:—To find the co-ordinates for Boston, Mass., geographical latitude, 42° 21′ 28″ North—

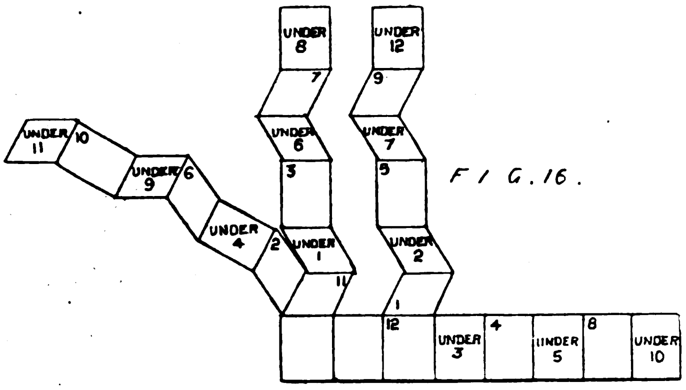
Log. cosine .................... = 9·86861
Log. A .......................... = 0·00066

$\rho$ cos. $l$ ...................... = 9·86927

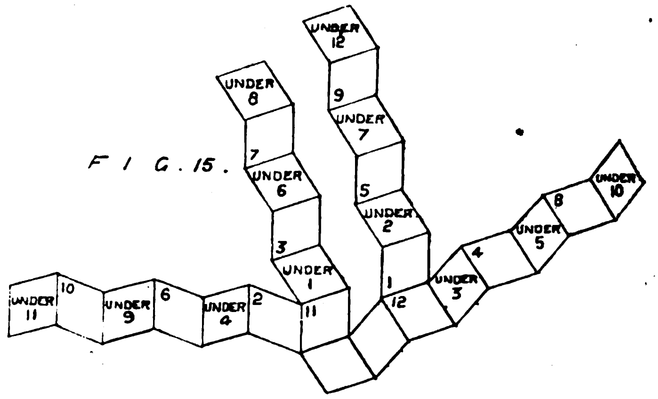
Log. sine ...................... = 9·82851
Log. B .......................... = 0·00225

$\rho$ sin. $l$ ....................... = 9·82626

This is an old method, but it may be new to



F I G. 16.



F I G. 15.

many, and the table will certainly be useful to all. It is calculated for every degree of geographical latitude, the figures carried out five places only, as that will insure all needed accuracy.

Table for Computing the Geocentric Coordinates of a Place.

| Geographical Latitude. | Log. A. Add to cosine. | Log. B. Deduct from sine. | Geographical Latitude. | Log. A. Add to cosine. | Log. B. Deduct from sine. |
|---|---|---|---|---|---|
| 0 | 0·00000 | 0·00291 | 45 | 0·00072 | 0·00219 |
| 1 | 0 | 291 | 46 | 75 | 216 |
| 2 | 0 | 291 | 47 | 77 | 214 |
| 3 | 0 | 291 | 48 | 80 | 211 |
| 4 | 1 | 290 | 49 | 83 | 208 |
| 5 | 0·00001 | 0·00290 | 50 | 0·00085 | 0·00206 |
| 6 | 2 | 289 | 51 | 88 | 203 |
| 7 | 2 | 289 | 52 | 90 | 201 |
| 8 | 3 | 288 | 53 | 92 | 199 |
| 9 | 4 | 287 | 54 | 85 | 196 |
| 10 | 0·00004 | 0·00287 | 55 | 0·00097 | 0·00194 |
| 11 | 5 | 286 | 56 | 100 | 191 |
| 12 | 6 | 285 | 57 | 102 | 189 |
| 13 | 7 | 284 | 58 | 104 | 187 |
| 14 | 9 | 283 | 59 | 107 | 184 |
| 15 | 0·00010 | 0·00281 | 60 | 0·00109 | 0·00182 |
| 16 | 11 | 280 | 61 | 111 | 180 |
| 17 | 12 | 279 | 62 | 113 | 178 |
| 18 | 14 | 277 | 63 | 115 | 176 |
| 19 | 15 | 276 | 64 | 117 | 174 |
| 20 | 0·00017 | 0·00274 | 65 | 0·00119 | 0·00172 |
| 21 | 19 | 272 | 66 | 121 | 170 |
| 22 | 20 | 271 | 67 | 123 | 168 |
| 23 | 21 | 269 | 68 | 125 | 166 |
| 24 | 24 | 267 | 69 | 127 | 164 |
| 25 | 0·00026 | 0 00265 | 70 | 0·00128 | 0 00163 |
| 26 | 28 | 263 | 71 | 130 | 161 |
| 27 | 30 | 261 | 72 | 131 | 160 |
| 28 | 32 | 259 | 73 | 133 | 158 |
| 29 | 34 | 257 | 74 | 134 | 157 |
| 30 | 0·00036 | 0·00255 | 75 | 0 00136 | 0·00155 |
| 31 | 38 | 253 | 76 | 137 | 154 |
| 32 | 41 | 250 | 77 | 138 | 153 |
| 33 | 43 | 248 | 78 | 139 | 152 |
| 34 | 45 | 246 | 79 | 140 | 151 |
| 35 | 0·00048 | 0·00243 | 80 | 0·00141 | 0·00150 |
| 36 | 50 | 241 | 81 | 142 | 149 |
| 37 | 52 | 239 | 82 | 143 | 148 |
| 38 | 55 | 236 | 83 | 143 | 148 |
| 39 | 57 | 234 | 84 | 144 | 147 |
| 40 | 0·00060 | 0·00231 | 85 | 0·00144 | 0·00147 |
| 41 | 62 | 229 | 86 | 145 | 146 |
| 42 | 65 | 226 | 87 | 145 | 146 |
| 43 | 67 | 224 | 88 | 145 | 146 |
| 44 | 70 | 221 | 89 | 145 | 146 |
|  |  |  | 90 | 0·00145 | 0·00146 |

We have had miserable observing weather here lately, with only an occasional fine night, during which, however, I have had some excellent views of Jupiter and a little time for comet-seeking.

In regard to striking the hours of the new time, why not strike *one* at the first, seventh, thirteenth, and nineteenth hours, *two* at the second, eighth, fourteenth, and twentieth hours, &c., up to six? I have fixed a clock to strike that way with the most satisfactory results. It is easily understood, and one is not at all likely to mistake the proper hour. **Chas. L. Woodside.**

Boston, Mass., May 26.

## A NEW METHOD OF FORMING CRYSTAL MODELS BY PLAITING.

[24346.] — Finding I am trespassing too much on your valuable space, I inclose, as my last letter on this subject, the analytical table of plaits requiring four fillets and two illustrations—Fig. 15, the rhombic dodecahedrom; and Fig. 16, the hexagonal prism.

It will be seen from the table that there are a variety of hexagonal prisms; each of them, however, is different from the rest. I should have liked, had space permitted, to say a little about this table, for I fear that its meaning is not very self-evident. However, perhaps some readers of the "E. M." may make it out, and if so, I hope this subject will interest them. I shall be willing at any time to give further help if it is wanted.

Analytical Table.

| | |
|---|---|
| Cube Composite, each face containing four isosceles triangles of 90°. | Cube. |
| Angles reduced from 90° to 83° 37′ 14″.................. | Tetrakis hexahedron. |
| Isosceles triangles of two kinds, 90° and 70°, united.......... | Right sq. prism, with 4-sided pyramids. |
| Isosceles triangles reduced from 90° to 70° 31′ 44″............. | Rhombic dodecahedron. |
| Rhombic Dodecahedron, lateral planes elongated. | |
| Angles of rhombs reduced from 109° 28′ 16″ to 99° 2′ 12″ .... | Hexagonal prism, with 3-sided, pyramids. |
| Lateral planes becoming 58° 24′ | Hexagonal prism (diaptose). |
| Angles of rhombs enlarged to 120°, lateral planes rect. .... | Hexagonal prism. |
| Each rhomb replaced by 2 isos. triangles .................... | Hexagonal Prism. |
| Lateral planes not elongaged, rhombs creased in long diagonals. | |
| Angles 60° and 120° .......... | Octohedron. |
| Angles 61° 55′ 50″ ............ | Triakis Octohedron. |
| Rhombs replaced by pentagons ........................ | Pentagon dodecahedron. |
| Rhombs resolved into 4 rect. triangles .................... | Composite rhombohedron. |

Park House, Tonbridge. **E. A. Tindall.**

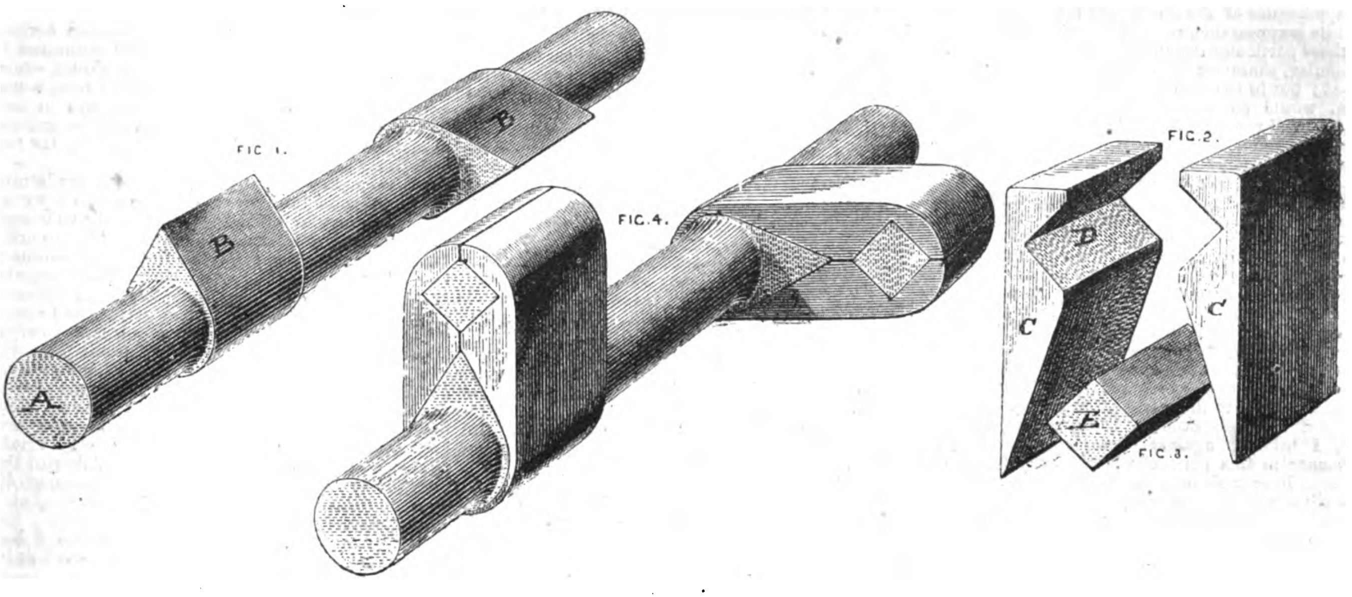
## MOUNTING BACTERIA—COMMA BACILLI.

[24347.]—I trust I shall have no difficulty in setting myself right with so kind a critic as "Medicinæ Doctor," who, after all, seems to believe that consumption is infective. I must acknowledge that I had in my mind not the feelings of the sick or of those who attend them, but the mere and simple position of the person who sits down to mount "bacteria." Such a person has no right to incur the slightest danger, either to himself or to others; he cannot tell whether he is "either owing to a temporary lowering of the system from other causes, or from a constitutional or hereditary tendency, liable to contract tuberculosis." Therefore, he is, I think, in duty bound to take all the care he reasonably can; and the little precautions I mentioned are easy in themselves, and become habitual and instinctive. I believe it is well they should do so; because then, if anything dangerous should come to the fore, and this is very likely to happen, even if only for the reason that a person who tries one kind of bacteria is likely to try another, they stand in the breach, and tend to prevent possibly calamitous consequences. At the same time, I desire clearly to say that I had no intention of conveying any impression that consumption is infectious in the same sense as typhus or measles; but I was keeping to my point, and speaking in the interest simply of the "bacterium" mounter. As to diphtheria sputum and the like, I frankly admit myself to be so cowardly that I would not do it without a solid reason; and if I did it, I would apply bichloride of mercury, wear a respirator with carbolic acid, or both. I may be unreasonable; but, like the navvy in the song, "I valleys my life." Besides, one has others to consider. As to stains, I have not my previous letter before me; but my impression is, that I mentioned not aniline green as the second stain in Heneage Gibbes's method—if I did so it was a slip of the pen—but a saturated watery solution of methylene blue. Heneage Gibbes ("Practical Histology and Pathology," pp. 141-2) says: "Make a saturated solution of methylene blue, methyl green, or iodine green (*i.e.*, iodine aniline green) in water. . . . The above-mentioned stains are the best for diagnostic work; but a watery solution of chrysoidin is the best when the structure of the bacillus has to be studied." Chrysolin, I have little doubt, is chrysoidin under another name. I got some "chrysoidin" from Hopkins and Williams, who supply Heneage Gibbes with his stains, and made a saturated solution with distilled water; but, like "Medicinæ Doctor," I found that it did not work well, the fault being that the stain was too faint. Nor did the iodine green and the methyl green (though beautiful stains for many purposes) work at all well, while the methylene blue has always done so admirably in my hands, producing preparations quite equal to the German ones or to those by Dr. Wallis, all of which are apparently dyed with this stain. It is true that the details of the bacilli do not come out so well when they are on a blue ground; but I think this is because of the intensity of the blue, which shines through, and not because of the blue in any way spoiling the coloration of the bacilli themselves, which are best studied where they are lying separately—in a hole in the blue, as it were. My chrysoidin slides certainly show them better on the whole; but I think this is simply and purely because the brown chrysoidin stain is fainter. As I said a fortnight ago, I can see them better with Gram's double stain than with anything else; and I have to apologise for an error in the description of the Gram, where, in describing the iodine fluid, I seem unaccountably to have left out the iodine. The receipt is: Water, 50 drachms, dissolve in it iodide of potassium 30, or, for single strength, 15 drachms. Then in this solution dissolve iodine 20 grains, or (single strength) 10 grains. The "single strength" sometimes acts sluggishly and imperfectly; and while it is always easy to weaken a strong liquid by merely adding water, it may be tedious to strengthen a weak one. And, finally, *Bacillus tuberculosis* is best seen in cultivations. With respect to comma bacilli, I think, before dismissing them with a verdict of not proven, another correspondent should read Mr. Watson Cheyne's articles in the *British Medical Journal*. However, I have never cultivated them, and cannot speak of their life-history at first hand. But if anyone wants to see bacilli almost like them—and yet not exactly similar in size or contour—he has only to examine, staining with magenta, a little of the sediment in the water with which he rinses out his mouth first thing in the morning. **F. Grant.**

## CRANK AXLES.

[24348.]—In reply to your correspondent "Crank Axle," p. 284, our mode of forging "The Fibrous Crank Axle" is as follows:—We first take a piece of iron and forge or draw it out in the usual way to form the shaft or axle (A, Fig. 1 on the accompanying drawings), leaving sufficient metal at two positions where the cranks are required, which we afterwards draw out, tapering at right angles to each other, thus forging the two portions (B) to receive the layers (C, Fig. 2) which we next forge with the grain or fibre of the iron running in the direction of their length; the layers are forged tapering, and of sufficient length to allow us to belt or clip them round the shaft in the welding up, and in them we form a groove or recess (D) at any required position by means of a V or other suitable tool in order to receive the billet or bar of iron (E, Fig. 3). This billet, which we also forge with the grain running parallel to its length, forms the journal or crank pin in the finished crank axle.

We now heat one of the tapered portions (B) of the shaft, and also the layers (C) and billet (E)



sufficiently to enable us to tack them all together. It is then placed into the furnace, and when of a welding heat it is brought under pressure and the whole formed into a solid mass (Fig. 4). This operation may be effected by the steam hammer, hydraulic, or other pressure. The other crank is next welded up in the same manner. The forging is now ready for slotting out and turning up, and the crank axle finished in the ordinary way.

Although in nearly all cases in which crank axles are made with our method of forging, it will not be necessary to twist the iron in order to obtain the right angles, yet in some incidental cases where the distance between the cranks is very small, it may be impossible to forge them without twisting on account of the difficulty of turning them in a furnace as at present used.

Please note in the above-mentioned drawings the shading lines are all drawn in the direction of the grain or fibre of the iron, thus obtaining the full maximum strength of the metal.

June 2nd. **Linney and Lawson.**

## CRANK AXLES.

[24349.]—I have been much surprised at the statement made by "Original Lockstitch," p. 302, that cranks break most in the crank-pins.

All our readers know where the Penistone crank went—just through the web close up to the crank-pin. That is the common place where they do all go. I only know of very few that went at any other place.

I also have the greatest faith in periodical examinations. I should like to know from "Lockstitch" how many per cent. are discovered on the Midland, because they claim the highest number on the Great Northern. Steel axles have broken on Midland engines 829, 61, 809, 823, 1104, 63, 1, 9, 73. We think it would be of value if "Meteor," "Lockstitch," or any other friend would give the miles run in each case. The new big 1667 class of 19in. cylinder engines have iron crank axles, and they seem better than steel.

The great question, as I take it, is "iron or steel"; but I don't find that "Lockstitch" gets on to this point at all; perhaps he will in his next.

I like iron cranks best, with hoops and four bearings, like the fine old 800's.

I don't agree with "Lockstitch" that forging iron to any extent avoids the fibres in the metal; it may compress them, but it does not remove them, and they ought to be all in the proper direction.

June 5. **Midland Driver.**

## THE BREAKING OF AXLES.

[24350.]—The Board of Trade returns relating to accidents during the three months ending 31st March, 1885, has been published. During that period 100 axles failed; 55 were engine axles—viz., 48 crank or driving, and 7 leading or trailing—3 tender axles, 40 waggon axles, 2 axles of salt-vans; 24 waggons, including the salt-vans, belonged to owners other than the railway companies.

Of the 48 crank or driving axles, 38 were made of iron and 10 of steel. The average mileage of

38 iron axles = 212,754 miles.
10 steel axles = 179,182 miles.

One of the broken waggon axles caused the waggon to be thrown foul of another set of rails at Penistone on the 1st January, 1885, when it was run into by a passenger train, four persons being thereby killed and 47 injured.

**Clement E. Stretton.**

Leicester, 6th June.

## RAILWAY-AXLE LUBRICATION.

[24351.]—In your issue of May 8th there is a communication (No. 24213) *re* above. And as no one has yet come forward to throw light on the subject, I will venture to give what I consider the best means of lubricating railway axles, but, with the writer of the letter referred to, think there is room for great improvement in this section of working.

The first question asked is, Which is the better lubricant—grease or oil? Oil is admittedly the best, but at present there is difficulty standing in the way of its general use—how to apply it continuously and yet economically. Capillary attractors, or wads, as they are called, are often made use of in applying the oil; but they have the great drawback of becoming glazed by friction against the journal, and when that takes place the flow of oil is impeded.

Another mode is to fill the cavity in the top of the axle-box with wadding or waste, and saturate it with oil, depending on gravity and shocks to carry the lubricant out of the sop down to the journal. But this is very unsatisfactory. Up to the present I have seen nothing to beat the arrangement used by the Midland Company for oil. A vessel, having one perforation in the bottom, and inside the vessel a small ball, loose, which, when the coaches are at rest, always takes a position covering the perforation, because of the concave shape given to the vessel's bottom; but when the train is in motion the slight shocks are continually moving the ball a little from side to side, allowing the oil to pass in sufficient quantities. It will be seen there is no feed unless the train is in motion.

With regard to the axle-box, I think a deal might be said, for upon the perfect working at that point depends the success of long-distance runs, in addition to the question of fuel consumption.

In designing boxes the points aimed at are, or ought to be, plenty of space for brass, strength with lightness, plenty of space for the lubricant, so that a good store may be carried, also good length of bearing surface, and care in deciding upon the width of sliding grooves.

As there are so many different kinds of boxes, and each one claiming the most advantages, I shall leave the matter of deciding which is really the best to someone whose experience has been wider than my own. **A. A. L.**

## AN ACCIDENT AT MANCHESTER.—TO "METEOR."

[24352].—The 12 o'clock noon train from St. Pancras, with engine No. 1666, ran into the buffer-stops at the Central Station, Manchester, on 24th April. Could "Meteor" oblige by stating why the accident happened, and what the Board of Trade inspector has reported on the matter?

**Passenger.**

## HEBERLEIN BRAKE.

[24353.]—I understand that a new form of this brake is in use on the Colne Railway. Is this brake the same construction as the Clark-Webb chain brake with automatic tight cord?

**Loco.**

## PARAFFIN LAMPS—GERMAN LATHES—A NEW CLOCK.

[24354.]—I am inclined to think that the heating of oil reservoirs does not cause so many explosions as general folly and ignorance. Petroleum lamps are used throughout this town, and the number of deaths from lamp explosions are very numerous. One of the chief causes of explosion is attempting to refill a lamp while burning, particularly cooking lamps. The lamps are all of the Silber pattern, with glass reservoirs and chimneys, formed at the bottom like the choke of a rocket. With cheap petroleum explosions will often occur when putting out the lamp, however carefully it may be done. Would it not be possible to fill glass reservoirs with sponge, so that if broken a spill would be avoided.

It seems to me strange that there is no plan for reversing hand planers. There is one Eckardt, of Stuttgart, who uses a system of clutches to reverse with; but his motion is patented, and his prices for complete machines do not suit my pocket at all. His machines run very lightly; but make a considerable pumping noise.

I was not aware that Messrs. Seidel and Walz, of Berlin, were leading makers of either England or of Germany. Most German lathes have the mandrel cones and collars dead hard, while the nose is tempered to blueness; but I never heard of their being trued with a diamond. The best makers are to be found in the Rheinland, not at Berlin. The Berlin makers have not the name that the former have.

In old German lathes the chuck-seatings are often 2in. larger than the nose. In one that I know very well there is the combination of cone, cylinder, and flat seating, which brings up the diameter of seating to about $3\frac{1}{2}$in.

About Christmas time I saw a clock similar to that described by "Garrison Gunner," in the shop of a clockmaker who makes paper clocks and such like novelties. The swan moved only every five minutes, and with a jerk.

2nd June. **A. F. Shakespear.**

## THE NEW TIME.

[24355.]—When I wrote my original communication on this subject (p. 36), my object was not to raise a discussion about it, but merely to advise astronomical contributors to this journal not to make use of the "new time" in their published observations without distinctly stating that they had used it; as it not having been generally adopted for astronomical purposes, their so making use of it would only lead to confusion. As, however, a very interesting discussion has been raised, and is now being carried on, I would like to make a few remarks, and having said all that it is, perhaps, necessary for me to say upon its advantages for the purposes of everyday life, for which purpose it must appear to every unprejudiced mind as admirably adapted, I will confine myself to that part of the proposed change which most affects the astronomer, viz., the changing the commencement of the astronomical day from noon to midnight, a point upon which, I think, I may confidently assert there is considerable diversity of opinion among those most interested.

As I remarked in my letter on p. 36, the advantages (?) to be gained by astronomers are of such a nature as to make it extremely doubtful whether the proposed change will be generally adopted for astronomical purposes; and though I have since then carefully read the Protocols of the Washington Conference, I can find no argument therein sufficiently strong to cause me to change that opinion. In the case of the phenomena of Jupiter's satellites there are great inconveniences attending the adoption of the "new time" by astronomers, as pointed out by "Conservative" (letter 24294, p. 282); the same inconvenience would attend the observation of an occultation of a star by the moon, as sometimes the disappearance of the star would take place one day and its reappearance would be observed on another; in these particular instances, and in observations of a similar character, the inconvenience would be great; but in the case of "a star observed at 11.59 p.m. would be different, for reduction, to one at 12.1 a.m.," referred to by "Conservative." I presume the difficulty is not so considerable, as the one star would simply be reduced for one day, and the other for the following.

We should, no doubt, soon get accustomed to changing the date in the midst of our observations; but it would at times be very inconvenient, to say the least, and the advantages, to my mind, are *nil*, excepting that the civil and astronomical day would agree, which, as astronomers are, comparatively speaking, a small body of men, and astronomy being a science, made a special study of by only a few individuals, I do not see that it matters much whether the two days agree or not. What astronomers choose to do as regards this point is a matter of indifference to the world at large, the only class affected by their decision being sailors, and they are, I believe, against changing the *Nautical Almanac* in this particular; at any rate, such of them as have spoken on the subject are agreed that if a change is made, it will have to take place some years hence, so that ample notice may be given, and the change made simultaneously in the various national ephemerides.

It is true, as Prof. Oppolzer says in his interesting paper in the March number of the *Monthly Notices*, that "Changes occur in other branches of science which necessitate more important alterations in the respective books . . . . without the least confusion arising"; but, with all deference to the professor, I may be permitted to point out that those branches of science in which changes are made without causing confusion are but in their infancy: changes are looked for by their respective students; but astronomy is an established science, and what is learnt by the earnest student to-day, has not got to be unlearnt by him to-morrow, as is the case with many branches of modern inquiry.

B. J. Hopkins.

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## THE NEW TIME.

[24356.]—I see in your journal, of which I am a very old subscriber, a number of readers continually calling attention to the new method of time tables for railway travelling. In reference to the twenty-four-hour system, I feel convinced that it would never be safe to travel under such a system unless all the porters, guards, signalmen, and others connected with the various railways were educated to it. I have travelled upwards of a quarter of a million of miles, consequently know something of travelling. I see a great many suggestions are made of printing time tables—some suggesting a thick line for the a.m. and a thin line for the p.m. This would be entirely useless, as the distinction would not be observed. I now beg to inclose you one of my new patent time tables, by which you will see at a glance the difference between the a.m. and the p.m. I simply print the a.m. time in black ink, that is, from twelve o'clock midnight until twelve o'clock midday; and from twelve o'clock midday until twelve o'clock midnight, which is the p.m., I print in red ink, therefore showing at a glance that the a.m. trains are black ink and the p.m. trains red ink. Should any of your correspondents like a copy I shall have great pleasure in forwarding one.

William Kloen.

Renwood, St. Peter's-road, Handsworth,
Birmingham.

[Capital for small card time tables and the like, but the objection from a printer's point of view in case of book tables is very obvious.—Ed.]

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## LATHE MATTERS.

[24357.]—This lathe talk seems like to end in nothing, as so many previous discussions have done; and out of the intolerable amount of talk, we shall get not even the miserable halfpennyworth of solid food. Surely in a practical journal we ought to get more definite results. Yet subject after subject passes under review, and there is no Q.E.D. reached to mark a stage in our progress, if indeed we make any.

First, as to screw threads. Has anyone introduced a new system? What is it? Is it growing in public favour as a substitute for *several* others?

Next as to the front slide lathe. What makers are making it? How many have been made since the discussion, and to what patterns? How do the users like them?

Thirdly, the "interchangeable" or "model mandrels." Who are making these as a regular article of trade? How many have been made? How are they liked? What are their exact dimensions? Also, does Evans or Hines send out chucks to gauge, guaranteed to run true, and a perfect fit, without seeing the mandrel, merely knowing its dimensions? If not, when will they advertise to do so?

The above have been talked to death, and as the questions left are workshop details, it seems time for practice to step in and solve it *ambulando*.

Now, in the present discussion, as usual, we wander from point to point, and so have contrived to muddle up three issues in one. Let us separate them.

First, then, can screws be cut with circular cutters? Square threads apparently cannot, V ones can under certain conditions. But the point is, Can the ordinary threads be cut (as well as) or better and more easily in practice with circular cutters than with the chaser or point tool? Well, then, let Mr. Hines, Mr. Evans, or Dr. Edmunds cut an inch bolt, and send it, with [illegible], to some central spot, where all may see it for themselves—say, to some stall at the "Inventions." It would be a good advertisement, and settle the question once for all.

A second part of the same question is the desirability and possibility of cutting and trueing hardened steel taps or screw-threads by laps and diamond dust. Again I ask Mr. Hines what firms do this for their taps, standard or otherwise? Also, has it been done to mandrel-noses, or is it a suggestion at present untried, and possibly unnecessary?

A third part is the trueing of hard steel by the fixed diamond tool. Mr. Wenham has, to some extent, settled this, and we can trust the accuracy of his work; but it would be more satisfactory if someone else could testify to the quality of this steelwork, and if the makers would write a line or two on their mode of working. Personally, I accept Mr. Wenham's statement, and trust his judgment.

And now, before saying anything on the question myself, I would thank those who have kindly answered my questions. I thank Mr. Hines for the offer of a piece of mild centred steel; but I did not want a proof of its quality, or existence, only to know where and how we amateurs could obtain it. This we can all now do. Mr. Wenham and "J. K. P." have been such true friends to us that I am now going to beg again, and let me assure them that my memory is not astonishing, seeing that I and others have so few letters on which we can implicitly rely—I know his by heart. My present want is a good scale drawing of a back-centre mandrel for 3½in. or 4in. general lathes. What are the advantages of a long mandrel, and beyond what limit is the gain not worth the candle? Is there a serious objection to saving cost of *bed* by cranking back the fixed head-slot, as in the "Harmonious Blacksmith's" design? What are reasons for and against the *centre point* being on mandrel Holtzapffel fashion? I see that the back support can be drilled for oil—but what else? What is a good section for bed for general lathe, as regards proportionate depth, breadth, and thickness?

As regards the lathe-nose and circular cutter question, I have nothing much to say. As to centring chucks, the Doctor says I confused two kinds of centring; but I don't think so. He said the screw was everywhere rejected as a centring agent, meaning, it seems, only as regards what he calls "predicable" centring, and I, objecting to the unqualified statement, asked what gave the centring in the Holtzapffel nose, and he answers, the screw; but that he did not mean centring generally, only predicable centring. Just so; that is all I wanted.

Nevertheless, most of what I said will suit "predicable" centring also. In fact, it is only a question of truth and gauge, and has not yet been often attempted; but that it is attainable Mr. Hartley has shown as regards the geometric chuck, and "J. K. P." as regards ordinary high-class work, which is good enough for most of us. But having said this, there seems little doubt truth and gauge may be attained and retained more easily by a cylinder and face than with a screw; but at the expense of simplicity, and, I think, of strength also, as well as of ease in the fitting of chucks. For ordinary work, I feel sure the plain screw will hold its own, and whether the new or old is to be used for ornamental work must be settled by experience.

As to the circular-cutter business, the Doctor is so clear usually in theory, that I am surprised he stated that the height of the cutter above centres makes no difference. Most certainly it would alter the rake, and deform the thread, as others have said. Doubtless it was a slip; but he should have withdrawn the statement. "J. K. P." seems to me to have been, I won't say wrong, but verging on error in one point also; but I see, by to-day's paper, he and the Doctor have settled their differences (or some of them), and that he intends to say no more. Just as I expected, we are to get nothing definite out of the talk. Will he, as our guide, kindly give the results at which he has arrived? Paley says that seeming discrepancies, shown to be really close agreements, are the strongest evidence of the correctness of the statements, proving that even bias could not affect truth. If, then, Dr. Edmunds and "J. K. P." will write a joint set of propositions to which they assent, we humble disciples will have something on which to pin our faith.

Bow.

## CUTTING SCREW-THREADS.

[24358.]—The value of a screw-thread derived from an isosceles triangle of 50° and truncated 7½ per cent. of its base, i.e., an angular thread whose altitude is equal to the length of its base, is one question. The methods by which this or any other screw-thread can best be cut is another question, yet we seem in danger of getting the two questions mixed up.

I have never proposed that ordinary screw-cutting should be done otherwise than by an ordinary angular point-tool fixed in the slide-rest, and tilted to the rake of the thread. But in order to meet cases which cannot be met by the ordinary methods, I have suggested that certain angular threads may be trued up by the revolving cutter or revolving lap-wheel used as a glazer, and armed with a very fine abradant or a polishing powder. The applicability of this method depends upon the various factors which I have already referred to. With a square thread the revolving cutter cannot clear itself, except by deforming the section. With an acute angular thread the revolving cutter cannot clear itself unless the pitch be very small. What we are discussing is the applicability of this method to the truing-up of angular threads of 50° and more, and of such pitch as would be used on a mandrel-nose.

As to the threads of this character which I had cut by this method, "Vulcan" has favoured us by examining them and reporting upon them (page 280 and 281). He writes as follows:—

"Last week I examined specimens of the actual Edmunds thread. The thread is as described—beautiful; its clean, sharp appearance being enhanced by the very slight, almost infinitesimal, concavity of the thread-face on the axial section. Two screws, with their axes parallel, and teeth engaged, just show this curve with a light behind and a watchmaker's lens in front—this looking along the inner tangent to the contacts in axial plane not *point* blank. Practically, this minute concavity is the sum total of the case against it. The thread is reversible—faultlessly so."

"Vulcan's" second letter (page 281-2) reads as if written with the assistance of a fit of the gout. This is fortunate, as showing that his testimony on the other matter does not need discounting. So long as our criticisms are kept within academic lines, entire freedom of expression is conducive to free healthy discussion, and it leaves us the more free to comment upon each others' notions. All I need ask is, How many screws will bear the test to which "Vulcan" has subjected mine? Then, again, Mr. Boord has kindly cut me two specimens of screws by the method now so vigorously attacked. One is an ordinary screw of typical "angular thread" of 50°, making three turns per inch on a cylinder 1·25in. in diameter. The other is a three-thread ·8in. twist drill, each groove having a rise of about ·7in. per turn. Both are exquisitely formed, and both were cut by means of the same fly-cutter—a sharp V-point tool of 50°—merely tilted to different angles, and speeded at different rates of traverse. Mr. Boord has kindly given me permission to submit his screw-models to the Editor.* Any one may now see twist drills being shaped by revolving cutters in the machines at work at the Inventories, and there can be no doubt that, with a clear understanding of the geometry which is involved, the method is one capable of doing work which no other methods can accomplish.

*Section.*—The question of what we are writing about when we apply this term to screws and screw-threads needs careful consideration. There is only one section to be practically regarded in a *screw*, and that is the section made by an axial plane—the *axial section*. The outline of the thread-section shown on this is, however, not the section which has to be practically regarded in the *screw-thread*. This is the *normal section*. Now, the normal section, or true cross-section of the screw-thread, is a plane only in one case, i.e., when the thread is an annulus returning into itself, and there is no *traverse*. Here the axial section is also the normal section. In all cases where the thread is a real screw-thread, i.e., when it has a longitudinal component put into it by the traverse, the normal section is *a screw-surface*, not a plane. If the thread is to be calculated from the axial section, the cutter must be used as a chaser is used in the slide-rest, i.e., it must have its cutting surface plane, not tilted, and be put into cut on an axial plane. In this case the base of the normal section of the thread will be the cosine of the base of the triangle of the V-point tool with which the thread was cut. Here the length of the cosine depends upon the pitch of the thread, and is got from the "hypothenusal line"—this being the hypothenuse of the right-angled triangle whose base is the length of the circumference of the pitch-cylinder, and whose height is the traverse made by one turn of the thread. But the shape of the normal section under these circumstances is really a helicoidal projection-form derived from the cutting face of the tool: its cosine base will therefore be twisted into a helix.

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* Certainly admirably executed.—[illegible]

*Thread-form.*—The form of the screw-thread is only in special cases a counterpart of the form of the tool with which the screw-groove is cut. It is a mistake to assume that a triangular or square tool cuts a screw-thread of the same form. If, for instance, the extreme pitch of a fluted column be considered, it will be seen that here a square-ended cutter, if entered so deeply as half the radius of the cylinder, will have undercut so completely as to detach the threads at their bases and leave them standing as triangular prisms connected with the cylinder only at their ends. Similar considerations have to be taken into account in the case of every screw-thread; but the subject is too abstruse to be dealt with now. It must, however, be dealt with if we are to understand this question, and "Vulcan," when convalescent, will no doubt kindly pioneer us. Perhaps, meanwhile, "Vulcan" will explain his tool more fully. But I fear that most screw thread forms will turn out to be "unnameable," except by some such agglutinate designations as moderns chemists have to produce so largely. Oh! that mine enemy would write a book! I agree with "Vulcan" that "it is beyond our mathematics to deal with a diagonal normal section cut by a plane." The normal section is, as I have already shown, always a screw-surface and never a plane. The base of the normal section is also always a screw-line, and never an ellipse. The elipse formed by the diagonal section of a cylinder has nothing to do with a screw-thread. That a helix is the shortest line between any two points on a cylinder is easily shown by developing the cylindrical surface, when it will be seen that the helix becomes a straight line, whereas the ellipse becomes an undulation-curve.

Mr. Wenham favoured us with another letter at page 237 apparently for the purpose of showing how cleverly he can "put his foot into it." His teaching is this: "If a rotary cutter is set just to scrape the surface, it must be set exactly at the angle, for if either more or less, it will trace a pathway wider than the cutter." Now, if any reader will take up a round ruler and hold against it the square end of a carpenter's chisel, he will see that only when the edge is in an axial plane can it be made to "just scrape the surface" for its full width. If it be set "either more or less," the width of the scrape will be *less* instead of more. And if the chisel represent a revolving cutter acting upon a rotating cylinder, it will be found that its square end, when tilted, will cut a hyperboloidal or dice-box bottomed groove. But this, again, is only an illustration that the tool-profile, projection-forms, and intercepts, all have to be taken into account if we are to predict the true form of the cut which we get in cutting screw-threads.

The screws cut by myself, those recently cut by Mr. Boord, and the V-point cutter with which they were cut, remain at the office of the ENGLISH MECHANIC, and may be examined by anyone interested in defining the facts.

**James Edmunds.**

Grafton-street, Bond-street.

### CUTTING SCREW-THREADS.

[24359.]—IN answer to "J. K. P.," page 280, I was myself surprised to see the words mentioned in inverted commas. I intended them to have been in italics, and to that end underlined them in my letter. This I still hold to be the usual way to denote italics, and have since had the opinion of a competent London compositor, whose words were: "Once underlined, italics; twice, small caps." So it is our printer.

Respecting the next part of "J. K. P.'s" letter, I still cannot see why a circular cutter cannot clear itself in a V-grooved, moderately-pitched screw. Take now any ordinary V-thread screw, and hold it between the eye and the light, inclining it so that the line of sight is in the same vertical plane as the rake of the thread at the top of the screw, and so that the sides and bottom line of the thread-groove can be seen; a plain V-gap will be seen with straight sides; and this I take it is the exact V-line which a circular cutter will work upon when used to cut that thread, and it will touch nowhere else.

Again, take a screw held between centres in the lathe, and let the fixed tool, which has just cut that thread, be set to just touch the bottom of the thread-groove; is it not plain that if the tool be either raised or lowered in the line of the rake of the thread, it ceases to touch the thread in any part, and this without any "Faugh-a-Ballagh" principle being brought into play, much more will it clear if the tool point be raised or lowered about a point in its shank as a centre, thus constituting a revolving cutter, and whether wheel or single fly-cutter matters not, the action being the same?

There seems to me one point entirely overlooked, and that is that a wheel-cutter can only touch the bottom of the thread-groove in a point, not in a line, as some of our correspondents seem to think, to judge from their arguments.

I am, I am sorry to say, too busy just now to write as I should like, and shall have barely time to catch the post so that this may appear this week, so any defects I must ask to be pardoned; but I think my meaning is plain enough.

**Hadah.**

[24360.]—MY letter (24293, p. 281) appearing, requires a few corrections, and a note or two: Line 9, 3rd column, "coupled" should be "angled." Line 30, 3rd column, "screws" = "screens." I do not now remember how I got the dimensions of the "critical" screw, p. 282, but they seemed approximately correct at the time I wrote them down. Some confusion of the "other-handed rectangular helixoid" for the "other-handed normal rectangular helixoid" has seemingly occurred. The principle is not, however, much affected by my pen-and-ink screwology, and spiro-spiroido-linear, helico-helicoido superficial trig. is fatiguing, and not yet at my fingers' ends.

Last but two paragraph, after "grinding" should be "period," and following it should read "At their best, &c." Next line, "same velocity" should be "slow velocity," and "centrifugal" should be followed by "and gravitational." The comma after "action" I hope I am not responsible for, and it should be omitted.

**Vulcan.**

### POSITIVE AND NEGATIVE LENSES.

[24361.]—THERE seems to be a good deal of confusion in the use and meaning of the above terms as applied to lenses, which is much to be regretted, as they are useful forms of expression, when one simply means to indicate the general character of the lens without going into detail.

Sir John Herschel uses the words in what I consider the only reasonable and proper way. He describes a positive lens as one "having a convex character, tending to produce convergence" ("Telescope," p. 101). This seems all right and intelligible; but when we come to study the textbooks on optics we find that the writers do not quite seem to have the same opinion about the matter. In Parkinson's "Optics," p. 93, we find it stated that the focus of a lens is positive or negative, according as the lens is thinnest or thickest at the axis, and that "a lens whose focal length is positive is called a concave lens; one whose focal length is negative is called a convex lens." Of course a distinction may be drawn between a positive lens and a lens with a positive focus; but in ordinary conversation I consider that the same thing is meant, and that a positive lens is one with a positive focus, and this we are told in the textbook I have mentioned is one which is thinnest in the centre, and is a concave lens.

In Glazebrook's "Physical Optics" the same thing is stated: "the focal length of a concave lens is positive, that of a convex lens negative."

Turning to another subject, I see it stated in Prof. Newcomb's "Astronomy" that Alvan Clark's object-glasses are all formed on Littrow's plan, an equi-convex crown, and flint with the same concave curve and flat back. As these glasses are of acknowledged excellence, it is clear that quite as good a glass can be made upon this plan as upon Barlow's.

**Ascalon.**

### CRAMMING IN PHYSICO-MATHEMATICAL SCIENCE.

[24362.]—IT is truly painful to observe to what a deplorable extent the modern examiner and the educational writer jointly play into the hands of that pernicious institution, the crammer "for all exams."

I have before me a much-belauded textbook of natural philosophy—a work which I believe finds favour with the authorities at the London University and elsewhere. Now this book, although excellently illustrated and clearly printed, is perhaps the most flagrant and mischievous specimen of the "Crammer's Assistant" now extant, and this is saying a good deal. Full of rules and formulæ, there is no attempt whatever to give the *rationale* of any of the processes indicated, nor, in fact, to teach anything beyond blind dependence upon memory alone. Plane trigonometry, it appears, is *not required* for the first London exam.; accordingly, we find in the work in question that the principles of mechanics, &c., are laid down (?) without reference to that branch of science, or to the fifth and sixth books of Euclid's Elements, which are, I contend, indispensable, if anything like a clear understanding of the subject is aimed at.

I have under my observation a youth of more than average intellect, whose brain is now, I fear, hopelessly bemuddled through an early and injudicious course of data and formulæ. Propound to him some simple mathematical problem, and he will reply with an air of great uncertainty, "*the formula is so and so, is it not?*" or, "I can't manage it, I have forgotten the formula;" or, worse still, he will straightway pick out from his superabundant but rather mixed store of rules the wrong one, and laboriously work out some absurd result. Now, if it is only sought, at the outset, to give a lad a sort of general view of the sciences included under the head of natural philosophy, why not direct his attention to such works as the late Dr. Paris's "Philosophy in Sport made Science in Earnest"? Or if, on the other hand, it is required to impart serious and solid instruction, could better masters be found than Wood, Whewel, and Phear, whose simple yet scientific methods leave nothing to be desired? We have, too, Deschanel, whose work on physics has been very well translated, and the noble work of Jamin, which it requires a very slight knowledge of the French language to read and understand.

June 6. **Recte Faciendo Securus.**

### COL. ROSS'S FILTER PIPE.

[24363.]—MAY I be permitted to add to the excellent description of this pipe in the ENGLISH MECHANIC, p. 295, that, if the sponge in the improved form is made according to the description there given, and placed so that its broad end obtrudes from the mouthpiece part of the pipe when unscrewed about one-tenth of an inch, the latter part is used (by me) *as a brush*, with which I paint the inside of the hot bowl, after a smoke, and the thin layer of ash has been gently scraped off with a penknife?

The result of this operation is that the condensed "oils" containing the nicotine are absorbed by the distended pores of the hot briar, and, being incombustible, or nearly so, not only preserve the briar from burning, but prevents all caking—i.e., coating of the interior of the bowl, after a few smokes, with a hard crust of conglomerated tobacco-ash, charred briar-wood, "oil," and saliva, which can only be removed afterwards by the application of a strong knife with great force, and the removal then generally destroys the bowl. In a pipe so treated the tobacco will be found to burn *regularly* downwards, with a clear ring of demarcation from the inner surface of the bowl, to smoke much "sweeter," and to consume to the very end, leaving no "plug" of moist tobacco at the bottom.

It should be remembered that the interests of the smoker (in which I now write), are, in this case, diametrically opposed to those of the pipe maker and of the tobacconist, whose chief object, of course, is to sell as many pipes and as much tobacco as possible. Nine-tenths of the former class object to taking any trouble with their pipes; or, as they call it, to being "bothered with them." But a little reflection will show them that there is much more "bother" in neglecting a pipe than in thus taking care of it, as pipes thus treated never become foul; at least, if they have the double-sized bore, with the necessity of which I have tried (hitherto in vain) to impress the makers. The horrible smell of these "oils" condensed on the sponge is, I admit, the greatest defect of my pipe, especially to surrounding non-smokers, but the following plan, which I have carried out in the midst of crowds at the Inventions Exhibition gardens, without anyone being aware of the fact, seems to obviate it. When I find (by a slight obstruction in the draught) that the sponge is becoming saturated, I unscrew the mouthpiece, press the obtruded sponge firmly against the ferrule-end of my umbrella or walking stick, held perpendicularly downwards, and blow strongly through the former, when the accumulated "oil," saliva, &c., drops to the ground; the smoke is then continued with increased pleasure.

**W. A. Ross.**

### THE MICRO-OBJECTIVE.

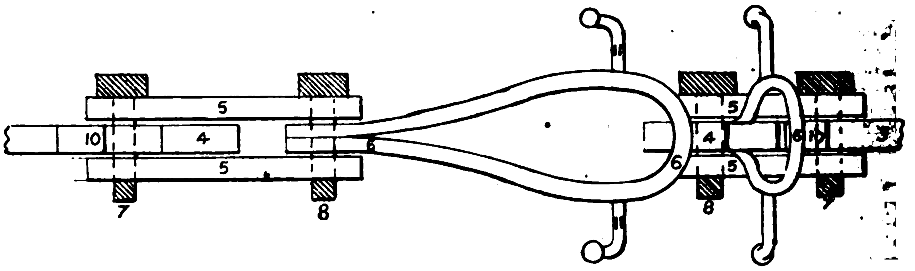
[24364.]—BEFORE grinding a flint concave it will be well to have a little practice at the plane side, as that is more difficult than the curve.

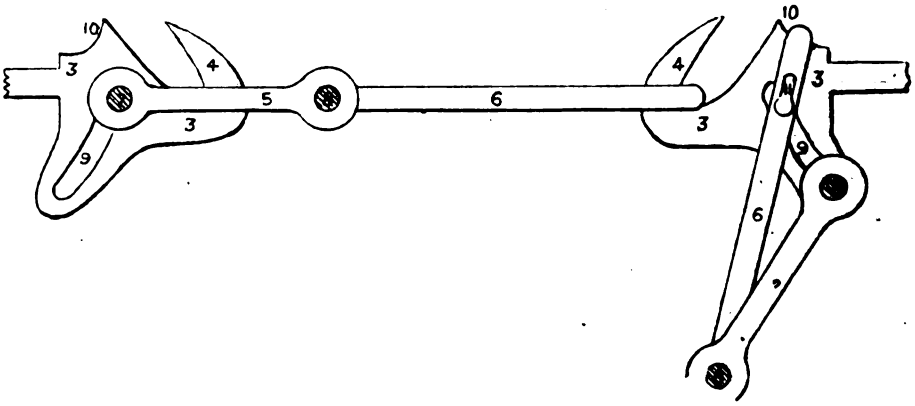
Take a little plate of flint-glass as described in our last note; stick with pitch or sealing-wax a small block of cork or wood to its centre, about ¼in. diameter, but as thin as it may be, and yet serve as a handle by which to work the glass on the laps. If this handle be at all high, it will tend to tip the glass on to its edge, which is to be avoided as much as possible.

Now rub the face of the glass on a level piece of iron with emery powder if it require it; that is if it be very rough, and when level, smooth it as much as the powder employed will allow. Spread some flour emery and water over a piece of thick plate-glass—any old stuff from a broken window will do—with water to form a thin paste; work the ground face of the future lens on this until it is free from all trace of scratches, and perfectly uniform in grain under a magnifier.

Turn the piece of plate over, and anoint its other side with washed emery and water, and working the ground face of lens hereon, produce as fine a surface as possible.

It is in this fine grinding that the Pons Asinorum lies. Get over this, and the remainder of the journey is easy. When the finished surface is examined with an inch focus lens, there should be no inequality in the grain, no cobweb-like lines, no tiny pits left by the emery grains, and, as a further test, note at what angle window bars may be seen by reflection therefrom.





I once saw it stated in "Ours," in reference to specula, that "the window bars were seen reflected from its ground surface, when held so that the light of the window fell upon its surface at some 30° or 60° from its perpendicular." Now I have generally been able to get my little flat surfaces fine enough to show window bars by an almost perpendicular incidence, that is as near to it as the head of the experimenter allows.

The object in getting a very perfectly ground surface is twofold—1st, it saves time in polishing; 2nd, it is a true surface geometrically, and will remain so if not polished too long; but prolonged polishing tends to make a convex surface of a most nondescript character.

Now for polishing. Cut a nice square of plate-glass, about 6in. by 8in. will do, and let it be thick. The wheel glass-cutters will cut anything up to an inch. I have done it; but ¼in. will do for this job. Now cut a piece of clean, strong paper about the same size, and stick it by one edge only to the glass; the other end must be held during the polishing. Cover this paper nearly with washed rouge, well rubbed on dry, and the loose powder shaken off. On this as a lap polish the lens by straight strokes; but be careful to turn it every few rubs, so as to get the cuts in every direction. There should be no fresh application of rouge required, nor should the paper be at all worn by the time the glass is brilliantly polished. The convexes and concaves are polished in the wet way on pitch tools moulded on the lens while warm, and used when cold again, with rouge and water.

In my next I will give curves and method of combining and arranging a modern o.g. with a method of testing. After which, with a few general cautions to be observed in working the curves, I shall conclude, unless anything further is asked for, in which case I will, with pleasure, add the information required. **Rob. Crus.**

# REPLIES TO QUERIES.

*⁂ In their answers, Correspondents are respectfully requested to mention, in each instance, the tit e and number of the query asked.*

[54698.]—**Round or Around.**—Although I introduced this discussion, it seems hardly suited to these pages. In one or two of the instances quoted by James Bird the word "around" seems permissible, and I have not said that the word should never be used. What I object to is its constant application in every instance, which is the case with an American paper which I have just been reading. "The circle around where the earth and heavens seem to meet," the second of Mr. Bird's quotations, is a miserable attempt at composition, quite beneath criticism or notice. Isolated instances don't justify the constant use of any word. The mention of Spenser, and the word "abed," reminds me of an answer by an Irish newspaper to one of its correspondents concerning the pronunciation of the word "Sardanapalus." Byron somewhere makes it rhyme with "ale 'us" (or some similar word), and the editor kindly informs his friend that "our English brethren pronounce alehouse 'ale 'us.'" The word "around" is only admissible where motion is neither expressed nor understood, and even then not in all cases. "Around" is, in my opinion, on a par with "agoing" and "acoming." I would say more on this and kindred matters; but I think it is considered rather outside the scope of the English Mechanic.—Os.

[56474.] — **Training for Athletics.** — This querist should procure one of the little handbooks published as guides on training. He must please himself as to what directions he will follow; but all the training needed is steady practice and attention to diet. Don't attempt to run at high-pressure speed at first; but work up gradually until you think you are perfectly fit. There is no "secret" in training; but the practice is a little different when training for a 300 yard burst and a ten mile race.—Nun. Dor.

[56475.]—**Nitrate of Iron.**—I venture to reply to this query, because I note the appeal of Henry Holmes on p. 307. He does not say whether he wants a ferrous nitrate or a ferric nitrate; but he does say that it must be made without copperas, which at once puts aside the easiest way. It can be made by dissolving ferrous sulphide in nitric acid; but the price at which it is sold shows that it is probably some by-product, or is at least produced where nitric acid is cheap—probably in factories where nitrate of soda is acted upon by sulphuric acid, and the nascent nitric acid is used to dissolve clean scrap iron. It would seem to be necessary, tco, to state for what purpose the "iron" is wanted, as dyers prefer a different nitrate for printing blue to that used in printing black. Perhaps, however, some of our chemical friends can help now.—Nun. Dor.

[56478.]—**Spectroscope.**—The prisms are long enough; but it is doubtful if they are right quality of glass or ground to the right angles. Cut by holding them against a disc of copper, with oil and fine emery on the edge, and revolving rapidly in the lathe.—Selim.

[56482.]—**Painting on Calico.**—Suppose this querist tries sizing his cloth before painting it? If necessary, the size can be taken out after painting. —N. E. Child.

[56486.]—**Pressure.**—If the dimensions were given, it would be possible to calculate roughly the power by the number of strokes of the handle; but that would necessitate the work to be pressed always being of exactly same dimensions. I suspect the only way is to have the pump fitted with a gauge.—N. E. Child.

[56487.]—**French Polishing.**—This art has been so often described in back numbers that "Turk" must expect to be referred to them, unless he will put some specific question, and also say in what way he fails. The work must be properly stopped first of all with whiting and tallow, plaster of Paris, or size for common; then with a pad of cotton wool saturated with the polish, and covered with a bit of clean calico, with just a touch of oil, coat the whole surface of the work with polish, and leave it to sink in and dry. Then paper down, and proceed to prepare for the polishing proper. Don't put so much polish in the rubber this time; always have the outside cover easily movable with just a touch of oil on it, and rub in circles. To finish you must have "finish," and use that the same way as the polishing coat, but not rubbing quite so hard. Nun. Dor.

[56493.]—**Waterproofing Tennis Racquet.** —I don't suppose that the gut was waterproofed in the sense usually given to that term; but it was probably well dressed with nut or poppy oil.—J. F. L.

[56580.] — **Tricycle Pedals.** — Turn a brass washer of a suitable size and thickness, cut a narrow groove on the edge; then cut the washer in half. It should then be placed in position, and a fine wire passed round in the groove and soldered. Another plan would be to get a small clock spring of the width of washer required, and wind round and solder the end. I have tried both the above, and am in favour of the former, which will answer well if put on square with pedal and kept lubricated.—Jack File.

[56582.]—**Safety Couplings.**—We beg to forward the inclosed drawings and instructions of our improvements in couplings for railway vehicles, now at the Inventions Exhibition:—Fig. 1 on the accompanying sheet of drawings is a plan, and Fig. 2 a side elevation, of our improved coupling. Our improved draw-hook, piece 3, is formed with a hook (4) to receive the end of a link piece, or a link of the chains at present commonly in use. This linkpiece is formed, as it were, of two link-like parts, 5 and 6, the first link, like part 5, being formed of two parallel rods of wrought iron, held together at each of their ends by wrought-iron pins, 7 and 8. One of these pins (7) is passed through a slot (9) formed in the body of the draw-hook piece 3, and the pin 7 is passed through holes formed in the ends of the parallel rods, which are thus connected together, one on each side of the draw-hook, leaving sufficient room for clearance. The pin 8 is passed through the holes formed in the other ends of the rods, and also through holes formed in the ends of the link-like part 6. This part 6 is formed by a rod of wrought iron bent into a loop, and having its two ends brought close together side by side, and placed between the ends of the rods of the part 5. The loop of the part 6 is formed nearly oval in shape, so as to admit of its being passed either over the hook 4 for coupling purposes, or over the hookpiece 3 for hanging on a small curved projection (10), when the link piece is not in use. When the part 6 is hanging on the curve projection 10, the pin 7 in the curved slot of 9 falls to the bottom and backward end of the slot. The slot 9 is so formed that when the linkpiece is coupled to another vehicle, and the distance between the two draw-hooks of the vehicle is lessened by any cause, the linkpieces, 5 and 6, will by its own weight tend to bend at the joint formed by the pin 8, whilst the pin 7 at the end of the part 5 will fall downwards towards the lower end of the slot 9, thus effectually preventing any chance of the link piece jamming. At the widest part of the oval or looped end of the part 6, there is formed at each side a short handle or projection, 11, for the use of the workmen when coupling or uncoupling with a stick from the outside of the vehicles.—Keeling and Rigley.

[56604.] — **Differential Equation.** — Much obliged to "M.I.C.E." for his reply. As he says, there is a misprint, the equation being $\frac{d^2y}{dx^2} - a\frac{dy}{dz} = 0$. The equation is that of distribution of potential of an alternating current, taking into consideration the capacity of the circuit.—H. H.

[56620.]—**Steam Carriages.**—"Nun. Dor.," answering on p. 286, concludes by expressing an idea that they will never become an "institution unless they run on rails." The word "rails" I suppose to mean iron rails. Would "pavement" answer the same purpose, providing it is of iron, on which vehicles of any gauge wheels could run as they pleased? Or does his idea include that the wheels must be flanged? Then comes the question of relative utility of flange and flat-tire wheels. Given a flat surface of iron for the wheel-bearing, can any amount of flange and groove improve upon it? And for speeds under ten miles per hour, would not the flat-tire vehicle have considerable advantages over the flange wheel, both as to requiring less motive power, less wear to both rail and wheel, and in being able to alter its course in the road? His letter shows there is no lack of means of providing different mechanical motive power for roads, providing there was the iron bearing for the wheels, and certain unjust restrictions removed from using them. Considering there has never yet been an Act of Parliament made for regulating the general traffic on highway roads, it may be near time such was done; and the removal of the unjust restrictions merely requires the voice of the public raised against them, and if shown to be unjust, there is no authority in England that could uphold them. The probable advantages of using mechanical motive power and providing iron tracks or bearing for wheels generally on highway roads are very great: 1st, the results of all motive power being increased (say) four times on iron bearing; 2nd, mechanical motive power being one-half less cost than animal horse-power; 3rd, the results of pedal power (as yet in its infancy) would also be increased four times on a suitable iron bearing; 4th, the wear of common roads is as much from horses' shoes as from wheels of vehicles; 5th, that 57 per cent. of the dust and slush of roads is caused from horse-droppings, which nuisance would be removed; and considering that all the traffic on railways is done on about 1ft. wide of bearing surface, and our roads we maintain 20ft. to 30ft. wide for a much less traffic, it shows that great improvements can be made in our road regulations if people's attention could be attracted to the subject, and a great impulse would be given for the construction of innumerable vehicles of many descriptions. At Portsmouth and Southsea there is now going on a "tug of war" between flat-tire and flange wheels. A number of well-appointed omnibuses with wheels of same gauge as the rails are running opposition, and using such parts of the tram-line as answers their purpose, and the public quite appreciate the prospect of this break-up of monopoly.—PROGRESS.

[56620.]—**Steam Carriage.**—The reply of "Nun. Dor." to this query is certainly very one-sided. He mentions that about fifty years ago steam carriages ran on turnpike roads with good success, and leaves his readers to infer that it was owing to some defect discovered in their working that they were given up. But the truth is far otherwise. Sir C. Dance, in 1831, ran a steam carriage from Gloucester to Cheltenham. It ran for five months without the slightest accident, and only ceased after the most determined opposition that it met with. The opposition took several shapes. Many turnpike bills, imposing heavy tolls on steam carriages, were quickly passed by the influence of those who thought their interests were endangered by the establishment of steam carriages. These tolls amounted in some cases to £2, and in some exceeded £3 at each gate. But his opponents were not satisfied with this. Large heaps of stones a foot and a half high, were laid right across the road in several places; from the arrangement of the stones the heaps could be intended for nothing else than to prevent the steam carriage running. It successfully surmounted these obstructions several times, but at last the axletree broke, and the combination against the steam carriage was too much for it. I have given this instance, but it is only one of many. Good speed has been obtained by steam carriages, even 35 miles an hour, and old Highgate-hill has been ascended with a gradient of 1 in 9. And then as to cost; in the Cheltenham coach above mentioned, the fees were half those of the ordinary coaches. Steam carriages are accused of doing more damage to the road than horses drawing ordinary carriages; but I do not think that this conclusion will be arrived at by anyone who considers the question without prejudice. In the case of horses, progression is made by repeated blows from iron shoes, while in the case of a steam carriage the wheel simply rolls. It may, perhaps, be urged that the wheel may revolve without moving forward, or out of proportion to the forward movement; but there is no need that this should occur, as the wheels may be widened, and thus more grip obtained at the same time that the road would be less worn. Moreover, if steam carriages were used universally in the place of horses, the asphalte and other such pavings could be much more used, as the chief objection to them would be taken away—viz, the slipping and falling of horses; and thus, the roads being rendered less irregular, the wear of any tires considered necessary for steam coaches would be much diminished. And now as to the tires: "Nun. Dor." says "no steam carriage can be successful on a common road, unless it has thick rubber tires or elastic wheels, which, so to speak, lay down the other 'element' in the shape of a rail." This is by no means yet proved, and I venture to doubt it *in toto*. None were used by Gurney and Dance, and their success is indubitable to anyone who will take the trouble to read the whole matter. I have hitherto spoken of *steam* carriages, but I am by no means certain that steam will be the most suitable one in the future, though it is so at present. The invention of electric accumulators within the last few years hold out a hope of the utilisation of electricity for such purposes, though at present the accumulators are almost practically useless. I cannot concur in "Nun. Dor.'s" opinion that the whole subject was thrashed out half a century ago. We may not have progressed much in this direction during those fifty years, but progress there certainly has been.—GWYLLM MAESGWYM.

[56620.]—**Steam Carriage.**—I observe further correspondence on this subject. There is much misapprehension as to the effect of the judgment against Sir Thomas Parkyns. It is true that he was fined a shilling, and that his appeal was given against him; but as there is no "informers clause" in the Highways Act, and the police have no right to interfere, it is highly improbable that much trouble would have resulted from this decision except in case of accidents from misfortune or recklessness. The real reason of the disappearance from public view of the "Baronet" motor tricycle, of which Sir Thomas Parkyns was the patentee and I the godfather, are of a different character, as there are many who would have risked infringing the Highways Act, and also others who have private grounds, exporters, foreign buyers, &c. Indeed, my firm received many positive orders from abroad. I have no doubt that satisfactory steam tricycles can be made, but I am equally certain they will never come into common use. With your permission I will give my views on the subject of the necessary qualifications for such a machine:—1. Must be easily worked by anyone, whether an engineer or not; 2. Absolute safety; 3. So constructed as to be impossible to work it wrong, remembering that many people prefer doing a thing wrong to right; 4. Durability; 5. Reasonable weight, having regard to occasional necessity of personal working; 6. Entire absence of visible smoke or steam; 7. Satisfactory condensing arrangements, as water in quantity is heavy to carry and cannot always be obtained; 8. A fuel that is not only efficient, but that can be bought anywhere; 9, Moderate price, so as to secure enough orders to make the article wholesale; 10, Inoffensive appearance. The difficulties lie in 5, 8, and 9. An ordinary tricycle weighs, say, 80lb.; this, having to carry machinery, &c., must be stronger, and therefore heavier, say 120lb. To this must be added double-cylinder or rotary engine, copper tube boiler, burners, tank, and at least 1¼ gallon water, circulating pumps, condenser, tank, and 1 gallon fuel; total, say nearly 200lb. This machine must necessarily be heavy to work by foot-power or to push up hills, as if the steam power be sufficient for this purpose, it would be positively dangerous on the level from the excessive speed possible (and very likely to be used). The fuel, however, is the greatest difficulty. Petroleum alone is easily obtainable in little out-of-the-way places, and that material cannot as yet be used on the small scale as a steam getter without both smell and heavy carbon deposit. Spirit which is all that can be desired is not commonly sold, and to be landed in a beautiful country 20 or 30 miles from the nearest town with a 200lb. machine to propel is a prospect certainly awful to contemplate. Finally, as the demand would not be very large, the price to cover all these requirements would be excessive; for a machine to carry one person, very different from the £40 originally talked about. The machine, as made by Sir Thomas Parkyns, was ingenious, and worked perfectly for, say, half a mile, on level ground; then something or other inevitably went wrong, and repairs were needed for a fresh start. In its then state it was an ingenious toy, but not a commercial article. To render it so, much pains was taken, and a lot of money spent, with the result that it became too complicated and liable to disarrangement. In short, the small size made the difficulty. A carriage to take several passengers could doubtless be comparatively easily managed, but I have been compelled long since to reluctantly abandon the idea of a practical steam tricycle.—A. H. BATEMAN, East Greenwich.

[56628.]—**Heliograph.**—I think this will be clear to "Magister Artibus." The heliograph is laid by means of a sighting vane, which is extended a few inches in front of the mirror by means of a jointed rod. To adjust the sighting-vane on a distant point, the signaller places himself in front of the mirror with his back to the distant station, and moves his head and eye until he sees the distant station reflected in the exact centre of the mirror. He then, without moving his head, moves the sighting-vane until the reflection of the sighting spot is brought accurately in line with the centre of the mirror and the reflection of the distant station. The sighting spot is then in a direct line between the distant station and the centre of the mirror, in whatever direction or inclination the latter is placed. The signaller now moves behind the instrument, and directs the reflection of the sun on the vane by moving the mirror vertically or horizontally. The sighting-vane is a piece of white metal on which is marked a sighting spot, which is either a black spot or a cross. A small circle in the exact centre of the mirror is left unsilvered, and consequently cannot reflect the rays of the sun, and this unreflecting circle causes a small disc of shadow to be projected in the centre of the reflected light, which is called the shadow spot. The shadow spot must be made to agree with the sighting spot while the key is depressed, and the light from the mirror will then be thrown on the distant station. As the sun has a continual motion in the heavens, so this shadow spot can only be kept adjusted to the sighting spot by constantly altering the direction of the mirror by the two slow-motion screws. The signaller, while sending a message, must fix his eyes constantly on the vane to see that he is keeping the shadow spot in the same relative position to the sighting spot when the key is released, that whenever he presses down the key the shadow spot should strike the sighting spot. ("Manual of Army Signalling," pp. 11—13). If the sun is behind the signaller, two mirrors have to be used, and the adjustment is made in a somewhat similar manner by moving the second mirror instead of the sighting vane. The second mirror has a sighting spot painted upon it, and is not moved during the course of transmission of a message.—A VOLUNTEER SIGNALLER.

[56650.]—**Lead Burning.**—I do not understand why Mr. Holmes should have troubled himself to state that I am not quite correct about the quality of acid, when my letter on page 287 of the "E.M." distinctly states that the very best sulphuric acid should be used by the young beginner. Of course, brown vitriol can be used, and also other such acids; but there is nothing like giving definite instructions with regard to the acid and zinc used. Mr. Holmes has simply repeated the words of my book delineated on pages 63, 64, 65, &c. He says, start with flat burning, and with 6lb. or 7lb. lead; that will be found on page 63, line 14 from top, right-hand column; and on pages 64 and 65 I have not only told my reader about nailing the lead on a piece of board, but have illustrated the same; and as to the cleaning of the lead, I should think I have spoken of this at least a dozen times. More than this, I can produce plenty of young plumbers who have mastered lead burning without any instruction save and except the reading of my writings in the "E. M." What would Mr. Holmes have us think when he speaks of "using clean zinc free from iron, wire, &c., and free from paint"? Surely he would not expect wire and paint to be mixed up with pure bar zinc, which I always recommend. It would be an easy matter for a young beginner to get wrong if he does not follow the instructions with regard to the class of material, and which I find of the greatest importance to instil into the minds of young beginners, and after the art of lead burning is learnt, with sufficient chemistry for making his gas, the workman can be credited not to break the laws by using inferior materials without being taught to do so in the pages of the "E. M.," and I still think it is too much to expect a second edition of the articles on lead burning within so short a time; more especially as the articles have been printed in book form. With regard to Mr. Holmes recommending "Young Beginner" to renew his acid and water as often as the gas begins to burn dirty, I would ask him if throwing the gas away is the only thing he would do under the circumstance, as I frequently find the gas dirtier at the first half-hour of the machine's work than I do at the finish. Does Mr. Holmes consider that there is nothing to be done but to throw the acid away? I should consider it a great waste throwing the acid away in that manner; and has Mr. Holmes noticed this phenomenon, especially when using the brown acid which he speaks of?—P. J. DAVIES.

[56659.]—**Cutting Ebonite.**—A well-hardened tool, with elbow grease and an oilstone, is, I believe, the only method.—F. M. ROGERS.

[56660.]—**Eclipses of Small Hand of 24h. Clock.**—Multiply $2\frac{14}{23}$min. by the hour past which you wish to time eclipse; $2\frac{14}{23}$min. being the time required by the minute hand to gain on the hour hand the space between any two hours. Example: $2\frac{14}{23} \times 23 = 60$min., minutes past 23 o'clock, at which eclipse takes place.—SCOTCH WORKING MECHANIC.

[56667.]—**Re Drill Chuck.**—By far the best drill chuck for medium and large-sized drills is the Oneida, or Little Giant; it has the most powerful grip, and is very durable indeed. Besides taking in a very large drill, it will also hold a needle. For smaller and lighter work, I think the Invincible drill chuck (a new one) is the best, as it is well made and grips very firmly.—W. BUNDY.

[56678.]—**Hardening Jaws of Chuck.**—Jaws should be well heated to a dull red heat, and then cooled in potash and water. If your correspondent likes to send jaws to me, I will get my men to harden them for him, as it requires some care and experience. I won't charge him anything, of course.—W. BUNDY, Queen Anne Chambers, 62, Holborn Viaduct, London, E.C.

[56679.]—**Supported Beam.**—With all due respect to your correspondents "R. W.," "Hemisus," and "J. S. C.," I beg leave to state that their replies to this query are entirely wrong. The beam has a tendency to break by shearing at every point, unless it is without weight, in which case it would not be supported by the points on which it is supposed to rest.—BACCHUS.

[56682.]—**Struck by Lightning.**—If the pains are rheumatic, a 10-grain dose of salicylate of soda will probably give relief in a few minutes.—F. M. ROGERS, F.C.S.

[56687.]—**Wheel Calculations.**—If I understand the drawing illustrating this query, the handle makes B move in an orbit, the radius of which orbit is same as radius of wheels A and C. If this is so, the replies in last issue are very wide of the mark. Dividing 50 by 23 gives quotient

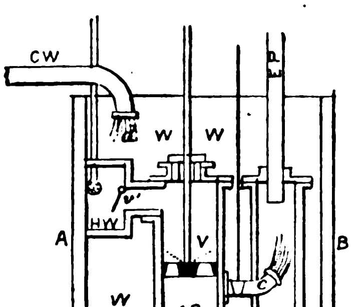
$2\frac{4}{23}$, which is the number of revolutions on its axis B makes for one turn of handle. Now, these axial revolutions would, if B did not move in its orbit, make C revolve once, because $\frac{23 \times 2\frac{4}{23}}{50} = 1$, and the orbital movement of B, would of itself also make C revolve once in the same time and in the same direction, therefore the two movements being combined C will revolve twice for one turn of handle. The size of B is quite immaterial to the result. For example: Suppose B to contain 100 teeth, then $50 \div 100 = \frac{1}{2}$, and $\frac{100 \times \frac{1}{2}}{50} = 1$ revolution of C due to the axial half-revolution of B, which added to the one revolution due to the orbital movement of B, gives, as before, two revolutions of C for one turn of handle.—Scotch Working Mechanic.

[56697.]—**Cutting Glass Bottles.**—I have cut many bottles, &c., of considerable thickness by the following method: Fill the bottle with oil (linseed oil is the best) up to the level of the line where it has to be cut; then immerse slowly into the oil an iron heated nearly to white heat, the glass will separate directly at the level of the oil. The oil can be used again.—E. Gravenstone.

[56697.]—**Cutting Glass Bottles.**—If "Sodium" will fill the glass bottles with cold water to the height he wants them cutting, and get an iron ring about ½in. thick, 1in. broad, and 1in. larger in diameter than the bottles; then get the ring red-hot, and hold it over the bottle at the water line, he will hear the bottle crack. He must then lift off the ring immediately; also the bottle top. I have cut several three-gill spirit bottles in this way to make pint bichromate batteries with success.—G. H. Hepworth, Westgate, Cleckheaton, Yorks.

[56698.]—**Quinine Manufacture.**—Use a wrought-iron coil placed in the oil tank, which should have a manhole cover. Steam can be passed direct from the boiler into the coil. If no regular boiler exists, a small superheater may be employed to raise the temperature of steam obtained from any vessel capable of generating it at a low pressure. If a sketch of tank be sent me, I will show the method employed for passing in the coil through manhole.—F. M. Rogers, F.C.S., 21, Finsbury-pavement.

[56699.]—**Condensing Engine.**—Newcomen was one of the first who condensed the steam behind a piston. In his engine the cylinder was placed immediately above the boiler, from which steam passed directly through a stopcock. As soon as the steam had forced the piston to the top of its stroke, a cock was opened, and cold water admitted into the cylinder to condense the steam that forced the piston up; a vacuum being thus obtained, the pressure of the air, about 15lb. on the square inch, immediately drove down the piston, hence it was called an atmospheric engine. Now, Watt having a similar engine to repair, thought whether he could not prevent the wasteful expenditure of steam, as the great disadvantage of Newcomen's engine was that the cylinder was at one time required to be hot, and at another cold, and that the fresh steam entered a cold, wet cylinder, thereby losing about three-quarters of its power, so he (Watt) set himself to solve the problem of a separate condenser. In this he completely succeeded, and I give a sketch of the condenser and air-pump of his engine. A B is a large casting, within which is placed the condenser C, the air-pump A P, and the hot well H W. V is the piston or bucket of the air-pump with its two valves shut down, but shown by dotted lines as they will appear when the piston V is descending. E P is the exhaust pipe to convey the used steam from the cylinder into the condenser C; C W is a pipe bringing cold water from the pump, *v* the foot valve, *v′* the delivery valve. W W W W is water surrounding the condenser and air-pump to keep the condenser cold. Let us suppose that the steam, having been used, comes from the cylinder through the exhaust pipe E P; the moment it enters the condenser it is met by a scattered jet of cold water from the rose head *c*, and is condensed. The condensed steam and water fall to the bottom of the condenser, and pass, or are drawn, through the foot valve *v*. Then the piston or bucket, V, of the air-pump comes down into the water; the pressure of water opens the two butterfly valves, and the water passes through the valves and so gets above the piston. When the piston is drawn up the two valves are closed by the weight above them, which is next forced or delivered into the hot well H W, through the delivery valve *v′*, from whence part of it is pumped into the boiler, through *d*, a part of the feed pump. As the air-pump ascends a vacuum is formed in A P, the air-pump being in connection with the condenser C, so that the condensing water passes by gravity, &c., through the foot valve *v*, or "follows the bucket." As the air-pump valve descends we see *v* must close, so must *v′*; on the contrary, as it ascends both delivery and foot valve will open. All water contains air more or less. The heat of the steam disengages the air from the condensing water, which would rise through the exhaust-pipe, and prevent the proper escape of steam, besides counteracting its pressure, if not got rid of. The air-pump was therefore added by Watt to his invention of the condenser, to prevent the air from accumulating and obstructing the engine. Hence its name *air* pump, its office being not only to pump out the condensing water, but to keep the condenser free from air. In Morton's ejector condenser the air-pump is done away with; the power in the rush of steam and water is found to be sufficient to carry all the water, air, and uncondensed steam into the hot well at once, without the intervention of an air-pump. That the advantages arising from the diminished reaction on the piston produced by the condensation of the steam are not altogether to be placed to the account of increased moving power will be apparent when it is observed that no inconsiderable part of the power thus gained is absorbed by the cold water pump, the air-pump, and the hot-water pump, all of which are worked by the engine. Neither is the vacuum into which the piston moves so absolute as it might at first appear to be. It is not found practicable to keep the water in the condenser at a temperature lower than, I believe, 100°, and at that temperature steam is evolved which has a pressure of about 1lb. per square inch, which, after all, will still react upon the piston. In comparing, then, the non-condensing and condensing engine, it is apparent that while the latter gives a much greater amount of moving power with the same rate of evaporation, and consequently with the same consumption of fuel, the former is vastly more simple in its mechanism, lighter in its weight, more inexpensive in construction and maintenance, and much more portable. I hope now that with the aid of the sketch you will understand the working of a condensing engine. You ask for description of a surface-condenser, but I am afraid I have taken up too much valuable space already. However, it simply consists in exposing the hot steam to large cold surfaces. Hall's surface condenser consists of an immense number of vertical tubes or pipes placed in a large tank. The steam, after being used in the cylinder, passes through these tubes. Water surrounds these tubes, and is forced through the tank in among the tubes. The cold water enters at the opposite end to that at which the steam enters, thus the hot steam meets the warmer water first and the colder last, by which arrangement the water is made to carry off as much heat as possible. —A. Plucknett.



[56703.]—**Algebraical Problem.**—The number of variations of *n* things taken *r* at a time is—

$$n(n-1)(n-2)\,\ldots\ldots\ldots(n-r+1).$$

And of *n* things taken (*r* − 1 at a time will be—

$$n(n-1)(n-2)\,\ldots\ldots\ldots\ldots(n-r+2).$$

Hence—

$$n-r+1=10$$
$$\text{or, } n-r=9.$$

The number of combinations of *n* things taken *r* together is—

$$\frac{n(n-1)(n-2)\,\ldots\ldots\ldots(n-r+1)}{\underline{|r}}$$

and taken *r* − 1 together—

$$\frac{n(n-1)(n-2)\,\ldots\ldots\ldots\ldots n-r+2}{\underline{|r-1}}$$

Hence—

$$\frac{(n-r+1)\,\underline{|r-1}}{\underline{|r}}=\frac{5}{3}$$

$$\text{or } \frac{n-r+1}{r}=\frac{5}{3}$$

therefore $r = 6$ and $n = 15$.—H. H.

[56705.]—**Potter's Kiln.**—My kiln was a round one, built to burn red and fancy ware, 7ft. to the spring of dome, 14in. brickwork; dome to rise 2ft. single brickwork, with chimney 3ft. high, 9in. flue, with drawing damper to regulate the draught, laying in one brick thick from top of dome, to be built with four fire holes equal distance apart, 9in. wide, 2ft. 9in. high from ground to top of fire hole, the grates 1ft. from ground, with cast-iron doors 9in. square; the kiln to be banded at the spring of dome, and also just under the bottom of the wicket, and close above the fire holes; the wicket to be 18in. wide, and carried up from the level of top of false bottom of kiln to the spring of dome; the kiln to contain a false bottom 3ft. up from the ground to where the wicket commences. The bottom to be built with a space of 1½in. up from where the grate commences all round from the wall of kiln, to allow the fire to circulate freely; the false bottom to be built with a space of about 1in. between each brick to allow for draught, and also holes to be left in the false bottom about 1ft. or 15in. in, to correspond with the fire holes in the kiln walls, the bricks to be gradually brought over the fire holes in the false bottom, so that you finish the bottom of kiln all one nice level, the bricks left about ½in. apart, then 9in. slabs or tiles with 1½in. teits, forming like a low stool, to be built on edge-ways all around the kiln inside, three courses high from top of false bottom, the teits of the slabs to rest against the sides of kiln inside the space between the slabs and that of the false bottom, correspond and carry the heat to the upper part of kiln, and regulate the firing better. Hope Mr. Townley will understand; if not, write to me. The false bottom should be firebricks, or bricks made of clay 1 part and sand 1 part. Also the fire holes should be lined with firebricks.—S. Arlidge.

[56711.]—**Fulcrum.**—The weight of bar will act through its centre of gravity, which will be at middle of bar, so we have 6lb. and 4lb. 5in. apart. Divide the distance apart by the sum of the weights, and multiply quotient by 6 for distance of fulcrum from centre of gravity, or by 4 for distance of fulcrum from 6lb. end, thus $\frac{5}{10} = \frac{1}{2}$in., which multiplied by 4 gives 2in. as distance of fulcrum from 6lb. end.—Scotch Working Mechanic.

[56715.]—**Hydraulic Capstans.**—These can be made in various ways, one of which is a 3-cylinder engine, driving wheel and worm gear.—F. M. Rogers, 21, Finsbury Pavement, E.C.

[56722.]—**Flywheel.**—Weight depends on what engine has to do; for instance, if it drives a fan or centrifugal pump, it may be smaller than if it drives a shaping machine. Say for what purpose it is used, and I will try and help you.—S. Beeching.

[56727.]—**Resistance Coils.**—Ordinary wooden reels, such as are used for cotton, will do very well for the smaller sizes, if previously boiled in melted paraffin. For larger and more accurate coils, to obviate errors through heating, it is better to wind the G.S. wire (covered of course) round a brass tube, which is then inserted in a little brass box, with an ebonite top, the terminals projecting through this top.—S. Bottone.

[56737.]—**Cutting Indiarubber Discs.**—It depends upon the number of discs required, as to the apparatus I should recommend for the purpose; if only a few dozen, a tool like a pair of trammels might be used, one leg being for centre, the other holding the knife. If a large number are required, there should be a surfaced table of hard wood, a disc to press on top of rubber, and an adjustable knife driven by upright spindle and gear, and lever to regulate cut. It is against the rules of "Ours" to mention names of makers; but if "Novice" will look out my address in "Sale" Column, I will give him full information.—S. Beeching.

[56743.]—**L. and N.W.R. Engines.**—The principal dimensions of the "Severe" class are: Driving wheels (four-coupled), 6ft. 6in.; leading wheels, 3ft. 9in.; cylinders, 17in. by 24in. Inside bearings. Weight, 29tons 4cwt. This class of engine was built by Mr. Ramsbottom. The drivers much prefer the ordinary "Precedent" class of express engine to the "Compound" type, which is hardly to be wondered at. The engine 173 "Cornwall" is, or was till lately, stationed at Whitchurch, and worked the traffic between Wellington, Crewe, and Manchester.—H. Bill.

[56745.]—**North-Eastern Engines.**—I am informed that the engines recently built are constructed on much the same general plan as Fletcher's express engines, Newcastle-on-Tyne.—Wm. John Grey, F.C.S., Analytical Chemist.

[56746.]—**A Disagreeable Noise.**—There is, I am afraid, little to be done in this case. I would place under each post of the bed a pad of vulcanised rubber, an inch thick, if you can get it.—Os.

[56746.]—**A Disagreeable Noise.**—In my opinion it is purely a case of conduction of sound, not of air-transmitted sound. No padding of windows would in any way relieve it. The best way is to bed the anvil itself on some elastic body, such as a layer of cork, or sheet rubber. Very probably either a sewer, or water, or gas pipes run under your shop, and across to the house in question. At any rate, an elastic cushion under the anvil will take away the nasty jar complained of—INVICTA.

[56747.]—**Governors.**—To give you all particulars and sizes would need at least a sketch, and that I could not give satisfactorily, unless I saw the whole design of the engine, so that the governor could be arranged to suit it. My own time is much taken up; but if no one else deals with it fairly, I will, on seeing general plan of engine, do my best for you. Boiler: I would refer you to page 221, reply 56463, where you will find a boiler described for an engine a trifle larger than yours. But if you are going to run at 200 a minute with gas-fuel, you will find it none too large. For 200 a minute I would also advise at least 30lb. pressure, or you will do but a very little work with such an engine. Any further details with pleasure, if needed.—INVICTA.

[56750.]—**Gold Plating.**—The best and cheapest way would be to coat your steel with lacquer, coloured with some yellow dye. They must, of course, be polished first. They can be gilt; but should be previously coppered, and you will be astonished how cheaply this can be done if you have a quantity. The best finish for steel or iron goods is nickel plating.—OS.

[56750.]—**Gold Plating.**—To a solution of muriate of gold add nearly as much sulphuric ether. The ether reduces the gold to a metallic state, and keeps it in solution, while the muriatic acid separates, deprived of its gold, and forms a distinct fluid. Then make your steelwork bright and free from any oily substance, put the steel into the ether, which speedily evaporates, depositing a coat of gold on the metal by dint of the attraction between them. After the steel has been immersed it should be dipped in cold water, and then burnish it, which strengthens its adhesion, and finally polish with rottenstone and rouge. Figures, flowers, and different devices can be drawn on the steel with very good effect by using a pen dipped in the ether. —JIM.

[56755.]—**Magnesia Firebricks.**—I think this query is identical in substance with No. 56494, "Soapstone Firebricks," p. 200, about which information has been asked from America.—ESSAR.

[56756.]—**Electro-Plating.**—As an amateur, I never considered pewter worth plating, although, as a commercial industry, it is largely done. Have you tried dipping them in a weak solution of nitrate of mercury? The coating of silver must be very thin, as it will then be less likely to strip.—OS.

[56757.]—**Steam Expansion.**—The height of a column of water equal to a pressure of 60lb. per square inch is $\frac{60 \times 144}{62 \cdot 5} = 119 \cdot 17$ft. and $v^2 = 2gh$, $\therefore 2g = 64 \cdot 4$, and as the volume of steam to that of water at 60lb. pressure is 437 to 1, $\therefore v = \sqrt{119 \cdot 17 \times 64 \cdot 4 \times 437} = 1831 \cdot 3$, being the velocity of steam per feet per second into a vacuum.—R. N.

[56763.]—**Water Analysis.**—In the analysis of water, it is usual to estimate each base and acid separately, and then to calculate the amounts of the various salts which are presumed to exist in the water. The querist will find an example fully worked out in Fresenius' book on quantitative analysis. 70cc. is much too small a quantity of water for the purpose.—WM. JOHN GREY, F.C.S., Analytical Chemist, Newcastle-upon-Tyne.

[56764.]—**Tempering Carpenters' Tools.**—This is such a general question, and the back numbers and vols. contain so much information on the subject, it would be well for the querist to search the indices in the first place, and if unsuccessful, to state what his difficulty is.—OS.

[56764.]—**Tempering Carpenters' Tools.**—"Tool Worker" asks for a good book which explains the right way to temper carpenters' tools. In Lock's "Workshop Receipts" (third series) of which Messrs. Spon are the publishers, he should find all he wants. The book contains much valuable information on this subject, and the frontispiece is a colour scale for tempering all kinds of tools.—BOBADIL.

[56764.]—**Tempering Tools, &c.**—The best information yet published on this and other workshop matters is given in a book called the "Works' Manager's Handbook for Engineers," by Hutton, published by Crosby Lockwood and Co., Stationers' Hall-court, Ludgate-hill, London. A very complete and practical work, different to all other books in this line.—A. COLE.

[56765.]—**Polish for Walnut Table.**—Eau de Cologne is made with spirit of wine, and has taken off the polish. It might perhaps be revived, to a certain extent, by careful rubbing with a mixture of linseed oil and methylated spirit; but the only radical cure is to have it repolished.—OS.

[56770.]—**Putty.**—Linseed oil and whiting make the best of putty; but before use it does require to be well worked with the hands; if it will not stick, it is probably too hard (too much whiting). A pound of putty can be bought for about twopence, and it must then be worked till quite soft; it will not hurt the hands, rather improve them than otherwise, and hot water and soap will remove the last traces.—OS.

[56775.]—**Small Gas-Engine.**—To "INVICTA."—I am very glad that at least one subscriber has assisted me to ventilate this matter, and I trust more will follow. Replying to your first suggestion, I certainly agree with you on the point you raise; why all should not participate seems to me depreciating the value of concession. At one time it was suggested that the decision of the Editor should be taken, and to be final, as to who were or were not, in his judgment, amateurs or who should participate. Now, personally, I should like the idea of a referee such as our mutual friend, the Editor. But would he, without considerable trouble, be able to say yes or no? Of course, if we could persuade him to act as our arbitrator in the matter, I should feel more than satisfied. Now, supposing that it was arranged thuswise: that the Editor (assuming him to be so good as to undertake the office) should say—(1) If the applicant was entitled to be regarded as a subscriber; and also to fix, if needs be, the minimum time he should have so been a subscriber. (2) Then I would suggest that it be put to the Editor to decide a more important question—viz., whether or not the applicant was, in his opinion, in possession of such ample means that he could afford to buy a gas or other engine at full price, and therefore should, or should not, be entitled to indirectly get an engine at the cost of making only. These are two points which, I fancy, are of value, and I think that they are not altogether unreasonable. It might be even arranged on some coupon system. But, doubtless, this will evoke further remarks of value. Now, I know the only dangerous point on the other side, and it is this: that no patentee, or company, or manufacturer would be likely to throw open or give use to any but those who they are assured would not be cash buyers otherwise. And hence my wish that such a question be referred to and definitely settled by the Editor, say. Further still, persons in trade, and wishing to use the engine for daily trade purposes, are hardly on the same basis as an amateur requiring the engine for his own private use, because a tradesman can, as a rule, afford to buy an engine in the usual way. I don't want to say more on this, as it may perhaps raise difficulties; but what I do wish is to help amateur mechanics, or those taking an interest in mechanics, and who would therefore hail an engine with delight. Now, on the last paragraph of our friend "Theo's" communication there is no doubt that it is quite possible to make an engine on some already expired patent; but the only one of any real use is that of Lenoir, of 1860 and 1862. His was the first engine of real practical use, in my opinion. Now the construction of such an engine would be far beyond the usual amateur, as the boring and pattern-making is very complicated. I have had placed in my hands for perusal a quantity of information in the shape of letters from the actual constructor of the Lenoir gas-engine in England, and I must say, that although I respect it as the first practical engine, yet very little seems to have sufficed to put it out of order. As I am not sure, speaking from memory, whether Mr. Wenham's engine was before the Lenoir, I mention this, as in that case not desiring to in any way ignore the motor produced by the former gentleman. But both Mr. Wenham's engine, I am told, and the Lenoir, I know, make a good deal of noise in working, whilst the motor I want to get into the hands of my brother amateurs runs as silently and steadily as the Otto; and I want to get for the general good the best to be got. Besides the Lenoir there are lots of expired patents; but I do not see a single one that would be suitable. Not only so, but I differ from "Theo" on the point of gas consumption. Surely it is worth some little trouble to get an engine burning, say, only three farthings or a pennyworth of gas an hour, rather than accept one burning say, 4d., with perhaps lots of bump and other noises. And it is the silent running of a steam-engine that is one of its points for an amateur; therefore our gas-engine ought to be equally silent. Many of us want to place them on perhaps upper floors, and absence of bump and noise and vibration are then indispensable. My reply has already reached such an inordinate length, that I cannot now say more than that I trust we shall hear more on the matter.—INVICTA.

[We could accept no such responsibility as is suggested. Moreover, this discussion is fast bordering on an advertisement, and any such cooperation as is sought must be sought in the ordinary way.—ED.]

[56776.]—**Electro-Motors.**—To MR. BOTTONE.—I should strongly advise you to address a query to Mr. H. Jones, through the medium of our paper, on this subject. His experience with these motors is far greater than mine, and therefore more likely to be serviceable to you.—S. BOTTONE.

[56777.]—**Putty.**—The way we made it when I was an apprentice was: the whiting was stoved to dry it, when cool rubbed through a fine sieve, mixed with raw linseed oil on a stone slab until stiff, left for a day or two to sweat, as we called it, then worked up again with dry whiting till stiff again; treated this way about every couple of days for about a fortnight, then you will have good putty—the kind you will not be able to buy at the oil and colour shops, as it is "mill" putty that is sold, made up of all sorts of "stuff."—J. A. P.

[56778.]—**Circle.**—Let $a$ $b$ be the speeds of A. and B. respectively, and $c$ the length of the circumference of the circle. Then, when they meet, A. has gone a distance $\frac{ac}{a+b}$, and when A. again overtakes B. he has gone a distance $c + \frac{2ac}{a+b}$. Therefore, we have $b\left(c + \frac{2ac}{a+b}\right) = ac$; whence $a : b :: 1 + \sqrt{2} : 1$.—EAST ANGLIAN.

[56778.]—**Circle.**—Let C = the circumference of the circle in feet. Let $a$ and $b$ represent the number of feet per minute that A. and B. can run. Since A. and B. can run $(a + b)$ feet in one minute, this will complete the circle in $\frac{C}{a+b}$ minutes, and A will have run $\frac{aC}{a+b}$ feet, and B $\frac{bC}{a+b}$ feet. Now, by the conditions of the question if A. reverses his direction he will overtake B. after traversing $\left(C + \frac{aC}{a+b}\right)$ feet; but in the time A. runs this distance, B. in order to meet him at the starting point, must have run over the distance formerly traversed by A., or $\frac{aC}{a+b}$ feet.

$$\text{Therefore, } \left(C + \frac{aC}{a+b}\right) \div a = \frac{aC}{a+b} \div b$$

$$\text{or, } \frac{C}{a} + \frac{C}{a+b} = \frac{aC}{b(a+b)}$$

$$\therefore\ b(a+b) + ab = a^2$$

$$\therefore\ a^2 + 2ab + b^2 = 2a^2$$

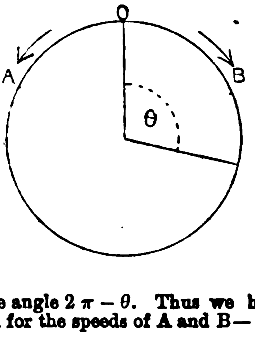
$$\therefore\ a + b = a\sqrt{2}$$

$$\therefore\ b = a(\sqrt{2} - 1)$$

$$\therefore\ a : b :: 1 : \sqrt{2} - 1.$$

—J. C. KELLY.

[56778.]—**Circle.**—Let O be the starting point on the circle, and $\theta$ the angle which B has moved through when B meets A. Then A has moved



through the angle $2\pi - \theta$. Thus we have, if A and B stand for the speeds of A and B—

$$\frac{A}{B} = \frac{2\pi - \theta}{\theta} \qquad (1)$$

Again by the question—

$$\frac{A}{B} = \frac{2\pi + (2\pi - \theta)}{2\pi - \theta} \qquad (2)$$

These two equations give the value of $\theta$ by a quadratic as—

$$\theta = \pi(2 \pm \sqrt{2}).$$

Since A is supposed greater than B, we take the minus sign. So that we have from (1)—

$$\frac{A}{B} = \frac{2\pi - \pi(2 - \sqrt{2})}{\pi(2 - \sqrt{2})}$$

$$= \frac{\pi\sqrt{2}}{\pi(2 - \sqrt{2})} = \frac{\sqrt{2}}{2 - \sqrt{2}}$$

$$= \frac{1}{\sqrt{2} - 1} \text{ Ans.}$$

—L. EDMUNDS.

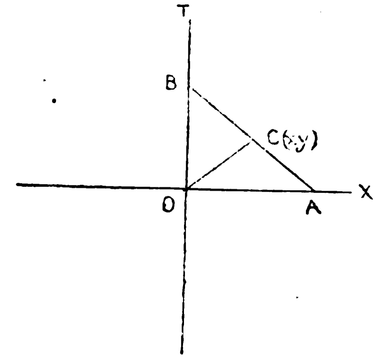
[56779.]—**Problem.**—Let $2a$ be the length of each of the straight lines, so that $a$ is the distance of their extremities from the point of intersection. Take this point as origin, and the straight lines as axes, then the points $(h, 0)$, and $(0, \sqrt{a^2 - h^2})$ are contemporary positions of A and B; and the co-ordinates of C at the same time are given by

$$x = \frac{h}{2} \qquad y = \frac{1}{2}\sqrt{a^2 - h^2}.$$

Therefore, eliminating $h$, we have for the locus of

C $4(x^2 + y^2) = a^2$, and this represents a circle whose centre is at the origin, and whose radius is $\frac{a}{2}$.—East Anglian.

[56779.]—**Problem.**—Let $x_1 y$ be the co-ordinates of the point $c$, and let $x_1' y'$ be the lengths O A, O B.



Thus we have—

$$x'^2 + y'^2 = a^2$$

where $a$ is half the traverse. Now $2x = x'$, and $2y = y'$ by the figure.

$$\therefore 4x^2 + 4y^2 = a^2$$

and—
$$x^2 + y^2 = \left(\frac{a}{2}\right)^2.$$

Hence C describes a circle with O as centre and radius equal to half the traverse.—L. Edmunds.

[56780.]—**Camping Stoves.**—Certainly you will find the methylated spirit stove far superior to any oil burning stove in any open boat or small yacht. I speak from experience of many sorts. The spirit stove heats much quicker than the oil. The burners want no attention, and, above all, your utensils require no outside cleaning after use. There is no unpleasant smell even in a small cabin. The fuel is certainly more costly, but you require less of it. There is this drawback—that you cannot replenish your stock in out-of-the-way villages. You are right in having two stoves, and I include two kettles in my canteen. If you want a lamp, have one with a duplex burner, burning colza oil; but I have long discarded mine altogether, as it only makes the boat a rendezvous for all the insects within sight.—W. M. J. L.

[56780.]—**Camping Stoves.**—Having been on several camping-out trips I strongly recommend a good paraffin stove as the most all-round useful (either Rippingille's or Wright and Butler's); my last was of the latter make, and for two years since it has done good service at home in the summer, when fires can be dispensed with. Our last trip had three passengers, and a small-size W. and B. square stove served us very well; we also had a very small spirit stove as a supernumerary, such as to boil an egg. For compactness in packing for transit it would be easy to make some of the pans and kettle fit one into the other. I got a tinman once to make for me a small "cuisine" for spirit, with pan (for frying), saucepan, and kettle, the lamp fitted into the kettle, these into saucepan with frying-pan outside, for one person's use; but the "kit" was coveted by a cousin-canoeist, and I had not much practical trial of it. I hope you will only have as much pleasure out of your boating and camping-out trip as I have had on the three or four which I have taken.—Cæsar.

[56782.]—**Marking Bone or Ivory.**—I have seen toothbrushes marked with ordinary steel punches, the punches being blacked in a smoky flame, care being taken not to draw the temper.—Os.

[56783.]—**Steam Brake.**—I recollect some years ago riding on the footplate of an engine, I think on the Paris, Lyons, and Mediterranean Railway fitted with this brake. It certainly seemed to answer well, and I understood that a good number of engines were so fitted. If I recollect aright, one drawback was that so many points needed attention, that perhaps for that reason it was not generally used. For instance, the regulator had to be partly opened, I think, and a valve closed so that air was drawn in from outside the smokebox, whilst the water-jet had to be turned on. Then, again, I recollect that at one place the brake was nearly useless. As the full power must be applied, or nothing, the wheels slipped so much on a greasy piece of road, that we had to resort to the tender brakes. In these days of continuous brakes, such a retarding agent is not as simple as a steam brake on the drivers. I trust some other contributor who has seen the system at work will also reply.—Invicta.

[56786.]—**Mechanics.**—"Dumbuck" does not make it clear whether the force, P, is to be applied to an upper corner, or to the middle of an upper edge of his cube of stone. However, as there will be no tilting of the cube in either case, this makes no difference whatever. His question is—At what inclination to the horizon must the force act, which is dragging the mass along the level floor, in order that it may be the least force sufficient for the purpose? The answer is: The required inclination, or angle, is that whose tangent is $k$, the coefficient of friction, or the ratio of the friction to the pressure of the mass moved. To prove this—When a force, P, is pulling at the mass with an upward inclination, $\theta$, the pressure of the mass on the floor is its weight, W, *minus* the lifting tendency of the upward-inclined P; that is $W - P \sin. \theta$. But the resistance of the friction is this pressure multiplied by the coefficient of friction—that is $(W - P. \sin. \theta)\, k$; the resistance is also $P. \cos. \theta$. Equating these, a slight transposition gives us $P\,(k \sin. \theta + \cos. \theta) = W\,k$ (equation A). Now that P may be a mininum, as desired, $k \sin. \theta + \cos. \theta$, must be a maximum; therefore its differential $(k \cos. \theta - \sin. \theta)\, d\,\theta$, must be zero; whence $k \cos. \theta = \sin. \theta$, and $k = \tan. \theta$; or the required angle is that whose tan. is $k$. Now, expressing $\sin. \theta$ and $\cos. \theta$ in terms of $k$, we easily get from A, $P = W \sin. \theta$. In the proposed case of stone moving on stone, $k$ is just about ·5, as a fair average value; and therefore $\theta$, the angle required, is the angle whose tan. is ·5—*i.e.*, 26½° very nearly; and P the force required, is W sin. 26½°, or 447lb. nearly (W being 1,000). For wood on stone, $k$ would be about ·42, and $\theta$ about 23°, and P about 387lb.—Dubliniensis.

[56787.]—**Drilling Rough Plate-Glass.**—If large holes are required, use bits of copper tube notched on edge and a little fine emery and oil. If small holes, an ordinary drill kept moist with water—or, if you like it better, turpentine—will do the work.—Essar.

[56787.]—**Drilling Rough Plate-Glass.**—Small holes in plate-glass, rough or otherwise, can be drilled with a drill of the ordinary diamond shape, tempered in mercury, and lubricated with spirits of turpentine during work. Of course a diamond-tipped drill is preferable, but it is an expensive tool. When in the glass working profession on the Continent, I always used for large holes a drill formed of a copper tube of the diameter of the hole desired, with the outer edge bevelled. When in use it has to be wetted with emery and water; it must be mounted in such a fashion that emery and water can also be put inside. This method is the safest, as there is no danger of cracking the glass. The drills must be always driven at a high speed, with little pressure on the glass.—E. Gravenstone.

[56788.]—**Agglomerate Battery.**—The blocks are probably exhausted, and if so, it would be better to purchase new ones than attempt to repair the old ones. Or the carbon terminals may be corroded, and so prevent the passage of the current. Scrape off the corrosion (if any) with a file or a knife.—Bobadil.

[56789.]—**Klinkerfues' Barometer.**—If you have not another Klinkerfues handy to compare with, you may set your instrument by an ordinary barometer. Divide your scale by ink dots into three inches, 28 to 31, and you can easily get an approximate position. It will not matter that this is not exact, for the great value of the Klinkerfues weather-glass is not its permanent record, but the forecast afforded by the index change from a known position to another within a certain period of time. The range of the Klinkerfues is more extensive than that of the ordinary barometer, so that the two must not be expected to keep together.—J. R. C.

# UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

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# QUERIES.

[56794.]—**Storage Batteries.**—Will any of your electrical correspondents tell me how to make storage batteries with lead plates, for storing electricity, for lighting purposes, giving, if possible, sketch of same with connections, size of plates required, and number of cells for 30 20-c.p. lamps? Would the lead that comes on tea-chests do for same, as I have a large quantity by me?—An Old Subscriber, Walsall.

[56795.]—**To Mr. Wimshurst.**—Would Mr. Wimshurst kindly explain the inductive action carried on between the revolving discs of his influence machine? Also what action is carried on by the so-called neutralising rods and brushes, upon the brass sectors; and if not trespassing too far, could not a spark, and therefore a charge, be obtained if the neutralising rods were connected to an insulated prime conductor, the same being at one end of the frame work?—W. B.

[56796.]—**Boiler Query.**—To "Invicta."—I have a wrought-welded iron boiler, 9in. square, 20in. high, ⅜in. thick plate, by me, and as I want to convert the same into a steam boiler, I shall be glad if "Invicta" will kindly give me the pressure it is safe to work it at, also the size of bore of cylinder that it is capable of working. I may mention that it was made for a high-pressure range boiler, and that it is new. Also I should be glad if he would give me the diameter of the safety-valve, and the length of lever?—R. Hearn.

[56797.]—**Lamp Wick.**—Is there such a thing as an incombustible wick? Would asbestos answer?—Backwoodsman.

[56798.]—**Filter.**—Can any of "ours" kindly assist me to ascertain the size of filter that would be required to filter a stream of water, running in a flume, that has only a fall of 4in. in 400ft.? Size of flume, 10in. by 12in. A constant flow of water is required for five months, during which time the supply must not cease for more than a few minutes. At lower end of flume the water is a little over one third the depth of flume, or nearly 4in. deep by 12 wide—something reliable and inexpensive is wanted. A fall of ten feet at lower end of flume can be utilised for filter if required.—Backwoodsman.

[56799.]—**Sand for Cores.**—Will some reader kindly tell me what kind of sand to use for cores for brass bushes, &c.? Being in the country, I have no opportunity of buying right sort; but thought, perhaps, as there is plenty of sand about, I might, with a little advice, mix some that will answer.—G. G.

[56800.]—**Pianoforte Tuning Hammer.**—Would any of your musical correspondents kindly let me know the best kind of pianoforte tuning hammer now used?—Vanduara.

[56801.]—**Organ.**—A reader of the English Mechanic will be glad to know what is the smallest quantity of water that could be used to blow an organ having three rows of keys, the fall required, and the apparatus to be used under the circumstances?—A. H. F.

[56802.]—**Shunts.**—With the shunts $\frac{1}{999}$, $\frac{1}{99}$, $\frac{1}{9}$, compare the currents in the galvanometer when any two of the shunts, and when all three, are in circuit together?—K. L. M.

[56803.]—**Electrical Calculations and Measurements.**—I hope Mr. Wright, of S. Hampstead, will give us a further instalment of his interesting formulæ. I see he promises to do this at the end of his letter on page 429, Vol. XXXIV., but I have looked for it in vain.—Glatton.

[56804.]—**Fifteen-Lighter Dynamo.**—Will Mr. W. H. Eaves kindly give me dimensions of armature, armature rings, field-magnets, &c., and quantity and size of wire for constructing a dynamo, similar to the one he is at present describing in "Ours," but to light only 15 lamps instead of 30? I should also like to know resistance of wire on armature and field-magnets, also number of volts and ampères the machine will give at the proper speed, and number of extra lamps it will light for a short time, without heating?—Electricity.

[56805.]—**Torrigelli Barometer.**—Can anyone favour me with the letterpress of the Torrigelli dial, together with the respective tenths or hundredths at which each variation should be placed?—R. Hannen.

[56806.]—**Foci of Lenses.**—Will some of "ours" kindly tell me how to find the focus of any magnifying glass? Are concave do., and achromatic, found in the same way? How are achromatic lenses separated, and what kind of cement is used to join them?—Ignorant.

[56807.]—**Buttons and Buttonholes.—A Hint to the Inventive.**—The button has not yet been invented, and that plague of life still afflicts us. The truth is, inventors are on the wrong track; what we want is a buttonhole, not a button. We cut a hole to hold the button, and then have to fill up the hole with the end of the finger, and so prevent the passage of the button; with what result to the temper is too well known.—Verb Sap.

[56808.]—**Alcohol.**—Can any reader of "ours" kindly give me a rough test for the proportions in a mixture of alcohol and water?—Chemicus.

[56809.]—**Dynamo for Arc Lights.**—To Mr. W. H. Eaves.—Will you kindly say what amount of wire should be wound on an armature, similar to that of your 30-lighter, but 12in. external diameter, and 12in. long? Also size and quantity of wire for F.M.? The machine is to run two arc lamps. What will be the probable strength of each light?—E. K. S.

[56810.]—**Stamp Duty.**—Will Mr. Wetherfield kindly say if an account or poor rate paid by cheque and indorsed paid by cheque, is legal, without adding a stamp to such receipt or rate? Is it absolutely necessary to use two stamps for one transaction, one on cheque and one on receipt?—J. C.

[56811.]—**Surface Condenser.**—To "Invicta" and Others.—I propose to fit up a low-pressure engine, not over 2lb. steam pressure, and use surface condenser. Will you please describe best form and size of surface-condenser for ½-h.p., amount of cold water per hour, and size of tank in which condenser is placed? It will be supplied from rainwater cistern. Also give size of engine cylinder, and air-pump working at same speed as engine? Your full answer will greatly oblige—SAFE MOTOR.

[56812.]—**Terrestrial Telescope.**—Having one of these of 1¼in. aperture, the flint glass of the achro. o.g. of which has become broken by accident, will some friend kindly say if I could get a new flint glass fitted to it, and how I had better proceed to that end?—C. BORER.

[56813.]—**Fracture of Water Gauge Tube.**—If a boiler attendant unwittingly cleans his water gauge glass (interior) with a piece of cotton waste on a piece of iron wire, that glass tube will assuredly break as soon as steam is up. Why? Also, as an experiment I have laid very carefully up on a shelf, out of harm's way, a glass (gauge) tube, and as carefully inserted a piece of iron wire, without touching the glass, and withdrawn it again, and in nine cases out of ten the glass, though remaining untouched, will fly into several pieces, generally with a longitudinal slit and several transverse ones. Why?—C. BORER.

[56814.]—**Hot Foods in Hot Climates.**—Why are curries, &c., partaken of by people in hot climates? What physiological effect have they to make them so sought after and consumed?—C. BORER.

[56815.]—**Tank.**—Will some of my brother readers answer the following and oblige? Given a tank of 3ft. deep filled with water, the level of which is 10ft. above point of discharge; required to know whether tank would be emptied quicker by a 1¼in. outlet pipe in bottom, or by a siphon, same size, starting near bottom passing up to water level and then down through bottom tank as before? Discharge to be started by a valve in both cases.—PLUMBUM.

[56816.]—**Tables of the Planet Venus.**—Will "A Fellow of the Royal Astronomical Society" kindly say which are the latest and most accurate tables of the planet Venus, containing especially the equation of the centre for each degree of the planet's orbit?—J. H. T.

[56817.]—**To Mr. Wenham.**—Would Mr. Wenham kindly publish the way Andrew Muir's link was fitted on to the slide rest, so that the screw nut could be shifted on to different places on the guide screw of a screw-cutting lathe, and how the nut was lifted out of gear?—WM. JAS. BROWN.

[56818.]—**Spherical Aberration.**—In large object-glasses of telescopes in which the crown and the flint glass lenses are separated, does the alteration of the distance between them, which is intended to correct the chromatism, also effect any change in the spherical aberration?—D. T. R.

[56819.]—**Pickle for Brass.**—I should be obliged to any practical man who would say what pickle or liquid dirty brass ornaments are dipped into for the purpose of brightening them, or the process they have to pass through previous to lacquering?—J. H. D.

[56820.]—**Commutator.**—I am manufacturing a sparking coil, primary, two turns No. 18 silk-covered copper wire; secondary, ½lb. No. 40 silk covered wire. Is a commutator necessary for the above, if so, what is its use? The secondary is put on in eight divisions; is this the right form and make up for the coil to give a 1in. spark with three 1-quart bichromate cells? I hope that some of our brother readers will favour me with a reply.—B. JACOBS.

[56821.]—**Grass Seed.**—Can some one give me the name of a treatise on methods of cleaning and separating grass seeds, if such exists, treating the subject both theoretically and practically?—SAAT.

[56822.]—**Small Dynamo.**—To MR. S. BOTTONE.—Having finished a small dynamo of the type described by you in No. 1,007 of the "E.M." Will you tell me the best size and quantity of wire for it? The armature is 5in. external and 5⅛in. internal diameter; 2½in. broad, with sixteen cogs; the spaces for wire are 2½in. long by ⅜in. broad by ⅜in. deep. The electro-magnets 7in. long, by 1⅜in. in diameter; the electro-magnets are wrought iron, and screwed into the pole pieces.—BON BON.

[56823.]—**Steam.**—Will any reader show me how to get the cubic inches of steam in the cylinder, and the quantity of water, in cubic inches, to condense the above with? The steam cylinder is 32in. diameter, 6ft. stroke, pressure on piston 35lb., cuts off at 2·10 the stroke, diameter of air-pump 22in., size of injector pipe 5in.—YOUNG ENGINEER.

[56824.]—**Watch Work.**—Would any reader kindly inform me how to fasten ruby pin in roller?—and oblige—T. W.

[56825.]—**Mechanical Questions.**—Will any of the readers of "Ours" oblige by working out the answers to the following two questions in Applied Mechanics and they will oblige a student? 1st, A beam of fir, supported at each end, is inclined at an angle of 60deg. to the horizon, and is loaded at the centre of its length with a weight of 1 ton. The length of the beam is 10ft. and its breadth is 2in. Find its depth, the breaking load on the centre of a beam 1ft. long, 1in. broad, and 1in. deep, and supported at the ends in a horizontal position, being 450lb.—STUDENT.

[56826.]—**Loss of Power.**—A weight of ½ ton is moved on well lubricated cast-iron plane surfaces, such as the V grooves in a planing machine, and moves to and fro through 4ft. making two double strokes per minute. Estimate in-foot pounds the loss of work in moving this mass and bringing it to rest, and in overcoming the friction of the rubbing surfaces,—STUDENT.

[56827.]—**Large and Small Chilled Rolls.**—Will any reader of the ENGLISH MECHANIC oblige one doubtful with the proportions of metals for the above, to give chill from 1in. to 2in., and if it is right to set chill moulds aslant in casting?—A CONSTANT READER.

[56828.]—**Hot Water Pipes.**—You have an ordinary flow and return pipe running along a landing one above the other, a certain distance above the boards, i.e., not under the floor. Now can you dip these pipes in order to get past a doorway that has no step, provided the relative position is the same where they go under the boards, past the door, i.e., one above the other?—S. F.

[56829.]—**Paraffin Lamps.**—To MR. POSTLETHWAITE.—I have read your letter *re* Paraffin Oil Lamps in the ENGLISH MECHANIC, No. 24266, with much interest. Soon after the Silber lamp came out, I tested it against the Duplex and Capt. Doty's burner. I regret to say I have since lost the notes I then made, but distinctly remember that I then considered I obtained more light from the Silber than either of the others for the same money, and that at that time the Silber cost ½d. per hour, the oil, I think, costing 2s. 6d. per gallon. My object in troubling you with this letter is to beg that you will give us the results of your experiments, and a description of the lamp of 22c.p., that you can burn continuously for 132 hours. I also use a magic-lantern with oxycalcium, and Newton three-wick petroleum lamp, in which, by the way, I always think there must be loss of light from the fact of the three wicks being all set "edge on."—E. E. MONTFORD.

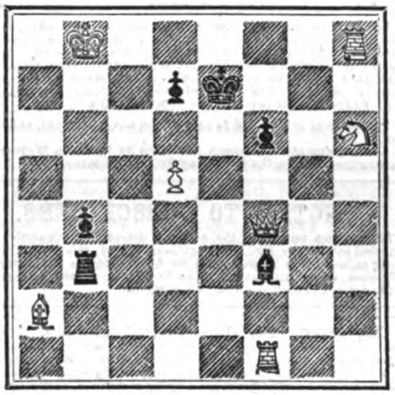
[56830.]—**Pianoforte Making.**—To MR. DAVIES.—In Vol. XXVII. you wrote some articles on "How to Make a Pianoforte." Will you kindly answer one or two queries? In article II. you describe the bellying of the soundboard, but there is nothing said about the back of ditto. I suppose there is a back, or is not one wanted? Then, again, is there nothing besides the traverse bars to support the soundboard, and do they (the bars) rest on the bracings at the ends or not? Surely the thin soundboard would not bear the downward pressure of all the strings. I cannot get the first article, as the number is out of print; so would you give me the sizes of the framework, and the manner in which put together? Is there any bracing required between the two outside bracings?—A PIANOFORTE.

## CHESS.

ALL Communications for this department must be addressed to J. PIERCE, Langley House, Dorking.

PROBLEM DCCCCXLIII.—PATHFINDER.

*Black.*



*White.* [7+6

White to play and mate in two moves.

SOLUTION TO 941.

| *White.* | *Black.* |
|---|---|
| 1. B-K B 5 | 1. Anything. |
| 2. Q, R B or Kt mates. | |

(Eight variations.)

NOTICES TO CORRESPONDENTS.

CORRECT solutions to 940 by J. A. Miles (very fine problem), G. T. Stringfellow, T. L. Robins, A. A. E. Lecluse (very fine), F. O'N. H., I. H. (but main variation 1. K-K 2, not given).

To 941 by J. A. Miles (a block of the old type, and key move very stale), G. T. Stringfellow, Streetgate, A. W. Orr, A. A. Lecluse (ingenious), Rev. W. Anderson (Old Romney), R. F. Sunderland, I. H., J. E. Piper (the best that has appeared), R. A. Bennett, S. L. Chivers.

To 942 by E. S. (admirable) and Rev. W. Anderson (Old Romney).

I. H.—Of course you start at a disadvantage; but it is impossible to foresee the result yet, as there are several problems to follow, therefore we recommend you by all means to compete.

F. A. VINCENT.—You have probably noticed that the problem is quite correct.

J. M. (Ealing), AND F. B. WEBB.—You have overlooked in 941, that if 1. Q takes P, Kt discs. (ch).

C. W. Last.—Game received with thanks.

**Every Workman** connected with the Building Trades requiring a Situation should advertise in "THE BUILDING NEWS," published every FRIDAY, price Fourpence, at 332, Strand, London, W.C.

"THE BUILDING NEWS" is the Principal Journal representing Architects and Builders, and has the largest circulation of any Professional Journal in the kingdom.

Every Workman should insist on seeing "THE BUILDING NEWS" every week at his Club or Coffee House. He will find more "Lists of Tenders" for new work in it every week than in any similar paper, and can thus judge where work is likely to be had. He is also specially invited to make use of "Intercommunication" if he wants to know anything about his trade; to write to the Editor if he has any suggestions to make, and to advertise in the paper when he wants work.

The charge for Advertisements for Situations is One Shilling for Twenty-four Words, and Sixpence for every Eight Words after.

## ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

*** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, June 10th, and unacknowledged elsewhere:—

MORRIS COHEN.—W. Ryan, C.E.—Bausch and Lomb Optical Co.—A. J. Herbert.—Centaur Cycle Co.—W. Munro.—J. Parnell.—J. M. Chadwick.—R. T. Lewis.—C. Richardson.—G. M. Heaven.—W. Jesse Lovett.—Tiller.—D. Booth.—Penwith.—Egroeg.—Num Skull.—Isaac W. Ward.—F. A. M.—Wild Rushes.—Alexander.—Rosicrucian.—W. Bundy.—W. R. A.—G. Bouron.—W. H. O.—Rev. Jas. Pearson.—Bouclier Ignorant.—H. Cambourne.—E. R. H.—T. H. and S.—Eyepiece.—T. H. L.—A Fellow of the Royal Astronomical Society.—Meniscus.

A CONSTANT READER. (Steel such as is used for making files or drills will answer. In what way does your steel fail? Do you use a lubricant, such as water, when boring?)—PLODDER. (Joy's valve-gear has been explained many times in our columns. You will find an illustration of it as applied to a locomotive in No. 954.)—C. REVELL. (You should have stated whether you meant the mercurial process used for looking glasses, or the silver process for telescope mirrors. You will find the latter described in Vol. XXXIV., pp. 22, 38, 91, 111, 187, 285, 308, 463, &c.)—OUBA JUTHOS. (Query is of too limited interest. There is nothing to prevent you adopting chemistry as a profession; but if you cannot attend a series of laboratory lectures you have a very small chance of obtaining sufficient knowledge to secure an appointment as chemist.)—F. J. L. (Try benzine. Turpentine is usually effective.)—ALFRED SEDGLEY. (For general description of the gyroscope, see p. 225, No. 946. See also the indices. Your query should have asked for specific information, as it is impossible to repeat general descriptions in order to possibly enable a querist to discover a defect.)—VALERIA. (For lacquering brasswork, see the indices. It is difficult work, to be learned only by practice. The work must be as hot as can be held, or rather hotter, and the brush should not be taken over the same place twice. Recipes for making lacquer have been frequently given; but it is cheaper and better to buy.)—J. E. PATTERSON. (It is a male specimen of the cockchafer or May beetle (Melolontha vulgaris), which lives for about a week. The female burrows into the earth and deposits her eggs, which soon hatch into little white maggots, that commence at once an attack upon the roots of grass, wheat, potatoes, and almost anything vegetable, which lasts for three years, when the grubs have grown to a considerable size, and almost burst their skins with fat. At the end of three years the grubs cease eating, and commence the metamorphosis, issuing about the end of May or beginning of June in perfect form as a beetle, like that sent. In that stage they do a great deal of damage to trees, and are a great nuisance in the evening, flying about here and there, and not unfrequently catching the pedestrian a smart blow on the face. At present, no method of dealing with the grubs is known, as they bury themselves deep enough to keep out of the reach of any insecticide. Rooks, however, dig them up, and follow the plough in search of them. The beetles can, however, be destroyed by placing a cloth under trees infested with them and shaking the branches, emptying the beetles into boiling hot water. That must be done in the daytime when they are reposing on the undersides of the leaves.)—ARTIST. (It is best prepared by heating nitrate of ammonia. See a textbook on chemistry, or the indices of back volumes. It is useful as an anæsthetic, but should not be played with.)—H. B. (The address is—Secretary, Science and Art Department, South Kensington.)—BIRMINGHAM. (The instrument is worked by a spring in the usual manner. The coin simply releases the detent by falling on a lever, and is itself tested by the size of the slot and by the fact that it moves the lever, to do which it must be up to weight.)—LUMP. (You must let a medical man examine it.)—IGNORANT. (It seems simple enough, and the defects are probably only in the surfaces in contact. The falling arm is, we presume, insulated.)—NOTTINGHAM. (It is known as Lucas's paradox, and you will find all about it in Vol. XXVI. with illustrations. See p. 532, that volume, for instance. If you try again, you will find that the fitting is not accurate, and that a space equal to one square inch is uncovered.)—ASTON ON RIBBLE. (It is indiarubber mixed with sulphur and vulcanised under the influences of heat and pressure. Steam supplies both heat and pressure, as in the dentist's vulcaniser.)—F. HASKE. (Yes, the broad gauge was in use on the Metropolitan Railway when it opened. The line was laid with both gauges.)—G. MITCHELL. (See the article on p. 292. Any reduction of pressure puts all the brakes on. If a brake cylinder is injured so as to be inoperative, it is cut out of the system by turning a tap. The arrangements and the mode of working have been frequently explained in back volumes.)—R. E. C. (If you mean Dagam wood, you will find all we know about it on p. 279, last volume.)—W. P. (We do not know; but the principle is old. It is a question of the neatest and best way of utilising it.)—Engineer. (You can be apprenticed for the sum named to a mechanical engineer; but it would be advisable to seek a shop in which they do general repairs as well as make engines.)—Turk. (If you would only look through back volumes you would find ample information about French polishing. See pp. 175, 227, Vol. XXXII., for instance. You might wait until such a query reached the U.Q. column, for it is tolerably certain that it has not been answered because so much information on the subject has been given before.)—G. M. H. (See indices. Electric bells are scarcely novelties nowadays, and you can get the parts from any of the dealers.)—Poor Man. (The only thing that can be done is to obtain the best medical advice. We do not know of any institution for such cases.)—James R. Hargan. (We do not remember the "controversy," and would advise you to consult an ophthalmologist if there is anything the matter with your eyes.)—Amateur Binder. (See indices, or p. 377, Vol. XXX. For illustrations of the lying press and plough, procure a list from the makers. No. 388 contains a hand press, and No. 613 a plough and stitching frame in an article on Amateur Bookbinding.)—A Sister's Friend. (It is a hard case, but you can do nothing if your sister is a consenting party; or if she is not, you are equally powerless if she is over 16.)—One in a Fix. (It can be stamped at any time on payment of a £10 penalty. The copy retained by the apprentice need not be stamped at all.)—S. Smith. (You will have to send it to the makers; but you will save time and money by throwing it away and getting a proper filter with an animal charcoal or spongy iron filtering block accessible at pleasure, so that it can be scrubbed or scraped clean once a fortnight.)—Albert H. Williams. (You should have repeated the query. If it has not appeared this week, and has not been replied to in this column, it has either not reached us, or is against the rule of "Hints to Correspondents No. 4.")

## USEFUL AND SCIENTIFIC NOTES.

**Verbascum for Consumption.**—From time immemorial verbascum has enjoyed considerable reputation as a remedy for phthisis. The Irish peasants employ by preference the leaves of the large Verbascum thapsus. They use 100 grammes of the fresh leaves or 30 of the dried in a litre of fresh goat's milk: this mixture, allowed to macerate for ten minutes, is then filtered, sweetened, and drunk warm. Two or three litres are consumed every day. Dr. Quinlan has tried this treatment for a period of two years in 127 patients. He believes that in the premonitory and "pre-tubercular" stage of consumption, the remedy possesses curative and nutritive properties more marked than those of cod-liver oil, and nearly equal to those of koumiss. The increase of body weight is certainly due to the verbascum, since the milk alone does not yield the same results. The remedy effectually relieves cough, checks diarrhœa, and alleviates all the symptoms of consumption except the sweatings. The leaves, smoked like tobacco, relieve the symptoms of irritation of the respiratory passages. —*Lancet*.

**Metre v. Yard: Kilo v. Pound.**—Writing in an American journal, Mr. Coleman Sellers says: "If a bar of ordinary forged iron be planed up to measure 1in. square, and the bar be one English yard long, it will weigh 10lb., and the tenth of such a bar will weigh 1lb. more accurately than will the ordinary litre of water weigh 1 kilo. The English engineer, in these days of iron, knows when he uses shapes of iron, rolled of uniform section, that the tenth of their weight in pounds per yard gives him the area of the section, and this one admirable incident will long fix the desirability of the present unit of England and America."

With the object of producing manganese copper in a readier and less expensive way than at present, Mr. G. A. Dick melts pure copper in a crucible with ferro-manganese containing a large percentage of manganese, and in the presence of silicium. When pouring out into ordinary moulds, the manganese will be found to have combined with the copper, and the silicium with the iron, the latter forming a layer upon the manganese copper. The greater the amount of silicium present the more perfect is the separation, though even so small a quantity as 1 per cent. of silicium as compared with the manganese present suffices for the desired effect. In some cases the ferro-manganese contains in itself sufficient quantity of silicium to produce the necessary reaction upon the iron so as to set the manganese free to combine with the copper.

**Epps's Cocoa.**—Grateful and Comforting:—"By a thorough knowledge of the natural laws which govern the operations of digestion and nutrition, and by a careful application of the fine properties of well-selected Cocoa, Mr. Epps has provided our breakfast tables with a delicately flavoured beverage which may save us many heavy doctors' bills. It is by the judicious use of such articles of diet that a constitution may be gradually built up until strong enough to resist every tendency to disease. Hundreds of subtle maladies are floating around us ready to attack wherever there is a weak point. We may escape many a fatal shaft by keeping ourselves well fortified with pure blood and a properly nourished frame."—*Civil Service Gazette*.—Made simply with boiling water or milk. Sold only in packets, labelled—"JAMES EPPS and CO., Homœopathic Chemists, London."—Also makers of Epps's Chocolate Essence

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5s. 6d. for Six Months and 11s. for Twelve months, Post Free to any part of the United Kingdom. For the United States, 13s., or 3 dols. 25c. gold; to France or Belgium, 13s., or 16f. 50c.; to India (via Brindisi), 15s. 2d.; to New Zealand, the Cape, the West Indies, Canada, Nova Scotia, Natal, or any of the Australian Colonies, 13s.

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Messrs. JAMES W. QUEEN and Co., of 924, Chestnut-street, Philadelphia, are authorised to receive subscriptions for the United States for the ENGLISH MECHANIC, at the rate of 3 dols. 25c. gold, or Thirteen Shillings per annum, post free. The copies will be forwarded direct by mail from the publishing office in London. All subscriptions will commence with the number first issued after the receipt of the subscription. If back numbers are required to complete volumes, they must be paid for at the rate of 4d. each copy, to cover extra postage.

Vols. IV., VII., XXVI., XXVIII., XXX., XXXII., XXXIII., XXXIV., XXXV., XXXVI., XXXVII., XXXVIII., XXXIX., and XL., bound in cloth, 7s. each. Post free, 7s. 9d.

All the other bound volumes are out of print. Subscribers would do well to order volumes as soon as possible after the conclusion of each half-yearly volume in February and August, as only a limited number are bound up, and these soon run out of print. Most of our back numbers can be had singly, price 2d. each, through any bookseller or newsagent, or 2½d. each, post free from the office (except index numbers, which are 3d. each, or post free, 3½d.)

Indexes for Vols. I., VI., VII., VIII., and IX., 2d. each. Post free 2½d. each. Indexes to Vol. XI. and to subsequent vols., 3d. each, or post free, 3½d. Cases for binding, 1s. 6d. each.

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*** It must be borne in mind that no Displayed advertisements can appear in the "Sixpenny Sale Column." All advertisements must be prepaid; no reduction is made on repeated insertions; and in cases where the amount sent exceeds One Shilling, the publisher would be grateful if a P.O.O. could be sent, and not stamps. Stamps, however (preferably halfpenny stamps), may be sent where it is inconvenient to obtain P.O.O's.

The address is included as part of the advertisement, and charged for.

Advertisements *must* reach the office by 1 p.m. on Wednesday, to insure insertion in the following Friday's number.

## NOTICE TO SUBSCRIBERS.

Subscribers receiving their copies direct from the office are requested to observe that the last number of the term for which their subscription is paid will be forwarded to them in a PINK Wrapper, as an intimation that a fresh remittance is necessary, if it is desired to continue the Subscription.

**Holloway's Pills.**—Throughout the seasons good health may be maintained by occasional doses of Holloway's Pills, which purify the blood and act as wholesome stimulants to the skin, stomach, liver, bowels, and kidneys. By a timely recourse to them the first erring function may be reclaimed, suffering spared, and life saved.—[ADVT.]

## OUR EXCHANGE COLUMN.

*The charge for Exchange Notices is 3d. for the first 24 words, and 3d. for every succeeding 8 words.*

**Good Value Offered** (cash or instruments) for all kinds of sound or repairable Scientific Appliances.—Caplatzi, Science Depot, Chenies-street, near British Museum. Established 1862.

**Lathe Head,** 7in., cones for lathe wheels and lathe heads, gut, turned and bored bicycle fittings. Exchange offers to W. Smith, Bilston-road, Wolverhampton.

Wanted, collection of above 1,000 **Stamps** in exchange for Books, Scarf Pin, Electric Bell, Batteries, and other Electrical Apparatus.—H. Bunting, Didsbury.

"**Electrical Reviews,**" bound: also English Mechanic (unbound), several volumes of each. Offers wanted. Also some Electrical Apparatus.—R. C., 1, Canonbury-lane, Islington, N.

**Dynamo Castings,** 800 c.p., with all fittings, on mahogany bed, nearly ready for using. Exchange for 54 Bicycle, or Photographic, or offers. Also Lamp and Bunsen Batteries.—C. H. Hatch, Alderley Edge, Nr. Manchester.

Four Vols., from 1 to 48 parts of "**Science for All,**" illustrated, clean, unbound. Exchange Model Engine, or offers. —R. Walker, James-street, West Stanley, R. S. O. Durham.

What offers for Tait's Double-action **Air Pump,** 7in. plate (equal to new), four receivers, Induction Coil, 1in. spark, 1 dozen vacuum tubes, 4-cell and 2-cell Bichromate Batteries, 20-candle Dynamo, with wire, unfinished, and sundries. Want good whole-plate Photo. Lenses and Burnisher.—G. M., 12, Victoria-road, Twickenham.

Victoria 2-Lens **Camera,** nearly new; 100 Sheets Albuminised Paper, quantity of Gem and Victoria Mounts, &c., &c., for good Microscope, or anything useful.—W. Sharpe, Madeley, Salop.

What offers, 30 2s. parts of "**Modern Mechanical** Engineering and Machine Making," by R. Scott Burns.—W. N. Cooper, 21, Upper Park, London, N.

**Lathe,** 3in. centre, complete, value £4. Exchange for 53 or 54in. Bicycle; must be in good condition.—A. E. Bowers, 5, Gloucester-road, Kew, S.W.

Exchange good Cocoa Concert **Flute,** 8 German-silver keys, mounted on pillars, for ½-plate Bellows, Camera, and Backs for dry-plate work.—R. D. Abney, Malahide, Co. Dublin.

56in. **Bicycle,** dropped handles, gunmetal hubs, suspension saddle, lamps, &c., thorough order. Exchange.—C. Braddock, jun., Long Ditton, Surrey.

**Tricycle Lamp,** in good condition, cost 15s. Offers exchange.—P. G., 112, Belvedere-road, Lambeth, S.E.

New hand-power radial **Bench Drilling Machine,** takes 3ft. diameter, self-acting variable feed, quick return, instantly charged. Offers invited.—Henry Kilburn, Bishop Auckland.

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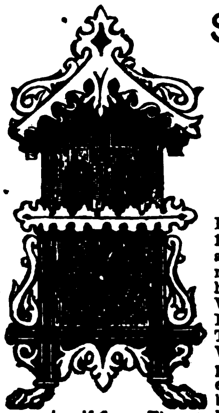

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The English Mechanic
AND WORLD OF SCIENCE AND ART.
*FRIDAY, JUNE* 19, 1885.

## GAS AND ITS APPLICATIONS.

THE meeting of the Gas Institute last week, and the action of the Council of the Parkes Museum in promoting a series of exhibitions of apparatus for utilising gas in cooking, heating, lighting, &c., both afford evidence of the greater interest which is now taken in gas by those immediately concerned in its manufacture and by the general public. The success of the electric light, limited as it may be in this country, is still sufficient to teach gas managers that there is at least a possibility of considerable development, and though they know very well that they have nothing really to fear from the competition of electricity, it is certain that those interested in gas have of late years exhibited a little more desire for progress than could have been discovered before the electric light demonstrated its capability of becoming a formidable rival to gas as the illuminant of the public streets and large buildings. The gasmen know now that they are quite safe, so long as it is a question of price; but expense is not always a complete measure of the demand for an article, and if electricity does cost more than gas as an illuminating agent, it possesses certain advantages which in many cases will turn the scale in its favour. Alderman Bailey, who welcomed the Gas Institute to Manchester, told the members that he did not care so much for cheap gas: he would prefer to pay more for a better article, and he unquestionably spoke for a large number of consumers who want the best and purest illuminant that can be provided. The question, however, is, Can gas be materially improved as an illuminating agent at a moderate increase in price?—and the answer may be found in the address of the president, Mr. T. Newbigging, C.E., who intimated clearly that managers were looking to the application of gas for cooking, heating, and motive power for their future triumphs. He knows that, as an illuminating agent, gas has nearly reached its possible perfection—that very little more can be done to improve its light-giving power, while a wider field of usefulness is at present comparatively unworked. As it is, the Manchester gas is superior to that supplied to London, for it has an average illuminating power of 20 candles, and there is no "company" to adulterate it with the view of annoying consumers. Gas of higher illuminating power can scarcely be wanted, so that it would appear Alderman Bailey is not satisfied with the purity of the illuminating agent supplied to him, and would be glad to pay more money to have his gas entirely free from sulphur. It must be confessed that there is room for improvement in that direction, for even in the metropolis the gas frequently contains 13 grains of sulphur per 100 cubic feet. It is true that the limit allowed by Act of Parliament is 22 grains per 100 feet, and 4 grains of ammonia in the same quantity. It is well known that the manager is anxious to get all the ammonia possible out of his gas, and as a matter of fact in London he does not leave so much as half a grain in 100 cubic feet. It would be unfair to say that manufacturers of gas are not so anxious about eliminating sulphur, which is valueless, as they are in seizing ammonia; but admitting the difficulty of entirely purifying the gas from sulphur, we might fairly ask for something less than 13 grains per 100 feet. Mr. Newbigging told his hearers that the "resources of civilisation and science are far from being exhausted as regards the developments which may yet take place in gasworks"; but that was in connection with coal-tar products, and the probable increase in the quantity of ammonia seized and converted into liquor—viz., instead of only 30lb. of sulphate of ammonia per ton of coal, the president looks forward to 75lb. and 95lb. of sulphate. To obtain that, much of the coke must be utilised, unless some cheaper means of producing hydrogen than by the decomposition of steam is discovered. Most persons will be surprised to learn, from the carefully prepared returns forwarded to the president of the Gas Institute, that only about 6 per cent. of the total product of the gasworks of the United Kingdom is used for purposes other than lighting, though, making a select list of those districts where special efforts are employed to induce the public to utilise gas for heating and cooking purposes, the proportion rises to 14 per cent. The town of Northampton, it appears, has taken the lead in utilising gas for heating and other purposes connected with the arts, for out of a total consumption of 215 million feet, 90 million are used for purposes other than lighting—viz., in 250 gas-fires, 2,700 cooking and boiling apparatus, 400 small stoves used by shoemakers for heating finishing tools, and 40 gas-engines. Mr. Newbigging is not sanguine that the gas-engine will eventually supplant the steam-engine; but he evidently does look forward to the time when a more extended use of gas will solve the smoke problem, or at least reduce the nuisance within the limits of toleration. There is no reason why coal should be used on furnace fires when coke would do at least as well, and the gas makers would be glad to extract the gas, the tar, and the ammonia, and provide work for their plant which, at certain seasons of the year, is necessarily idle for many hours out of the twenty-four. At the Colne Vale Works, Longwood, near Huddersfield, the much-needed reform is being carried out on a small scale, and it is found that the coke from a ton of bituminous coal will do as much work in the furnace of a Lancashire boiler as the ton of coal would have done: if the grate is specially constructed for burning coke the latter will do 15 per cent. more than the coal. Those statements are made on the authority of the manager of the works, and it is obvious that if the coke obtained from a ton of coal will do the work of the coal itself under a steam boiler, then the gas, and the tar, and the ammonia are so much valuable materials wilfully wasted. We are not prepared to accept the statements as data to be relied upon in all conditions; but it is easy to understand that if the coal now sent up the London chimneys were to be taken to the gasworks first, and then distributed as gas and coke, it would be equally beneficial both to the pockets and the lungs of the residents. The president of the Gas Institute denies that the recent advent of the electric light has had the effect of infusing new life into the action of the gas authorities of the kingdom; but he acknowledges that the introduction of the electric light has led to a demand on the part of the public for more light. We are not concerned to split this difference: the important fact is that the gasmen have now an opportunity of showing what they can do, and if they were at once to boldly demand liberty to put down another series of mains, in order to supply cheap heating gas, they would, we believe, meet with little opposition. Mr. Frederick Siemens has taken up this idea of his more distinguished brother, the late Sir W. Siemens, and while endeavouring to introduce his new regenerative gaslight apparatus, which is designed to distribute the light while concealing it from direct vision, is not unmindful of the utilisation of gas for heating and cooking purposes. In this latter connection no one has done more than Mr. Fletcher, of Warrington, whose ingenious contrivances are highly esteemed by all who have tried them. There seems no reason why, with gas as the medium, we should not obtain heat and light at the same time under suitable conditions, and it is certain that as soon as the demand arises there are plenty of inventors ready to supply it. If Mr. F. Siemens' stove and his burner are really all that is claimed, they will go a long way to meet the wants of the public, especially as his lamp is also a ventilating agent, and the stove is more economical than the open coal fire, which is decidedly wasteful, but to English people very cheering. It must not be forgotten that the larger the quantity of gas produced by any given plant, the cheaper the rate at which it can be supplied, and it also follows that if gas companies can themselves utilise all the products of their distillation of coal the greater the advantage to the public. For instance, Mr. J. Hepworth, of Carlisle, suggests that gas companies should make sulphuric acid in their works and use it for converting the ammoniacal liquor into sulphate of ammonia. The spent oxide of iron, when discarded from the gasworks, contains on the average 50 per cent. of sulphur, and there is no doubt that it could be more economically utilised *in situ* than in distant works. There is a tendency amongst gas companies to thoroughly exhaust the coal on their premises, to utilise every by-product which can be turned to account, and to discard only the rubbish—rubbish because no use has yet been found for it; and there seems no reason why, as manufacturers, they should not get all that is possible out of the crude material they import. The utilisation of gas for motive-power purposes has recently met with a serious check, for it has been demonstrated that a gas suitable for exploding in engines can be more cheaply made by decomposing steam; and though for convenience small power-users will still employ the gas supplied for illuminating purposes, with the increase in the number of gas-engines, there will not be a proportionate increase in the consumption of coal-gas, for those who have sufficient space will erect the Dowson, the Wilson, or the Strong apparatus for producing a mixture of hydrogen and carbonic oxide by passing steam through incandescent coke. We have already described the Dowson process, which yields a suitable gas at the rate of about 3d. per 1,000 cubic feet. A larger quantity of that is required than is the case with coal-gas; but an expenditure of about 1s. enables the same quantity of work to be done as can be accomplished with 1,000 cubic feet of the richest coal-gas. As a matter of fact the Dowson gas gives one indicated horse-power for every 1·2lb. of coal, while the best steam engines require at least 1·5lb., and can do with so small a quantity only when the steam is passed through three cylinders. For that reason gas managers have ceased to look for any very great demand from the users of power; but they are wisely turning their attention to the development of cooking and heating applications, though even in those fields they have a formidable opponent in the so-called "water gas," which in Germany is now made by the aid of refuse coal, and is utilised for illuminating purposes by rendering wires and rods of magnesia incandescent. Water-gas, however, is not yet laid on and supplied through a service of pipes, and it is doubtful if it ever will be, at least in towns, for the absence of any smell is a decided objection to its use for ordinary domestic purposes, on account of the difficulty of discovering any leakage. In the United States that danger is surmounted by carburetting the gas with petroleum, which not only renders it illuminating, but also

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imparts to it what may be termed a safety odour. Producer gas has a future before it in connection with gas-engines, but where steam boilers are used it will probably be found more economical to burn coke. Altogether it may be said that the importance of gas, whether "coal" or "water," is at last beginning to be recognised by the public, and we may probably yet see London without its smoky pall even in November.

## REVIEWS.

*Ballooning: a Concise Sketch of its History and Principles.* By G. MAY. London: Symons and Co.

THIS concise little sketch of the art of aërostatics is published at an opportune time—just when attention has been directed to the subject by the alleged successes of the French experts and an exhibition of aëronautics is to be held at the Alexandra Palace. Mr. May gives us an historical *résumé* of the earlier attempts at aërial navigation, and enters into more detail in connection with the latest exploits. So far his work will be useful to those who desire to acquaint themselves with what has already been done, but we fail to find that the author has any practical suggestions to make. He thinks that it would be "venturesome to assert that aërial navigation has no future, looking to what it has accomplished during the past century," which is certainly very little indeed; but we are quite ready to agree with the author that "it is quite within the scope of discovery to contrive some appliance partly to effect a more practical solution of the difficult problem of balloon steering." Aërial navigation is at present a misnomer, for so long as it is necessary to overcome the effect of gravity by means of a huge vessel of gas to give ascensional power and support in the air, not much will be done in the way of steering or pursuing a definite course. It may be possible by the aid of sails, rudders, propellers, &c., to exercise some little influence on the direction taken by a balloon; but, after all, it must go the way the wind blows it. Most people will agree with Mr. May when he says that "manifestly, aërial travelling will never be cheaper than by railway or steamboat." The book, which is issued in the "Specialist's Series," edited by Dr. Paget Higgs, contains illustrations of Giffard's balloon, Tissandier's device, with the propelling apparatus and the plant for making hydrogen, and the more recent device of Renard and Krebs. It will be very useful to those who want to know what has already been done, and have no time to hunt up the records.

*Pattern Making.* By A FOREMAN PATTERN MAKER. London: Crosby Lockwood and Co.

IT is not necessary to do much more than state that this volume is mainly a reprint of the articles which have recently appeared in these columns. Our readers have been able to form their own opinions of their practical utility, and many of them will be glad to have the matter in the handy form presented to us by Messrs. Lockwood. The articles have, we need scarcely say, been revised and corrected, have been expanded by the incorporation of new matter, additional sketches, and useful tables, while a copious index will now afford the means of readily referring to any point on which information is required. The volume is dedicated to the author's fellow workmen, to draughtsmen who have not had a practical training in the shops, to pupils, managers, and employers—in short, to all who seek more than a mere smattering of knowledge and desire to learn not only the best practices, but also why they are the best. More than 370 illustrations help to explain the text, which is, however, always clear and explicit, thus rendering the work an excellent vade-mecum for the apprentice who desires to become master of his trade.

*The Chemistry of Cookery.* By W. MATTIEU WILLIAMS. London: Chatto and Windus.

BY the noble army of cooks, if they condescend to read this work, many of the opinions expressed by Mr. Mattieu Williams will be denounced as rank heresy; but the author has made almost a life-long study of the subject, and deals with the science of cookery as opposed to the mystery of the cuisine. It is nearly thirty years ago since the author first touched on the subject in lectures delivered at the then infant Birmingham and Midland Institute, and in that interval little if anything has been done by anyone else in working out the chemistry of cookery. The "chemistry of food" has been dealt with often enough, but the chemistry of cookery is of as much importance, and those who will read what Mr. Mattieu Williams has to say will find a good deal of suggestive material for further investigation. For instance, cheese, as we suppose every one knows, contains weight for weight more nutritious material than any other food ordinarily obtainable; but, as Mr. Williams says, its cookery is singularly neglected, and is practically an unknown art in this country, while all that is required to render cheese, next to bread, the staple food of Britons is scientific cookery. We will quote one of the recipes given by the author, because it contains an important note which it is necessary to observe if cheese is made a staple food. Take a ¼lb. of grated cheese; add to it a gill of milk, in which is dissolved as much powdered bicarbonate of potash as will stand upon a threepenny piece. Heat carefully until the cheese is completely dissolved; then beat up three eggs, yolks and whites together, and add to this solution, stirring the whole. Put a little butter into a shallow dish or tray that will bear heating, and when the butter frizzles pour the mixture in and bake or fry until it is nearly solidified. Mustard, pepper, &c., are to be added to the solution of cheese, "according to taste," and Mr. Williams says that if a cheaper dish is desired the proportion of cheese to eggs may be increased. The carbonate of potash is the novelty in this recipe, and its use is advocated because it effects a better solution of the casein by neutralising the free lactic acid in the milk and any remaining in the cheese; also, more importantly, because it restores to the cheese the salts of potash which were left behind in the whey. Milk is not necessary, as the cheese may be dissolved in water by grating or thinly slicing it into its own bulk of water in which carbonate of potash has been dissolved at the rate of about a quarter of an ounce to a pound of cheese. This solution of cheese is to be added to porridge, to mashed baked potatoes, to hasty pudding, to rice, and so on. The chapter on Count Rumford's Cookery and cheap dinners should be studied carefully in these times, but in all the nineteen chapters into which the work is divided there is much both to interest and to instruct the general reader, while deserving the attention of the "dietetic reformer."

*The Moon and the Weather.* By WALTER L. BROWNE. London; Baillière, Tindall, and Cox.

IN the preface to this work the author says that "the lunar theory is often spoken of, but no attempt is made to demonstrate that theory; not because such demonstration is impossible, for it can be demonstrated, and its truth decided in the most positive manner." The reason why the lunar theory is not demonstrated we are left to guess; but we have a number of assertions, a remarkable specimen being the statement that "the weather, in its larger and minute variations, must be governed by law, or there can be no such thing as a science." The author says that this law is "periodical and recurring"; but all we know about it is that if certain causes are acting certain effects will follow. There is no periodicity about them, except, perhaps, in given localities, so far as the major effects are concerned. Local conditions have indisputably more effect on weather and climate than any supposed lunar influences; and, as a matter of fact, the author's opening statement puts the case clearly, for he writes, "It has been asserted over and over again by most scientific men of the present day that the moon has no influence on the weather"—an assertion which is either incorrect or true; but if incorrect it should be an easy matter to demonstrate it. We have been unable to find any demonstration of lunar influence on weather in these pages, and we quite agree with the author when he says that "the weather enigma is yet an unsolved problem." His work will, however, interest a limited class, and more especially those who have rival hypotheses.

*Supplement to "Euclid and his Modern Rivals."* By C. L. DODGSON. London: Macmillan and Co.

WE reviewed Mr. Dodgson's "Euclid and his Modern Rivals" on p. 174, Vol. XXIX., and this supplement will be read with renewed interest, for so far none of the numerous writers on geometry has gained much *kudos* in the controversy. The supplement, which is paged continuously with the work, is a criticism, in the form of a dialogue between "Niemand" and "Minos," of Professor Henrici's "Elementary Geometry," and it is at once interesting and amusing, for Mr. Dodgson is a master of his subject, and a very able defender of Euclid. Prof. Sylvester was, we believe, the first to suggest that Euclid ought to be banished from our schools, and, as we know, books on geometry have been produced by the score; but the time-honoured work of the Alexandrian Geometer, with all its faults—if faults they are—still holds its own, while those of his modern rivals suffer considerably at the hands of this genial if caustic critic.

We have also received *The Works' Manager's Handbook*, by WALTER S. HUTTON (London: Crosby Lockwood and Co.), a valuable book of modern rules, tables, and data, which has rapidly reached a second edition. Some new matter has been added, and the errors of the first edition, almost unavoidable in a work of such magnitude, have been corrected. It will fill a useful place in the library of every engineering works. *Technological Dictionary*, Part II., German—English, by F. J. WERSHOVEN, D.Sc. (London: Symons and Co.), is a handy vocabulary of technical terms used in the physical, mechanical, and chemical sciences.——*German Grammar and Reader*, by EMIL BEYER (London: D. Nutt), is written expressly for the use of science students and those who have little time to work through the more elaborate works; the most important features of the new German spelling are pointed out, and it may be recommended to those who are desirous of rapidly acquiring a sufficient acquaintance with the principles of the German language to enable them to read scientific treatises with comparative ease.——*Practical Problems and Lines for Working Drawings* (Manchester: Abel Heywood and Son), is a volume embracing within its limits a variety of problems, rules, and calculations which may be of service in the routine of the workshop.——*The Magic Lantern Manual*, by W. J. CHADWICK (London: Frederick Warne and Co.), is the second edition of a little work which should be in the library of all users of the lantern.——*The Winds*, by W. Leighton Jordan (London: David Bogue), is the third edition, revised and abridged, of a little work which forms the third and fourth chapters of the author's "New Principles of Natural Philosophy."——*William Hedley, the Inventor of Railway Locomotion* (Crosby Lockwood and Co.), is the third edition, with additional matter, of Mr. M. Archer's brochure, in which he shows that William Hedley can claim to be the first to make the locomotive a practical success.——*Of the Origin and Reproduction of Animal and Vegetable Life on our Globe*, by Thomas Spencer, F.C.S., F.R.M.S., &c. (London: Effingham Wilson), is an attempt to show that suboxide of iron causes the formation of carbonic acid from its elements, and is the origin of animal and vegetable life.——*On the Principles of Electric Lighting*, by Sydney F. Walker, M.S.T.E. and E. (Newcastle-on-Tyne: Andrew Reid), is a paper specially written for engineers, and gives all the information needed by practical men to apply the principles set forth. It is freely illustrated with a number of useful plates, and will be found valuable by all engaged in electric lighting.——*The Theory and Action of the Steam Engine*, by W. H. Northcott (Cassell and Co.), is the fourth edition of a deservedly appreciated treatise on the steam-engine specially written for practical men.——*Walks in Epping Forest*, edited by Percy Lindley (London: 123, 125, Fleet-street, E.C.), is a well-written, beautifully-illustrated guide to Epping Forest, useful alike to the pedestrian and the cyclist, and also the horseman. All the principal points are well described and mostly illustrated, and there is a chapter on the fauna and flora of the forest by A. H. Wall and the editor, and one on its geology by Horace B. Woodward, F.G.S. Those who wish to pay a visit to Epping Forest should procure this guide, read it, and take it with them.

We have also to acknowledge *Twenty Years with the Indicator*, by Thos. Pray, Jun. (New York: Wiley and Sons; London: E. and F. N. Spon); *Locomotive Engine Running and Management*, by Angus Sinclair (New York: Wiley and Sons; London: Trubner); *Gas Engines*, by William Macgregor (London: Symons and Co); and *The Structure of the Wool Fibre*, by F. H. Bowman, D.Sc. (Manchester: Palmer and Howe), all of which require a more lengthy notice than can be given under this heading.

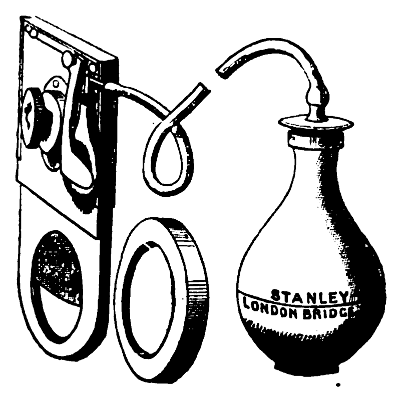
## THE INTERNATIONAL INVENTIONS EXHIBITION.—VII.

### Machine Tools and Machinery.

For some reason or other machine tools and machinery are placed in Group X., and Group XI. is supposed to be devoted to hydraulic machines, presses, machines for raising heavy weights, &c. So far as the visitor is concerned, no particular harm is done, as the two groups are located close together, and an inspection of the stands will show that there is very little difference in the nature of the exhibits, which are mixed, as will be seen further on. Perhaps the most remarkable "group" in the whole exhibition is No. XII., which is supposed to be devoted to the elements of machines, and which has less than half a dozen exhibits, two of those being improvements in lock-nuts! An exhibit which really does belong to "elements of machines"—the collection of educational models shown by Mr. J. Rigg—is placed amongst the philosophical instruments in Group XXVIII. There may be some explanation of so eccentric an arrangement, which helps to increase the bulk of the catalogue without any corresponding advantage to either visitors or exhibitors. We will deal with the three groups as one. Judged by the space it occupies, the cask-making machinery of Ransome and Co. is an important exhibit: it certainly attracts a crowd, but is scarcely a novelty, though very interesting. They also show samples of their steam tree-feller, consisting of a saw attached to the piston-rod of a steam cylinder, a device also exhibited by Worssam and Co. The group contains a number of machines which it is impossible to describe without engravings, and also many which, while of great value, are not of much interest to the general body of readers. Greenwood and Batley, of Leeds, for instance, have an interesting collection of machine tools, including Parker's automatic screw-making machine, one or two milling machines, and an automatic grinding lathe for backing off twist drills, in which a little emery wheel clears away metal behind the cutting edge, thus enabling the drill to run freely in the hole with the minimum of friction. Emery-wheels of various sizes are shown by several makers, notably by A. H. Bateman, East Greenwich, who also exhibits specimens of work done by them, such as chilled cast-iron rollers, loco. slide-bars, and Nordenfelt bullets. The famous Tanite wheels are exhibited at the stand of Selig, Sonnenthal, and Co., who have a collection of useful appliances, including patent braiding and winding machines for covering wire, and their patent self-acting band-saw filing machine, which sharpens at the rate of 80 teeth per minute. The file is carried by an arm receiving motion from a crank on the driving shaft, which arm works in a guide readily adjustable for different sizes of saw. The saw is pushed forward by a little pawl which drops behind the front edge of a tooth and, receiving motion from a kind of eccentric, advances the teeth as fast as the file can accomplish the work. A fine screw-cutting lathe with turret head is also shown by this firm. Mr. J. H. Evans, of Wardour-street, exhibits three lathes, one on a wooden frame, and a collection of the ornamental turning appliances which he described in Vol. XXXIII., and subsequently. He also exhibits a number of specimens of ornamental turning in ivory and hard wood, many of which will be recognised by our readers. Messrs. Holtzapffel, of Charing Cross, exhibit fine specimens of their productions in lathes and appliances, and a novelty in the shape of a patent rose chuck, which will probably be described elsewhere in these columns before long. The collection of specimens of ornamental turning shown by this firm contains a number of objects which will be recognised by those who have seen Vol. V. of Holtzapffel's "Turning and Mechanical Manipulation." Pfeil and Co., of St. John-street, show a vertical planing attachment on a 6in. lathe, in which the motion of the tool is automatically reversed. The tool-holder has a branch working on a guide and striking against studs screwed to the guide, which at its upper portion is connected to a weighted crank which puts a movable pinion into gear alternately with two bevel wheels, and so reverses the motion of the screw carrying the tool-holder. The studs being movable, the length of cut can be readily adjusted within the limits of the machine. Near the entrance to the West Gallery there is a case of specimens of the Maindy steel, made by Jenkins Bros. and Co., of Cardiff, which is rapidly coming into favour as a tool steel in preference to the best specimens from Sheffield. Close by is a model of Stewart's patent "rapid" cupola, exhibited by Machell and Co., which, according to several practical trials, yields a ton of iron for 1cwt. of coke. The "Eclipse" jaw-chuck of Storey and Phillips, 62, Holborn Viaduct, can be here seen in some variety and in large sizes. We illustrated and described it on page 192, last volume. Mr. R. K. Jones, of Birkenhead, exhibits some improvements in braces with variable automatic feed, and tools for cutting out circular and elliptical holes in iron plates—e.g., for ships' cabin lights. Mr. Valda, of Chiswick, exhibits an arrangement for preventing the wear of plane irons on the return stroke, which consists of a roller in the front foot of the plane, pressed outwards by a spring, which thus lifts the body of the plane as the pressure is taken off in the return stroke. Mr. Marsden, of Sheffield, exhibits his apparatus for turning shafting, and his patent surface grinding and polishing machine, which consists of a ring holding segmental pieces of grit stone or emery composition, which is revolved against the face of the work. Planing is said to be not merely superseded but surpassed by the use of this machine. Perhaps the most interesting exhibit in Group X. is the stone-working machinery of Brunton and Trier, of Westminster. The ingenious application of a hollow cone of thin steel as a cutter for truing the faces of grindstones has already been mentioned in our columns; but the manner in which it is set, with sighting arrangements for adjusting it to put a perfectly true face on the stone, will commend this invention to those who have tools which require sharpening frequently. Their lathe for turning pillars of stone has a solid cutter of the disc pattern, but for the softer kinds the cutter is usually of chilled cast iron in the form of a hollow cone, the working edge being always the hardened surface. The most interesting machine in the exhibit of Messrs. Brunton and Trier is, however, the new moulding machine, provided with horizontal and vertical chucks, each carrying four cutters, so arranged that the cutters on the separate chucks clear one another and rapidly cut the moulding on the stone. The cutters fixed are of the cone type, which seems to be just what is wanted for working all the softer kinds of stone, including grit and sandstone. Stauffer's lubricator, which was first described in our columns on p. 249, Vol. XXVIII., and subsequently at greater length in Vol. XXXIX., p. 314, is also exhibited by Brunton and Trier, who find it very useful in connection with their stone-working machinery, as it is entirely closed, and the adhesive nature of the lubricant as it oozes out at the ends of the journals seizes on the flying dust from the stone and prevents it from finding its way into the bearings. Stauffer's lubricator is to be seen on many of the running machines in the exhibition. A novelty exhibited by Brunton and Trier is found in Kaiser's counter, an ingenious device in which all the wheels are locked and cannot move until they are compelled by the revolution of those indicating the smaller numbers. The wheels are all of the same size, and have a gap in the rim, in which a toothed wheel and a sort of pawl engage in such a manner that it is impossible for them to slip, while they are compelled to advance one division as the preceding wheel completes a revolution. This counter is, we understand, not yet in the market. Watts and Co., of Bristol, exhibit a double band-sawing machine, which takes two cuts at the same time in a plank, one saw being placed in advance and to one side of the other. One driving pulley works both saws, thus insuring uniform speed. A very useful general band-saw is shown by Worssam and Co., of Chelsea, in which the standard is made to cant by means of a rack operated by a worm and wheel. The centre of motion, or axis of the canting standard, is that point of the table where the saw passes through, and the saw pulleys being carried by the standard, the angle of the saw can be varied even while at work. All sorts of irregular shaped curves can be cut by this machine. Davis and Son, of Derby, exhibit Hamilton's hand-feed planing and jointing machine, the principal feature of which is the angling table on the feed side, which enables the operator either to cut wood unequally thick transversely, as is frequently required in pattern making, or to trim wood of unequal thickness to uniformity. At Chubb and Sons' stand there is a circular saw cutting through blocks of steel, the saw being lubricated by revolving through a tank containing soap and water. A useful slotting machine is shown by J. Spencer and Co., of Keighley, for either hand or steam power. It can be fixed on the bench or in the vice, or kept on its special standard, while it will cut a keyway perfectly parallel or deeper at one end than the other. An index at one end shows at a glance whether the machine is set for cutting taper or parallel slots, and an ingenious arrangement of a wedge keeps the cutter from the work on the return stroke, while forcing it up to the face on the effective stroke. The "Keyseater" is a machine shown by Harpers, Limited, of Aberdeen, specially designed for cutting keyseats in wheels, &c., however large their diameter. The machine is arranged in a vertical standard, with a table on which the pulley or the work is bolted. The cutter or saw is driven by the shaft in the base of the standard, and, being kept to its work by a hand lever, any desired taper can be given to the slot without adjusting the wheel on the table. Mr. Taylor, of Birmingham, exhibits a collection of his tool-holders, including the screw-cutter, which has a barrel with a swivelling movement, thus enabling V-threads to be cut either right or left hand of almost any diameter with a single cutter. Mr. Taylor also shows a useful parallel grip vice, in which the loose jaw is free to slide backwards and forwards in the slot, while the grip plate catches in the rack and carries the screw by which the jaw is tightened on the work. Mr. Snowdon, of Deronda-road, S.E., exhibits a model of his boring, recessing, and screw-cutting apparatus, which has been used with much satisfaction in boring the holes for fixing armour plates on the *Conqueror* and the *Rodney*. Without illustrations it is useless to attempt to describe this apparatus; but it may be mentioned that it contains a special form of thread-cutting spindle, with an expanding cutter for recessing the bottom of a hole. An automatic index shows the operator the amount of cut at each revolution, and also when the full thread has been completed. Another very interesting exhibit in Group X. is the sheet casks of Mr. F. Andrew, of Botolph-lane, E.C. These are intended for the packing of fish and sundry other articles, and are made either as casks or what may be termed cask-crates. The staves are secured to bands of hoop iron, and are forced into position and headed in a machine. When they have served their purpose as casks they can be opened out into "sheets," and thus occupy little space as returned empties. By attaching the staves to the iron bands at intervals a sort of crate is formed. The art of embossing tinware is shown at the stand of Mr. W. Newell, of Birmingham. The die is carried in a chuck, and the disc of tin-plate, previously stamped to shape, is placed over the die and held by little clips. A burnishing tool is then brought with considerable pressure against the tin-plate, which is at the same time spun into shape and forced into the lines of the die. Messrs. Mintons, of Stoke-upon-Trent, exhibit their apparatus for utilising compressed air in the manufacture of pottery, and the pneumatic arrangement for drawing off the powdered flint as it is ground off the china biscuit ware. The ingenious machinery for packing tobacco and making cigarettes, exhibited by Sales, Pollard, and Co., of Farringdon-road, E.C., will attract the attention of visitors. The cigarette machine is Leblond's patent, and is automatic in its action, the attendant having only to supply the endless band working in a trough with the tobacco. The paper is in the form of a reel at the top of the machine, is cut off to the required length, rolled up into tubes, and passed down a sort of step ladder until it reaches the level of the tobacco trough. Here it finds a portion of the tobacco cut off from the trough, which is immediately driven into it by a plunger, and the cigarette is tumbled off into a receptacle. It is stated that this machine makes cigarettes at the rate of 20,000 a day. Another automatic machine, which is sure to attract groups of admiring visitors, is the paper bagmaking machine exhibited by Mr. Bumsted, of Hednesford. In this the paper is cut from a roll, and pasted and folded entirely by the action of mechanical fingers, the bags being made either square or plain bottom as required, and delivered in a pressed form ready for packing. Visitors to this portion of the exhibition will not fail to inspect the pulsometers, several of which are shown in action, nor the hydraulic machines for riveting &c.; but the engineer or mechanic who stops to look at Tweddell's hydraulic riveters, shown by Fielding and Platt, of Gloucester, will be attracted by a model of a high-speed rotary engine, which is also shown driving a dynamo for electric lighting. This is the Fielding high-speed engine, a device which fairly baffles description. It has four "cylinders," which are not cylinders, but circular cavities, and it is practically a universal joint connecting two shafts which form an angle of about 157 degrees. Two cylinders are mounted on a chair-coupling on each shaft, and the four pistons are carried on a gimbal ring. The engine is compound in the ordinary sense, and is so remarkably compound besides that nothing but an examination of the working model which Messrs. Fielding and Platt have provided will serve to explain the action. The Davey "domestic motor," or safety engine, is exhibited by Hathorn, Davey, and Co., of Leeds, and will doubtless attract the attention of those of our readers who were interested in a recent discussion. The principle of the engine is the production of a vacuum, so that there is no pressure and no risk of explosion whatever. The exhibits of Price's Patent Candle Co. and of J. and J. C. Field will also attract groups of the curious to witness the machines braiding the wicks, and the operations of the lathe employed to turn a spiral on the candles. In this Group (XI.) the chief attractions to the engineer and mechanic are a steam hammer, shown by Glossop and Stacey, of Sheffield, which is self-acting, or controlled by hand, and will give a dead blow for stamping purposes, and Robson's patent gas hammer, exhibited by Tangye Brothers. The cylinder is placed over the anvil as usual; but it contains two pistons, the upper one working in the top half of the cylinder and having the duty of charging the cylinder with a mixture of gas and air, which is drawn in between the two pistons and exploded. The hammer is drawn back by two spiral springs arranged in casings each side of the cylinder, and connected by chains to a crosshead on the rod of the lower, or hammer, piston. Once started, the action is automatic, the admission valve being operated by a cam motion from the flywheel shaft. The force of the blows can be regulated by increasing or diminishing the quantity of explosive mixture admitted. Besides the gas hammer, Messrs. Tangye exhibit a collection of the various machines and appliances made by them, including pumps and hydraulic jacks, electric governors, and self-sustaining blocks. In referring to the last-named device we must mention the sheave blocks of Swalwell and Moore, of Acre-street, Battersea, which sustain the load directly the operator ceases to apply power, and enables him to lower it under perfect control by simply pulling the releasing cord. We shall probably describe at greater length these blocks and hoists. A notable exhibit in this group is the Worthington steam-pump, which has recently attracted some attention in this country. The pump chambers and steam cylinders are cast in pairs, and placed in line at opposite ends of the frame. The cylinders have ordinary slide valves which are operated by a vibrating arm on the main rod, the arrangements being such that the valve of one cylinder is shifted by the motion of the piston in the other. In these engines a large and direct water-way is obtained, and the parts are so readily accessible that there is little delay when any portion requires renewal, the parts being interchangeable. The collection of hydraulic machinery compares favourably with other groups in the exhibition, as it is fairly complete and contains examples from nearly all the principal makers. A portion of the group will be found in the east of the Queen's-gate Annexe, where there are several fire-escapes, fire-engines, and sundry other inventions having more or less connection with hydraulic machines.

## SARGEANT'S PATENT DROP-SHUTTER.

ONE of the most remarkable advances of modern photography is the production of highly sensitive dry plates, which permit, with certainty, moving life, forms and objects only dimly lighted, to be represented perfectly. But, in proportion to the sensitiveness of the plates, the difficulty in timing the exposure becomes greater, so that it is a great desideratum to be able to perfectly control the time of the exposure of a plate, upon which the perfection of the photograph almost entirely depends. This desideratum appears to be met in the drop-shutter invented by Mr. W. L. Sargeant, of which the above is an illustration, which has the special merit of being quite under the control of the operator, so that exposures of a quarter of a second may be given, or the exposure may be prolonged for a minute or more, with little change of the parts of the apparatus, the apparatus itself being very small and portable. Thus, for using this shutter for very rapid exposures, the small milled-head screw, shown at the top of the engraving, is drawn out a little, and the large milled-head screw is turned once round, until it *clicks*; it is then set for rapid exposure, and a single pressure of the pneumatic ball opens and closes the shutter in less than a quarter of a second. For longer exposures, the small screw is turned in up to its shoulder, the shutter being again set up by turning the large milled head until it clicks. The exposure will now continue so long as the ball is pressed and close immediately on its being released, so that this shutter answers perfectly for instantaneous or ordinary work, opening and closing without touching the camera to cause vibration—a fruitful source of blurred outlines. This shutter is otherwise especially constructed to avoid vibration, the opening and closing being actuated by the revolution of a single-arm crank, the crank pin moving in a slot which it *fits*, so that, however rapid the motion, the shutter is held firm at all positions. Another feature is that it opens and closes from the bottom, thereby giving the foreground of a landscape slightly longer exposure than the sky, which it requires. Mr. Stanley, of Railway Approach, London Bridge, is the manufacturer.



## THE AMATEUR WORKSHOP.—VIII.

### Planing Machines.—Power Gear (*continued*).

WE will now finish the special subject matter of our last article—the application of spur power gear for driving, and afterwards hasten on, with as little digression as possible, to the completion of the upper portion of the hand machine proper, reserving, perhaps, for a final chapter or two reference to some special pieces of mechanism. I had intended to draw and dimension unequal bevel wheels with their pulleys and bearings like those shown on Fig. 45, p. 46, for attachment to the side of this bed. Such, to be properly described in detail, would delay us another article, and as a good number of my readers will be wanting to see the work growing, I will let it go by.

It is obvious, on an examination of the views given in our last, that the work involved in the introduction of this spur driving-gear is almost enough to put it out of the range of ordinary home workers. Holes have to be bored and bushed, and these must be done in a boring mill, or upon a lathe of 9in. centres, or under a drilling machine capable of drilling 1⅜in. in diameter. But the intended possession of such a machine implies the existence of power to drive it, and presumably also to drill and bore it.

The modifications required in the bed pattern are these: The two brackets B and C, shown in Fig. 16, p. 511, of Vol. XL., are removed altogether, and a boss substituted at *d*; Figs. 68, 69, 70, on page 250, for the tappet lever. A jointed bearing, *e e*, is provided on each side of the lower portion of the bed (Figs. 68, 69, 70, and Fig. 81) to receive the shaft, *a*, while bosses bushed with brass are provided at *f*, *f* and *g* (enlarged in Figs. 82, 83, 84) to carry the spindles *c* and *b*. The angle bracket, *h*, is widened to receive the foot of a small bearing *k* (enlarged in Fig. 85), which takes the overhang of the spindle *b*, while for the overhang of the pulley shaft *a*, a special casting, Fig. 86, is provided to rest upon the floor or other convenient support. The rib F in Fig. 16, p. 511, is removed backwards 1in. (Fig. 68, *i*), to clear wheel C, and for the rocking-shaft of the striking gear a boss is added at each side of the bed at *j j*.

These various bosses are all skewered on, and it would be much the better to cast them all solid and drill their holes clean through at once. But if it is preferred to cut them out to save this labour, a round print 1⅛in. in diameter must be attached to one side only of each, those prints being all on the outside of the bed. The boss *d* for the striking lever need not be printed at all, because the pin is not large. The bearings *e e*, Fig. 81, will be brought up to breadth by pieces fitted on the outside of the fillets, and the bearing part cut out in the pattern itself to 1in. semi-diameter. The extra facing piece *l*, Figs. 68, 69, will be fastened on to the bracketing, and a hollow put behind it to stiffen it. The patterns of the brackets, Figs. 85, 86, with their caps are sufficiently clear from the sketches.

FIG 83

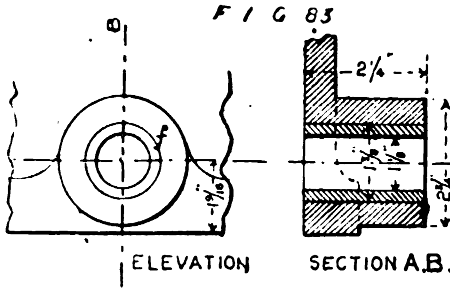


FIG. 84.

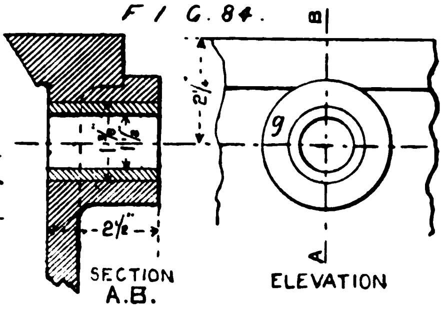


FIG. 87

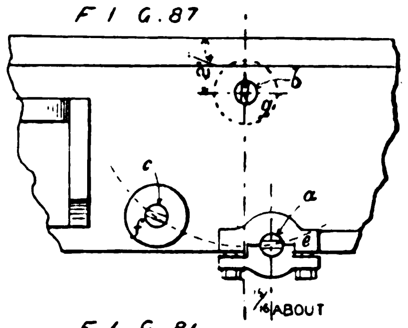


FIG. 82.

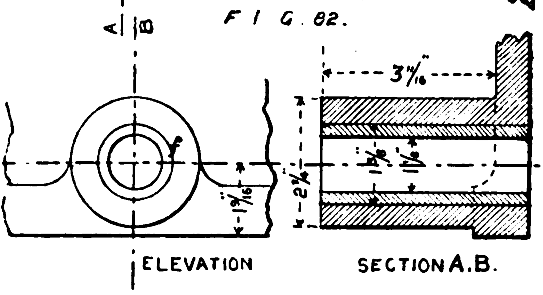


FIG 81

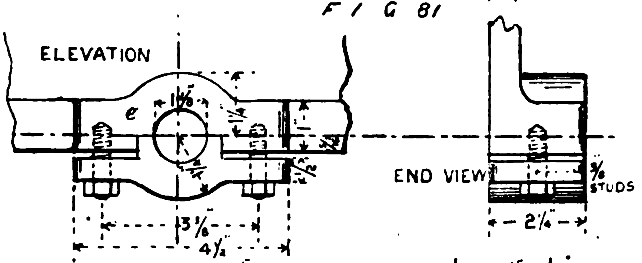


FIG. 85.

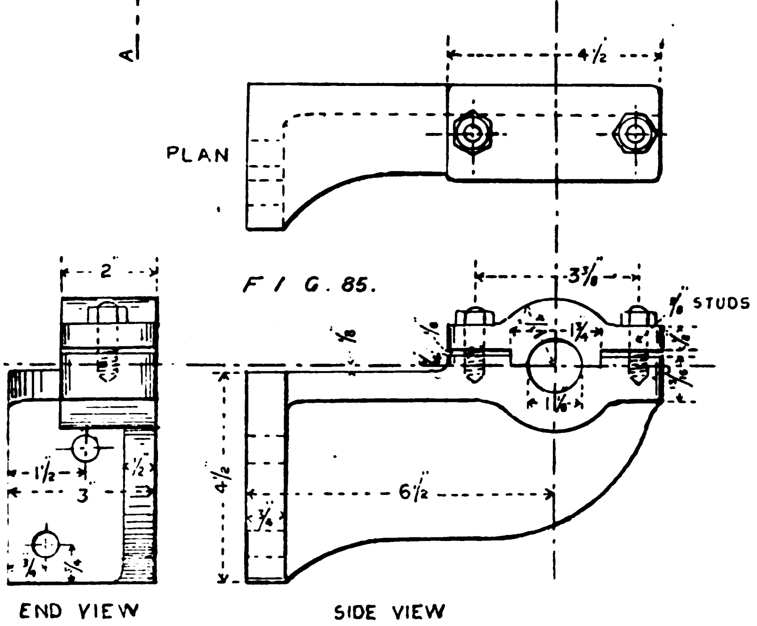
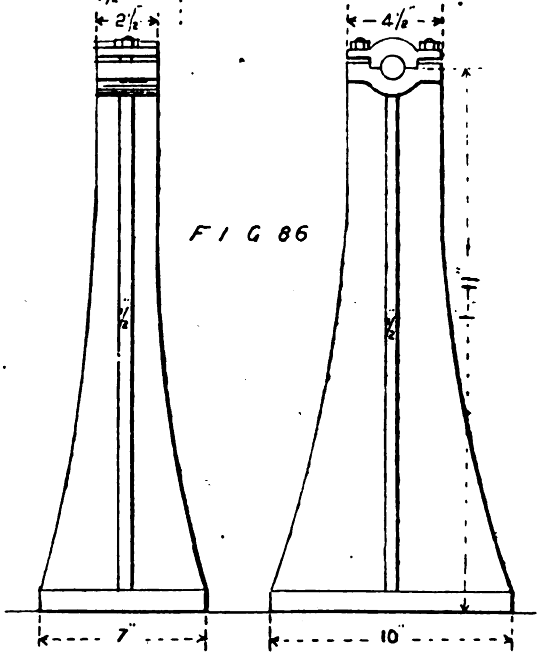


FIG 86



Now, assuming that we have our castings, the first thing is to bore the wheels in the lathe. When bored, it is always the safer way to try the centres of wheels which have to work with one another before marking out their bearing centres. This is necessary because unequal ramming, contraction, and variable qualities of metal produce variation in the sizes of castings moulded from the same pattern. A couple of teeth are chalked, and the positions of the pitch lines scratched on each of these in the particular pair of wheels which have to gear. The pitch lines then being brought to coincide with one another, the centres of the pair are tramelled on a slip of wood driven into the bore of each. These centres are then transferred to the intended centres of the shafts.

Now, in this instance the only centre whose position is of importance is that of the rack pinion spindle *b*, so we make that our starting point. If cored out, all the rough holes must be bridged with a slip of wood, and the caps also must be fitted into their places in the bottom bearings and bolted, and their holes bridged across. The bearing *k*, which carries the overhang of spindle *b*, should be fitted and bolted to its bracket also before being bored.

When all preparations are so made, the two centres—that on the bearing *k* and the one corresponding in the bed—should be marked in position. Carry a square, and scribe a line across the top of the bed, plumb over the cored holes for these rack spindle centres, apportioning to each its share of any variation that exists to one side or the other of the line. Square down on the faces of the bearings, and scribe across on these vertical lines, and at right angles with them, to a distance of 2¼in. from the top of the bed. From the point of intersection as a centre describe a 1⅜in. circle on the boss, and one of 1⅛in. diameter on the bearing, and remove the bearing.

Now trammelling the centres of wheels E and G—about 6⅜in., strike a line from the centres just obtained, cutting the spindle bearings *a* and *c*. Taking the centres of wheels B and C—about 4⅞ and 1/32in., set them on the bearings of spindles *a* and *c*, dividing the difference of inaccuracy of the holes between the two bearings, Fig. 87, and using the square across to maintain the spindles parallel with one another. Scribe 1⅛in. circles on the bottom bearing, and 1⅜in. on the boss bearings. Centre pop all holes.

The neatest tool to employ for boring these would be a boring bar and cutters set in a lathe or boring mill; but in the absence of these appliances a drilling-machine would be used, the bed faces and edges being well tried with a level before beginning to drill. It would be well to take the dirt out of the holes with a common drill in the first place, finishing with a twist-drill or a broach. The bushes (Figs. 82, 83, 84) would be castings made from patterns printed for coring out, and having 1/16in. allowance for turning and boring. They would be bored as well as turned before being driven in, a block of hard wood being interposed between the hammer and the brass to prevent burring over of the edge.

The pulleys will properly be bored first while held in the dogs of the face plate, and then put on an iron mandrel to be turned. Before turning, the outer skin of the rim should be taken off against the grindstone. The rounding will be given with a light feed imparted by the hand to the two slides of the rest—the file removing the tool marks afterwards. It is very possible that the pinion attached to the sleeve-pulley A", Fig. 78, page 250, will be out of truth with it, notwithstanding that the pattern itself is true, owing to inaccurate fitting of the moulding-box in which it happened to be made. This should be tried in the lathe before boring, and if the eccentricity amounts to more than 1 in., the casting should be discarded. Note also that the bosses of these pulleys stand out a bare 1/16in. beyond their edges, to keep those edges from actual contact. The only one which is keyed on is A, a keyway filed in the boss 8 in. by ¼in., and a flat to correspond on the shaft, will be wanted.

Of the three spindles *a b* and *c*, *a* and *c* will be of wrought iron, and *b* of steel. Their lengths are: *a* = 2ft. 4in., *c* = 1ft., 5⅜in., and *d* = 1ft. 2⅜in. A collar, Figs. 68 and 70, is placed on spindle *a*, to keep it steady in the one direction, the bearing, Fig. 86, maintaining it in the other. Oil holes will be drilled in all the bearings and bosses. Before the wheels are put on finally, the spindles should be tried through their bushes from side to side, and any tightness resulting from want of parallelism in the bushes should be eased with a scrape or a half-round fine cut file.

# ELECTRO-MOTIVE ACTION OF ILLUMINATED SELENIUM.

By Dr. Werner Siemens.

THE following is an abstract of a paper read by Dr. Werner Siemens before the Berlin Academy of Sciences on the Fritts' selenium cell, which we described on p. 93 in our issue for April 3.

Mr. Charles E. Fritts, of New York, sent me, early last year, a description of his method in relation to light-sensitive selenium plates, differing from mine in essential features, and accompanied the same by a number of the plates prepared by him. These do not, like mine, consist of parallel platinum wires embedded in a thin body of selenium, but of a thin homogeneous sheet of selenium, which is spread upon a metal plate and, after a subsequent heating—for the conversion of the amorphous into crystalline selenium—is covered over with a fine gold leaf. Mr. Fritts has found that the green light penetrating through the gold leaf by the further passage through the selenium, increases its electrical conductivity. In fact, the conductivity of the selenium plate between the gold leaf and the metallic base-plate is, by the illumination of the gold leaf with direct sunlight falling perpendicularly upon it, increased to the extent, in some of the specimens sent over, of from 20 to 200 times! The effect of illumination by diffused daylight is also greater in Mr. Fritts' constructions than in mine.

One of the plates sent over to me exhibited absolutely no sensitiveness to light; but in place of that it has another most remarkable property, namely, that a galvanometer connected up between the gold leaf and the base-plate shows the existence of an electric current in the direction of the light-action through the selenium, as long as the gold leaf is illuminated. I, in the beginning, conjectured that this current was not lasting, but had the character of a polarisation current, which continued only until the molecular modification of the selenium by the light was completed, and a first trial seemed to corroborate this idea. But further experiments convinced me that this supposition was erroneous. In reality, we have here an entirely new physical phenomenon to deal with, which is scientifically of the most far-reaching importance ("*die von grösster wissenschaftlicher Tragweite ist!*")

My experiments have shown that, by the illumination of the gold leaf, a difference of potential is established between it and the base-plate, which is, to all appearance, proportional to the intensity of the light, and which stands forth unchanged so long as the illumination remains constant. Obscure heat radiations do not produce electro-motive force, and therefore the supposition of a thermo-electric action, as the explanation of the phenomenon, is excluded. Mr. Fritts holds that the light waves penetrating into the selenium are transformed directly into electrical current, and therefrom states the fact that the strength of the current is proportional to the strength of the light. They showed themselves to be approximately so, by the collated experiments in the following table:—

| | | | | |
|---|---|---|---|---|
| Strength of the light in standard candles, | 6·4 | 9·9 | 12·8 | 16·8 |
| Strength of the current ............ | 18· | 30· | 40· | 48· |
| Quotient ............ | 2·8 | 3· | 3·1 | 2·8 |

The strength of the light was measured with a Bunsen's photometer, that of the current by the deflections of a sensitive mirror-galvanometer.

With the gold leaf exposed to the light from the south-eastern portion of a cloudless sky, while the sun itself was hidden by neighbouring high buildings, the series of measurements in the following table were obtained:—

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Hour of exposure— | 9.37 | 10.5 | 10.30 | 11 | 11.35 | 12 | 12·30 | 1 |
| Deflection of the galvanometer— | 190 | 196 | 209 | 223 | 250 | 250 | 244 | 235 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Hour of exposure— | 1.30 | 2 | 2.30 | 3 | 3.30 | 4 |
| Deflection of the galvanometer— | 249 | 228 | 188 | 173 | 172 | 108 |

It is shown from the foregoing that the electromotive force of the selenium plate very uniformly increased from 9.30 a.m. until 11.35 a.m., then the current remained nearly constant during two hours, and thereafter again quite uniformly decreased until 3 p.m. With regard to the reason why some of his selenium plates become more conductive during illumination, while others generate electro-motive force, Mr. Fritts give no explanation. He speaks of the uncertainty in the preparation of the plates, of whose properties nothing can be foreseen, and gives various manipulations through which unserviceable plates may often be made useful. There is also still needed thorough investigation, in order to determine upon what the electro-motive light-action of many selenium plates depends. Nevertheless, the existence already of even a single selenium plate having the property described is a fact of the greatest scientific significance, since there is here presented to us, for the first time, the direct conversion of the energy of light into electrical energy.

Note by Mr. Fritts:—The uncertainties mentioned by Dr. Siemens, as existing at the time I wrote the communication referred to (in February, 1884), have since been largely overcome. I have discovered the conditions upon which the electromotive light-action depends, and, with more perfect means for constructing the plates, I believe that I can even now accomplish the conversion of the greater portion of the energy of light into electrical energy. If my theory of the action proves to be complete, when fully carried out and tested in all of its variations, we may ere long see the photo-electric plate competing, in high efficiency of conversion, with the dynamo electric machine itself. I have also ascertained the causes of the frequent alterations in the electrical conductivity of selenium plates, and the conditions which will prevent them. I am now able to foresee the general properties of the plates, and indeed to give them such of the properties as I wish. I can cause a plate to show either an electromotive action or a higher conductivity, when exposed to light, or to show both properties. I can cause one surface of a plate to offer a higher resistance to a current than the other does, and can determine beforehand in which direction this action shall be exhibited. I can cause the resistance of a plate to increase and decrease in the same direction as the strength of the current is changed, or inversely; and can change the character of a plate by reversing its action in these respects, and re-reversing it at pleasure. I have ascertained the *rationale* of the speaking and singing plates described in my paper read before the American Association for the Advancement of Science in September last. Some of the foregoing was known long before the date of my communication to Dr. Siemens; but it is all mentioned here in order to show that the principal points are already pretty well worked out and understood. For obvious reasons I do not yet publish my methods; but many points in the action of selenium do remain which cannot yet be explained or accounted for.

In explanation of the slight irregularity in the action of the electro-motive plate mentioned, it should be stated that it had not been prepared for that purpose, but was sent to him as exhibiting another and entirely different property. During the development of that property, it had received some of the manipulations adapted for giving the electro-motive action, and in consequence thereof it could generate a slight current on exposure to light, although not with the uniformity of a specially prepared electro-motive plate. It should also be noted that the "south-eastern portion of a sky without clouds" (direct sunlight being cut off and excluded) is not a very intense source of illumination. But that fact will only render more satisfactory the proof of the reality of the phenomenon and its nature.

At the time of sending him the samples of my constructions, I had not a very large number of the electro-motive plates, and those were in almost daily use in experiments from which I hoped to deduce the philosophy of the action, so that they could not be spared, and I contented myself with pointing out that this plate could generate a current sufficient, at least, to demonstrate its possession of that property. After having my papers, data, and plates under consideration for nearly a year, Dr. Siemens, than whom there is no higher or better authority, has finally accorded the honour of first discovery to me. Whatever doubts or uncertainties may exist regarding the nature or cause of the phenomena adduced by other investigators, there can be none in this case, since all chemical polarisation and thermo-electric actions are here excluded from consideration, and the phenomenon is here unquestionably the direct conversion of the energy of light into electrical energy.

## BILGRAM'S GEAR CUTTER.

THE gear cutting machine devised by Mr. Hugo Bilgram, which is illustrated in the annexed engraving, is, in some respects, a novel departure from practice, and a radical change in the method of applying principles. The difficulty in cutting the teeth of bevel gear, for which this machine is specially designed, lies in the fact that the curvature of the sections from end to end is not uniform, and tools cannot produce altogether accurate results at once. Messrs. Brehmer Bros., of Philadelphia, send us some particulars of the machine invented by a member of their firm, together with the following remarks by an American contemporary. It should be mentioned that Brehmer Bros. have several of these machines at work cutting gears. The principle of the machine can, perhaps, be best explained as follows:—It is possible to make with any system of interchangeable gears a rack which will correctly gear with any wheel of the set. Any wheel that gears correctly with this rack must, therefore, also gear correctly with any other wheel of the set; and from this it follows that if any number of wheels are made to gear correctly with this rack, they must also gear correctly with one another. If the wheels were to be made with soft material, say wax, the teeth could be formed by simply rolling the blank into the rack, care being taken that the pitch line of the blank will roll on that of the rack without slip. The desirable clearance can be obtained by giving this rack just the converse of clearance. Gears are, however, made of material that cannot be removed by pressure, and the process must, therefore, be modified. The teeth of the rack might be made of hardened steel, with sharp edges at the ends; and by giving them a lateral motion the material could be cut away instead of being pressed to one side. The diagram, Fig. 1, shows distinctly how the tooth of an involute rack would cut its way through the rolling blank, thus forming one of the spaces between two teeth.

This is, in fact, the process by which this gear-cutter accomplishes its work. The cutting tool represents one tooth of a rack, pertaining to an interchangeable set of gears, and it obtains a reciprocating motion in the manner of a shaper tool, while the blank receives a movement as though it were rolling on its pitch surface. In bevel gears the tool representing the rack tooth, while cutting, passes through the varying depths or pitches; therefore the straight line, or involute rack tooth, is the only available one for this purpose. The tool, instead of running parallel with the pitch line, must run parallel with the bottom of the space. This will be more readily understood if it is considered that the rack of a bevel gear is nothing else but a bevel gear forming a pitch angle of 80° at the apex, or a flat, circular disc with teeth converging from the circumference towards the centre. The tool, in cutting, would follow the outline of the teeth of this imaginary plane wheel; and it is evident, therefore, that only one side of the converging space can be formed correctly at a time.

The machine, then, consists of two principal parts—the shaper, which holds and operates the tool, and what may be called the evolver, which holds and moves the blank. In order that the blank shall imitate the movement of a rolling cone, the axis must, in the first place, be moved in the manner of a conical pendulum. To accomplish this, the bearing of the arbor which carries the blank is secured in an inclined position between two uprights to a semicircular horizontal plate, which can be oscillated on a vertical axis passing through the apex of the blank. To complete the rolling action, the arbor must, in the second place, receive simultaneously the proper rotation, and this effect is produced in the machine by having a portion of a cone (corresponding with the pitch cone of the blank) attached to the arbor, and held by two flexible steel bands stretched in opposite directions, thus preventing this cone from making any but a rolling motion when the arbor receives the before-described conical swinging motion. One end of each of the two bands, of course, is attached to the cone, while the other is attached to the framework of the evolver.

Mathematically speaking, a cone does not terminate at the apex, but is extended beyond, and thus consists of two opposite sides of surfaces meeting in the apex. Basing on this principle, the rolling cone above described is placed on the side of the apex, opposite that on which the blank is placed, in order to avoid an interference with the tool.

The feed mechanism effects a slow intermittent movement of the semi-circular plate which supports the inclined arbor, thereby producing a slowly progressing rolling of the blank while the reciprocating tool forces its way through the metal. The feed can be reversed by the turning of a knob, or disengaged altogether, permitting the blank to be rolled to the one or the other side by a hand-crank.

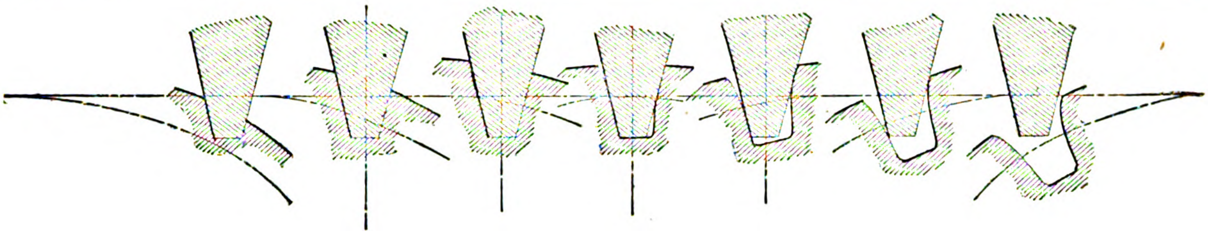
The arbor carrying the blank can be rotated independent of the rolling cone by means of a worm wheel, worm and index plate, which enables the blank to be presented to the cutting device at properly spaced divisions corresponding with the number of teeth of the desired wheel.

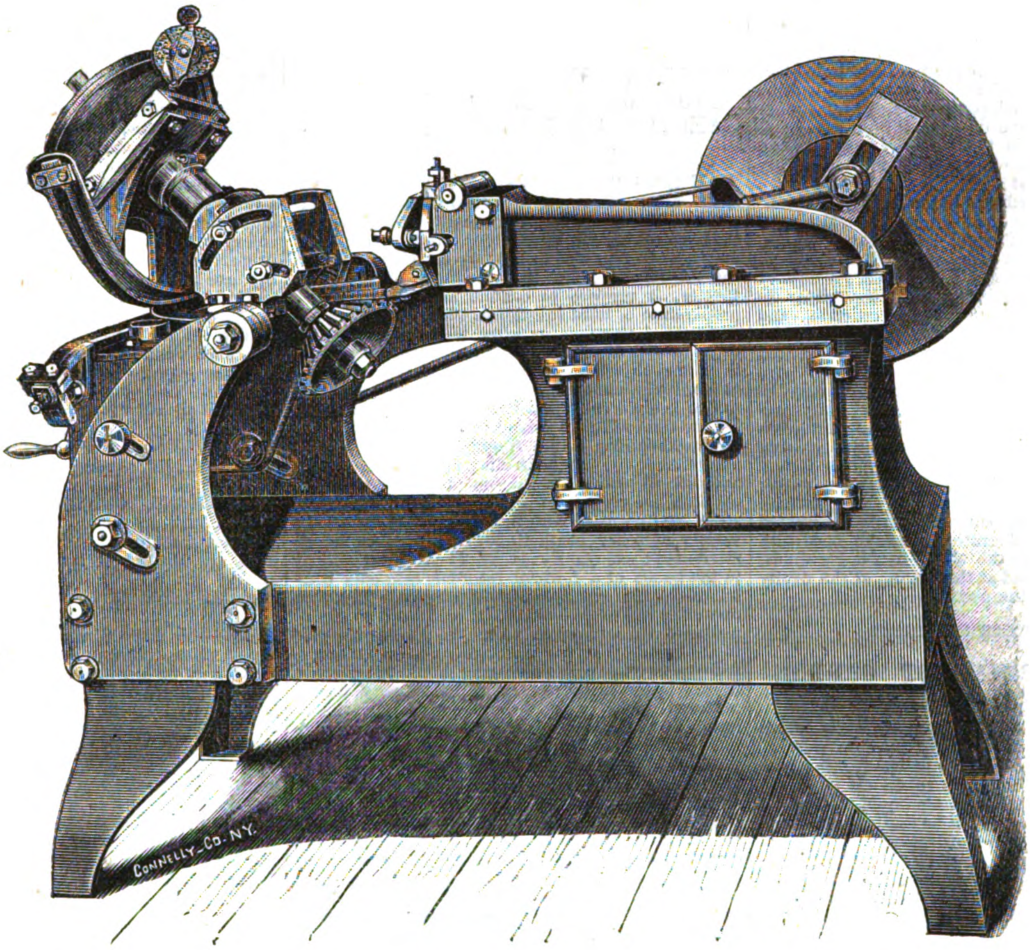
It is essential that the tool should be so adjusted that the lowest point of the cutting side should move exactly towards the apex of the blank, and, in order to set the tool, a gauge is provided by which the tool can be adjusted. A distance block is used between this gauge and the tool; this mode admits of a high degree of accuracy, since variations of distances can readily be detected by the touch when the eye ceases to discern.

When a wheel is to be cut out of the solid, the tool is at first adjusted at a slight distance from its correct position, and after each cut the feed motion of the evolver causes the blank to slowly roll, and allows the tool to cut out the stock in the manner shown in the diagram. All spaces are now treated in the same manner by using the index device, whereupon the tool is properly adjusted for one and then for the other side, each adjustment being followed by a repetition of the process in order to finish both sides of the teeth.

In securing the blank to the arbor, great care must be exercised in placing its apex exactly in the centre of the evolver. A special device enables the operator to gauge the distance of the ends of the teeth from the centre of the evolver, and, whenever this distance agrees with that calculated from the drawing, the apex of the blank is in its right place.

The inclination of the arbor which holds the blank is made adjustable, so as to adapt it to the angle of the desired gear. This adjustment must be exactly concentric with the centre of the evolver, *i.e.*, the apex of the blank. The rolling cone is




CONNELLY-CO. NY.

made detachable, in order that it may be replaced by such cones as correspond with the angle of the blank to be cut; but as the number of cones required would be unlimited, means have been devised to make a limited number of cones suffice.

The tool consists of a triangular bar of hardened steel, forming at the point an angle of 30°, 15° on each side, and held by a special holder. By grinding, it can be more or less truncated to suit the pitch of the gear to be cut. By this form of tool a much higher degree of accuracy is attainable than with tools having curved faces made to a gauge. The proper up and down and sideway adjustment is effected by two slides working at right angles, and operated by screws. The clamp which fastens the tool-holder is so constructed that it also clamps these said slides to the apron, securing the necessary stability. The apron is fitted with great care; the box in which the apron works is made in parts, and the faces are turned true with the pinholes, in order to get these faces exactly at right angles with the pin. The latter is fast in the apron, and revolves in the two sides, in which it has taper fits that the wear may be taken up. A device for lifting the apron during the return stroke prevents the dragging of the tool. The oscillating movement of the connecting-rod is employed for this purpose, by having a bar hinged at one end to a clamp which can be shifted on the connecting-rod while the other end impinges on the apron. By a lifting of the crank end of the connecting-rod, the loose end of this bar is pushed forward and the apron is lifted. It is easy to so adjust the clamp that this lifting action will occupy the time of the return stroke. The tool-bar is moved by a Whitworth quick-return motion, which is attached directly to the belt pulley. A double counter-shaft connected by cone pulleys is employed to change the speed if a shorter or longer stroke is desired. Gears cut on this machine are practically as nearly perfect as it is possible to produce plane surfaces on a planer. For this reason a careful preparation of the blanks is essential. One feature of involute gearing, which in practice in often troublesome, can be fully met by gears cut by this machine in a manner to be described. Whenever a pinion with a comparatively small number of teeth gears with a large wheel, there is a tendency of the points of the teeth of the wheel to cut into the flanks of the pinion. Reuleaux recommends that the number of teeth of the smallest gear of a set of interchangeable wheels should not be lower than 30. In practice this defect is, however, hardly noticeable when the number of teeth is not less than 20, but for a smaller number it becomes perceptible. In spur gearing the difficulty is generally met by giving the teeth of pinions more than the theoretical rounding; but this expedient is not a perfect cure, as may readily be attested by the experience of those who have cut 12-tooth involute pinions. Bevel wheels being always made in pairs, the above difficulty can be overcome by making the tooth-face of the wheel shorter than usual, *i.e.*, by cutting it off at that point of the face-involute, which, in running, will come in contact with the root of the involute of the pinion. By the extent to which the face of the wheel teeth is shortened by this measure, that of the pinion teeth is increased, and the flanks are made to correspond. It is evident that where this correction has been applied, the pitch line of the pinion is nearer to the base of the teeth, and that of the wheel nearer to the top than in the ordinary practice.

## RECOVERING SILVER FROM FIXING BATHS.*

FEW photographers who are not chemists are aware of the small percentage of the total silver in a sensitive gelatine plate which goes to the formation of the image. This is the case, notwithstanding the fact that, unlike wet collodion, the negative image is formed at the expense of the silver bromide which is itself reduced. Now as the function of the fixing bath is to remove all the unreduced bromide and leave remaining in the film only the portion that has been reduced by the developer to the form of metallic silver, it follows that a fixing bath which has exercised its functions upon several plates soon becomes surcharged with silver. It is one of the easiest operations in the whole realm of chemistry to make this saturated fixing bath yield up every particle of silver therein contained; and this being so, it is a pity that amateur photographers should heedlessly throw away so valuable a solution as a used-up fixing bath. We say "amateurs," advisedly, for professional photographers are too much alive to their own interests to permit any such waste. Each of them has his barrels, into which every drop of old hyposulphite solution, whether that from negatives or prints, is thrown, in order to have the silver extracted.

The following is the course we advise for the adoption of the user of dry plates on a moderate scale, who is not averse to the reduction of his expenses by saving his silver waste: Obtain a two-gallon glass jar having a loosely-fitting cover, and about 4in. from the bottom drill a hole in the side This hole is then fitted with a wooden plug, or, what is better, a small tap, which is retained in place by screwed nut, aided by rubber washers. This jar is placed on a shelf in a garden or outside of a window; at any rate, in some place with which there is direct open-air communication. This is rendered necessary on account of the offensive smell emitted at a subsequent stage. Into this the waste-fixing solutions are poured, and when the jar is nearly full, a small portion of a solution of potassium sulphide (sulphuret of potash or liver of sulphur) is poured in and mixed with the solution by stirring with a wooden or glass slab. Instantly there is a dense deposition of sulphide of silver in the form of a dark mass. Precisely how much of the sulphuret ought to be added can be determined only by experiment. After the precipitate descends a little, if the addition of two or three drops of the sulphuret is not seen to produce a further precipitate, then has enough been added; but if this addition causes further blackness, it must be continued until all the silver is found to be converted into sulphide. It is advisable that no more be added than suffices to effect this end. Owing to the slowness with which the precipitation takes place, it may, in many cases, be expedient to have in use two such jars as that described. After the precipitate had settled down to below the level of the hole or tap in the side of the jar, the supernatant liquid must be run off through this aperture. Upon replacing the plug, water may be added to wash the sulphide of silver which is insoluble in water. In this case the deposition will take place more quickly than before. Having obtained the silver sulphide as a dark pasty mass, the next query arises: What shall we do with it? In reply: It can either be placed in the hands of a professional metallurgist or reducer, who will most willingly either purchase it at full value or fuse it into a button of metallic silver; or, secondly, it can be converted into nitrate of silver by the addition of nitric acid into which it readily dissolves; or thirdly, it may be mixed with a flux composed of carbonate of soda, 7oz.; carbonate of potash, 7oz.; nitrate of potash, 2oz. Mixing this with the silver in equal proportions, placing in a crucible, and then fusing in a furnace, this gives a button of pure silver. The nitrate of silver obtained by the second operation is not sufficiently pure for some purposes, but, of course, it may be easily purified. The following is a pretty experiment, and one which is also useful, inasmuch as it reduces the sulphide very quickly. Having cut a hollow into a block of wood, place it in a mixture composed as follows:—Sulphur, two parts; nitre, four parts; fine sawdust, two parts; with an equal volume of silver sulphide. Apply a lighted match to this, and deflagration will take place with great rapidity, and at the close, in a few seconds, the silver will be found at the bottom of the cavity as a beautiful white lump of shining metal.

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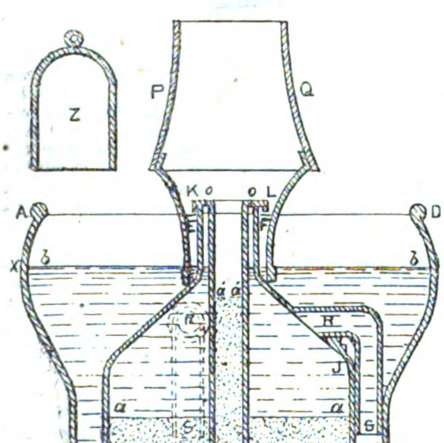
* Abridged from the *Photographic Times* (U.S).

## THE BISULPHIDE OF CARBON DISINFECTING LAMP.

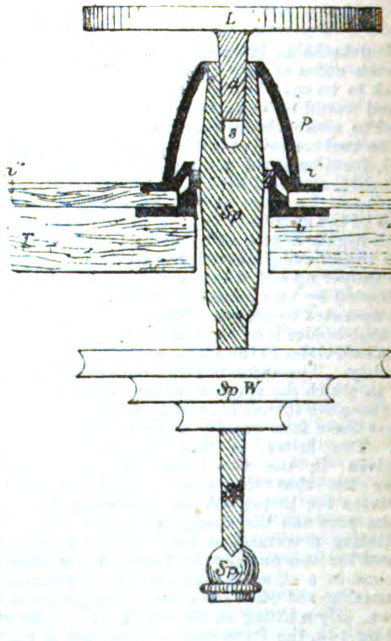
THE experiments made in Paris with bisulphide of carbon for disinfecting purposes were so satisfactory that a device was called for in which the liquid could be safely burned. It is an extremely volatile and inflammable liquid, and under ordinary conditions could not be ignited in a closed room without great danger of setting it on fire; but by means of a peculiar lamp devised by M. Ckiandi-Bey, any quantity of the bisulphide can be burnt with perfect safety. The lamp is made of copper, and consists of an exterior receptacle, A B C D, in which is placed the lamp I H E F. Three bent copper tubes, R S, pass through the sides of the lamp. The cylindrical tube, K L M N, containing a cotton wick in the upper part, reaches from the mouth of the lamp nearly to the bottom. The flame is surrounded by a copper chimney, P Q. The method of operating is as follows:—The lamp is filled with bisulphide of carbon to about the level *a a*. The outside receptacle is then filled with water to the level *b b*. By means of the bent tubes, R S, the water passes into the interior of the lamp, and forces the bisulphide up to the level *a′ a′* in the copper tube, where it is absorbed by the wick, and can be ignited at the top of the tube *o o*. As the bisulphide burns away, it is replaced by the water; and the lamp finally extinguishes itself. The combustion can be regulated by adding more or less water, so as to raise or lower the level *b b*. There is no danger of explosion; as the bisulphide is entirely surrounded by water, which keeps it cool, and only a small portion at a time is brought in contact with the flame. In disinfecting a room, about one pound of bisulphide is allowed to every thousand cubic feet. Any coloured materials likely to be bleached by the gas should be removed, the bisulphide ignited, and the room tightly closed, and left for several hours. After disinfection, the room should be thoroughly aired; and care must be taken not to inhale the gas.



## OBSERVATIONS ON THE PREPARATION OF MINERAL AND ROCK SECTIONS FOR THE MICROSCOPE.*

By John Ernest Ady.

DURING the past few years the study of the minute structure of minerals and rocks has received the attention of so many able geologists that microscopical mineralogy and petrography may now be regarded as a fairly established means for the identification and diagnosis of inorganic species. I propose to confine my remarks to the preparation of hard substances which do not require any special previous or after treatment to enable them to withstand the mechanical methods to which they are subjected. There are many trifling details of manipulation, the neglect or observance of which suffice to draw the line between failure and success. By the term failure I intend to imply that slovenly habit of securing a thin fragment of a section and mounting it anyhow, with clinging particles of dust and dirt, to which such errors of observation as a detailed description of rough surfaces, rugosities, striæ, cavities filled with unknown products, and a variety of other conflicting evidences, are to be attributed; whereas a successfully-prepared section, in the hands of a faithful recorder, can only contribute to the advancement of science. The first operation in the preparation of sections is to secure a slice of the mineral or rock. In the former case it is obvious that for purposes of investigation a definite series of sectional planes should be selected; in the latter instance, especially in very finely-textured rocks, without any natural or superinduced peculiarities, such as occur in finely-laminated examples, slates, schists, &c., or the presence of specially developed and local particles, the plane of section is immaterial, and a chip taken with a hammer may often suffice. The reduction of the slice may be accomplished by hand, or with the aid of a grinding bench. In either case the processes are essentially the same; the result to be aimed at is a section of the desired thickness, which shall be perfectly even and free from superficial scratches. The tenuity of the preparation must of course be regulated by the special requirements of each case; as a rule, however, the thinner a slice can be made the more valuable it becomes to the general investigator, especially with high powers of the microscope; minute endomorphs, cavities, and traces of fluidal structure may thus be revealed, and inferences often of great importance deduced therefrom. The mode of preparing hard sections is briefly as follows:—The slice or chip must be ground absolutely level and perfectly smooth on one side; it is not necessary to polish the face. The smooth facette may thereafter be firmly cemented on to a suitable piece of glass, and the other side then reduced until a sufficiently thin section is obtained. To do this by hand, a few soft metal plates, preferably of pewter, zinc, copper, or lap-metal, each about 12in. square, and ¼in. thick, three sizes of emery powder, and one or two Water-of-Ayr hones, are in reality all that is necessary. Glass plates are not to be tolerated, since they rapidly wear away irregularly unless extreme care is taken. For the final operation of grinding, flour emery which has been used and washed, or mirror-polishers' powder, is to be preferred. To produce a perfectly flat face upon the slice the surface of the plates should be slightly raised at their centres, so as to be somewhat convex. This may be produced by heating the central part over a spirit or Bunsen flame, when the four corners of the square will tend to bend slightly downwards, and give the desired degree of convexity to the upper grinding surface. The plate may then be fixed upon a support of wood covered with a layer of plaster of Paris, so as to prevent a springing motion during the process of grinding. The use of flour emery will secure a tolerably smooth surface, free from any serious scratches or roughness; but it is advisable to make use of a Water-of-Ayr hone, with a plentiful supply of water, in addition, to insure success. Indeed, *two* hones may be advantageously employed, and their surfaces are to be specially prepared beforehand thus:—The first hone, about 6in. long and 1½in. in breadth, is to be rubbed rapidly from end to end, longitudinally in one direction, upon a level slab of fine sandstone. This will develop a slightly convex surface upon the hone. The second hone, of similar proportions, must be treated in the same way, but it should in addition be further rubbed upon a slab of fine marble, so as to secure a smoother surface also slightly convex. The value of a convex grinding or polishing surface where the pressure is applied by the hand has long been known to practical mechanicians, for it is upon this principle that the so-called engineer's file is constructed. To the neglect of this item may be traced the cause of those inequalities which result in a section thick towards the centre and thin at the edges. In fastening the smoothened surface of the slice to a piece of glass, the best cement substance I have found for the purpose is that made of an admixture of Venice turpentine and orange shellac. The turpentine should be heated in a sand or water bath, and enough shellac ought to be added to it to produce on cooling a thoroughly hard yet tough solid; it may be tested from time to time by the removal of a small portion. The advantages of this cement are manifold: it is not prone to imbed particles of emery during the processes of grinding, its adhesive properties are exactly suited to the requirements of the case, and it is perfectly soluble in ordinary methylated spirit. By surrounding the edges of the slice with a small quantity of the cement, the borders of the latter will be perfectly protected. The slice ought to be fixed on to the small preliminary square of glass, with the fastening substance melted upon it over a spirit or Bunsen flame; it should be firmly pressed upon the glass slip (which, by the way, is all the better for being made of the best flattened plate-glass, about ¼in. thick, and 1½in. square) to the entire exclusion of air-bubbles. The process of reduction may be carried on with Nos. 60 and 80-hole emery powder, until in dark specimens, *e g.* basalts, &c., the slice becomes translucent. Flour emery may then be used, and the final touches given upon the Water-of-Ayr hones. During the latter stages, the specimen ought to be repeatedly examined under the microscope. All that is necessary now is to remove the finished section from the preliminary slip of glass. This may be best accomplished by soaking it in a saucer full of methylated spirit. The slice ought to float off of itself in the course of a few hours; it must not, on any account, be forced off. After detachment, it should be transferred to a dish of clean spirit for an hour or so, and gently washed therein with a fine camel's-hair or sable pencil. From the clean spirit the slice should be removed by means of a special lifter (a fine brush or stout needle will do), and placed between slips of clean white tissue paper, where it will dry rapidly and be ready for mounting. The best mounting fluid for rock sections is a filtered solution of equal parts of Canada balsam and gum damar in pure benzol. Hardened Canada balsam dissolved in benzol and filtered may also be used. A drop of the solution ought to be placed upon a clean warmed slip of glass, the section placed thereon, covered with another drop, and laid aside for about 10 or 12 hours in a dust-proof box, or under a bell glass. This process permits the medium to assume a suitable consistency before the cover glass is applied to the preparation. After exposure a fresh drop of balsam may be placed upon the



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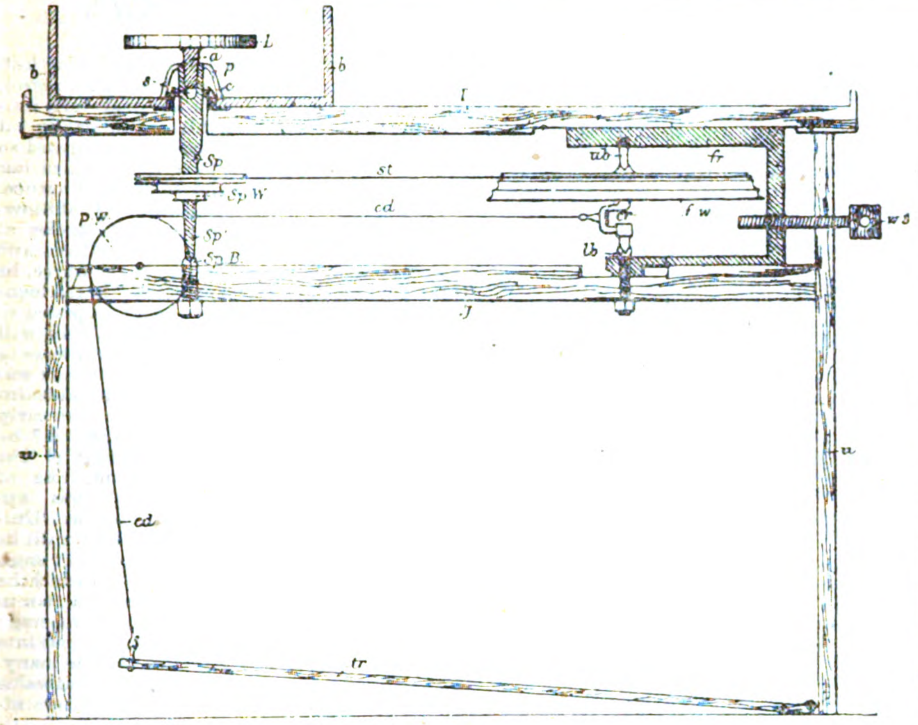
* Abridged from a paper read before the Mineralogical Society, and published in No. 29, Vol. VI. of the *Mineralogical Magazine*.



section, and a gently warmed cover glass lowered upon the whole. The labour of grinding sections of minerals and rocks for the microscope by hand is so tedious that few persons would follow that process where they could resort to a suitable grinding bench. Many instruments have been devised for this purpose, the best one in the English market being that of Messrs. Cotton and Johnson, and called the "Amateurs' Lapidary Machine." There is room, however, for vast improvements in instruments of this kind; those that are now made for scientific inquirers are either too expensive or mere toys; whilst working lapidaries use benches which require almost a term of apprenticeship to enable one to manage them. What is wanted by the petrologist is a thoroughly good machine with a horizontally disposed fly-wheel, treadle action, firm steady bearings, and the entire system so arranged as to admit of the ready change of laps, and the cleanly application of emery with the greatest possible utility. I am glad to be able here to describe a machine which fully meets all the wants I have just enumerated, and which has hitherto remained unnoticed. With its aid several hundreds of sections of the most perfect description were prepared in illustration of my journal on microscopical petography. The vertical treadle motion is modified into a powerful horizontal one by means of a strong cord passed over a pulley and attached to the crank of a fly-wheel. A connecting strap transfers the motion of the fly-wheel to a small horizontally-placed spindle-bearing wheel. The lower end of the spindle works upon a fixed iron bearing, whilst its upper extremity is free and slotted to receive the central attachment pins of the grinding discs. The circular grinding discs are provided with cylindrical rod-like attachment pins screwed into the centres of their lower faces at right angles thereto; they are simply allowed to slide into the receiving slot of the spindle-head, and can therefore be readily changed; their weight, and the pressure applied to their upper surfaces during the process of grinding, are sufficient to maintain them firmly. The fly-wheel works between two metal bearings supported by a strong framework, which can be made to slide forwards or backwards in the body of the bench by working a large adjustable wooden screw; thus, when the connecting strap becomes somewhat slack it can be speedily tightened by merely turning the screw-head. Before placing the lap into the slot of the spindle-head, the waste emery box must be placed around the latter, and over this a protecting metal cup-shaped cap is slid to prevent the possible passage of dirt to the working parts of the instrument. Lastly, the subjoined figures with explanatory notes and measurements will show the details of this new lapidary's lathe far better than any verbal description alone. It may be taken as a working plan.

### Explanation of Engravings.

Diagrammatic sectional drawing of lapidary's lathe for petographical work.—T, top of table; *u u*, upright supporting legs; J, middle joist; *tr*, treadle, *cd*, cord of treadle passing over pulley wheel (*p w*) to crank (*cr*) of fly-wheel (*f w*); *st*, strap from fly-wheel to spindle-bearing wheel (*sp w*); *Sp*, upper end of spindle; *Sp* 1, lower part of spindle resting on bearing (*Sp B*); *u b*, and *l b*, upper and lower bearings of fly-wheel, sunk in sliding frame (*fr*), which can be regulated by wooden screw (*w s*). The lower bearing, along with the inferior arm of the sliding frame, move in a limited groove in the joist (J), which is specially morticed at this part.

Enlarged diagram of grinding apparatus. — *i*., circular brass ring bordering aperture for upper end of spindle (*Sp*); it is provided with an upward projecting rim. The brass cap (*c*) acts as a steadying bearing to the spindle head (*Sp*); *i'*, circular metal ring with upward projecting rim fastened on edge of central aperture of waste emery box (*b*); the brass protecting cap (*p*) comes over the edge of this rim, and is apposed above to the free extremity of the spindle head, thus effectually preventing the entry of dirt to the bearing (*c*); *i''*, iron pegs for securing box (*b*) in its place. L, lap, or grinding disc; *a*, attachment pin of lap, is somewhat conical, and does not quite fill the slot (*s*); thus providing a grip which tends to become more firmly fixed during the process of grinding.

### Working Measurements.

Table: Height, 38in.; length, 40in.; width, 20in.

| | in. |
|---|---|
| Distance of joist (J) from top of table........ | 6 |
| Distance of spindle from nearest supporting leg (*u*) .............................. | 5 |
| Diameter of fly-wheel ........................ | 16 |
| Diameter of spindle-bearing wheel .......... | 6½ |
| Diameter of pulley wheel...................... | 5½ |
| Length of arms of sliding frame (*fr*) ........ | 10 |
| Side of square waste emery box (*b*) .......... | 12½ |

**The Chloris Baudet Cell.**—A Chloris Baudet "unpolarizable" battery was tested at the Philadelphia Exhibition. The cell is described as follows:—An outer rectangular cell, 22cm. by 18 by 9, and a porous cell for the zinc plate. Two porous jars, one for crystals of bichromate of potash, the other for sulphuric acid; one with holes and the other without; two plates of carbon, each with suitable wire connections, and a suitable cover for the whole. The solutions used were a saturated solution of bichromate of potash for the outer jar holding the carbon, and a super-saturated solution of acid sulphate of potash for the porous jar containing the zinc. In the test cell the bisulphate of potash was used in the porous jar. When first set up this cell had an electromotive force of 1·87 volt. It was then put in circuit with a resistance of 5·8 ohms, including a galvanometer, when the deflection was 47°, with a current of ·226 ampère. The internal resistance of the cell was 1·3 ohm, and the zinc was a half-inch rod immersed to a depth of about three inches. The needle fell one degree in the first five minutes, when after an hour it rose to 47½°, standing steadily for five hours; the next morning it was 45°. Here it remained practically constant for about 28 hours, when it suddenly fell.

THE East Coast railway from Newcastle to Edinburgh has had to be diverted about 2½ miles to the north of Berwick, owing to the encroachments of the sea, and at a cost, exclusive of purchase of land, of nearly £14,000.

# SCIENTIFIC SOCIETIES.

## ROYAL ASTRONOMICAL SOCIETY.

THE June meeting of the society was held at Burlington House, on Friday, the 12th inst., Ed. Dunkin, Esq., President, in the chair. The Rev. Thomas Perkins, M.A., of Shaftesbury School, Shaftesbury, Dorset, was elected a Fellow of the society.

Col. Tupman reported that sixty-two presents had been received by the society since their last meeting. Amongst them was a photograph of a portion of the Milky Way, taken by the Brothers Henry, of the Paris Observatory, with a new object-glass of their own construction of 13in. aperture and 11½ft. focal length. With an exposure of 60 minutes stars of the 14th magnitude were shown.

Mr. Knobel read a paper by Mr. W. F. Denning, on "The Velocity of Meteors." At the last meeting it was stated that in order to account for the stationary meteor radiants, which Mr. Denning claims to have discovered, it is necessary to assume that the meteoric bodies belonging to them come from outer space with a velocity at least fifty times as great as the velocity of the earth in its orbit about the sun. Mr. Denning wished to state that no such velocities had been observed by him. He agreed with Col. Tupman as to the difficulty of accounting for these long-enduring showers, but it was certain that the meteors coming from the fixed radiants did not meet the earth with velocities fifty times as great as the meteors belonging to known planetary showers. The question had been asked whether the velocity of any meteors belonging to fixed radiants had been determined by simultaneous observations of observers stationed at a distance from one another. Mr. Denning stated that there were several instances in which such observations had been made, and that the velocities did not differ greatly from the velocities of meteors belonging to the planetary streams.

Mr. Ranyard said: This seems to be a very important series of facts which Mr. Denning has communicated. If the velocity of a meteor shower coming from outer space were at all comparable with the velocity of the earth in its orbit, the radiant would, in the course of the year move in a circle many degrees in diameter, because the direction in which meteors appear to approach the earth is not the direction in which they are really moving in space; but it is determined by the relative motion, which is compounded of the meteor's motion and the earth's motion in its orbit. Meteors moving with a velocity fifty times as great as the ordinary planetary meteors, would probably give rise to quite a distinct class of phenomena. The heat generated is proportional to the square of the velocity, and consequently at the same altitude such rapid-moving meteors would be consumed in an incredibly short space of time. Planetary meteors become incandescent at a height of seventy or eighty miles above the earth's surface, and meteors moving with a velocity fifty times as great it is possible to conceive might become incandescent at twenty or even fifty times as high in a region where the atmosphere is very much rarer; but with such enormous velocities it seems probable that the process of burning the meteor would be much more rapid, and that the air would behave almost like a solid, and the meteor would be broken up with a rapidity comparable to the duration of an electric flash.

Col. Tupman endeavoured to show, by means of a diagram on the black-board, the relative heights above the earth's surface at which it would be necessary to suppose that meteors became incandescent, in order that the angular velocity of the two classes of meteors should correspond. The small relative velocity, compared with the earth, is, however, proved by the fact that the apparent velocity of the meteors, from both classes of radiants, is dependent upon the position of the radiant with respect to the apex of the earth's way. When the earth meets the meteors, their apparent velocity is much greater than when the meteors catch up the earth from behind.

Mr. Bryant read a paper on "The Elliptic Elements of Comet (Ross) II., 1883." The orbits of which elements have already been published of this comet, do not present such an agreement as might have been expected on the assumption that the comet is moving approximately in a parabola. By the advice of Mr. Hind, he had rejected all observations except those of Mr. Tebbutt; but he still failed to find a parabolic orbit which would correspond to them. Mr. Bryant, therefore, undertook to investigate its elliptic elements, and arrived at two sets of elements, both of which satisfied Mr. Tebbutt's observations with an error of six hundredths of a second of arc of Right Ascension. One gives a period of 87 years, and the other a period of 94 years.

Mr. Knobel read a paper on Al-Sufi's star magnitudes. He compared the discrepancies in different manuscripts, and illustrated on the blackboard how some of them may have been supposed to have arisen. In Ptolemy's catalogue a star of the 3-4 magnitude is indicated by the Greek letter γ, followed by the word ελασσων; a star a little larger than the third magnitude would be γ, μειζον, the letter γ signifying 3. The Arabic copyists not understanding the meaning of the words μειζον or ελασσων, as greater or less, translated them in various manners, sometimes giving the Arabic initial letters of the words and sometimes contractions.

A paper by Prof. Pritchard was read, intitled "An Inquiry as to the Grounds for Criticism by the Astronomers of Harvard College on the Oxford Stellar Photometry." Prof. Pickering had stated that the results obtained with a Wedge photometer should theoretically be affected by the brightness of the background of sky. In order to test this assertion Prof. Pritchard had examined about 1,000 observations of Polaris which had been made at Oxford during the last three years; he had had the observations divided into four classes corresponding with the four phases of the moon, but the part of the wedge at which the star was extinguished was found to be practically the same, whether the moon was full or new, there being only a difference of about one-hundredth of an inch in the average reading of the wedge for full moon and new moon which would correspond to a difference of about one-fiftieth of a magnitude. The four readings were 4·77, 4·76, 4·74, and 4·75 inches on the scale of the wedge. The paper then proceeded to deal with the probable errors of the measures given in the Harvard Catalogue, and in the Oxford Catalogue Prof. Pritchard claimed that there were no systematic errors in the Oxford Catalogue depending on the brightness of the field of view, or on the brightness of neighbouring stars. The magnitudes of the Harvard Catalogue mostly depended on measures made upon only three different nights, and as these measures are relative measures depending upon the comparison of one star with another, Prof. Pritchard claims that they are not likely to be as accurate as absolute measures made with an instrument which is independent of the sky illumination.

Mr. Stone said that he did not think Prof. Pritchard's way of comparing the various measures of the Harvard Catalogue with his own was fair. He had compared the extremes of the measures made at Harvard with the difference between the means of measures made at Oxford. He was very surprised to hear of the result which Prof. Pritchard had arrived at in comparing the differences between observations made at full moon and new moon. If Prof. Pritchard had determined the magnitudes by a differential method by which one star was compared with another, he could understand that both stars might be similarly affected, so that the relative brightness might not be changed, but with absolute measures, such as Prof. Pritchard endeavoured to make, he could not understand such a result. To the eye, and in the telescope, there were two or three magnitudes of difference between the apparent brightness of stars at new moon and full moon.

The Astronomer Royal said that he had had the advantage of examining Prof. Pritchard's work, and must congratulate him upon the accuracy he had introduced into celestial photometry by his wedge-photometer. He could understand how it was that the absolute measures of the brightness of the Pole-star differed by only about $\frac{3}{50}$th of a magnitude under different conditions. of moonlight illumination. The light of the star disc is enormously brighter than the light of the background, and it stands to reason that long before the star has disappeared, as the wedge is pushed onward, the background will have faded out of view, and will have no effect on the retina. Its effect would only be the same as absolute blackness; this objection, therefore, utterly falls to the ground.

General Tennant said that he had had an opportunity of examining Professor Pritchard's observations with Mr. Common, and he thought that a great part of the accordance which they seemed to show was brought about by the fact that Professor Pritchard rejected observations in a very wholesale way when they were not accordant.

Mr. Knobel said that he had looked very closely into the matter, and had himself made a number of observations of star magnitudes by the method of limiting apertures, and he had found that the result very much depended on the rapidity with which an observation was made; when the aperture was very slowly diminished, the retina retained its sensibility and could follow the star further than when the aperture was rapidly closed. He had especially asked Professor Pritchard how the observations were made, and whether the wedge was rapidly or slowly pushed onwards. Professor Pritchard stated that the star's brightness was greatly diminished, and then the screw of the wedge was rapidly turned. He thought that an explanation of the strange accordance of the observations might possibly be accounted or in this way.

Father Perry said that he agreed with Mr. Knobel; he had found a great deal of difference in the readings when the wedge was moved slowly or rapidly. He thought that the strange accordance might be due to the fact that the observer brought the wedge very nearly up to the old reading, and then moved it through a turn of the micrometer screw, which was not very far. He could, he believed, if he liked, extinguish the star over a large range of the wedge by such a method.

Lord McLaren said that he had endeavoured to make some observations of star magnitudes with a wedge photometer, and had found that there was a great deal of difference in the place where the star disappeared when the wedge was moved slowly or rapidly.

Mr. Ranyard said one would have expected a much greater difference in the measures when they were determined absolutely than when they were determined by Prof. Pickering's method of comparing one star with another, for a difference of clearness in the atmosphere from one night to another would probably make a greater difference in the brightness of a star than would be caused by the difference of clearness in the direction of the two stars which were compared on the same night.

Mr. Green showed some drawings of Jupiter, and called attention to some dark red spots which had recently appeared, following the well-known red spot, and in about the same latitude upon the planet.

The President mentioned that Mr. Todd, the Government Astronomer of South Australia, was present at the meeting, and called upon him to give an account of his work.

Mr. Todd said that he had not expected to have been called upon, and had made no preparation. When he first arrived in the colony the Observatory was very poorly equipped. One of his chief duties was to determine the time for the colony. This had not been very effectively done; a gun was fired every day at one o'clock, and there was a tradition that a chronometer-maker in the town used to set his chronometers by the gun, and the man who fired the gun would for long periods take his time from the chronometer-maker's window. One of their duties had been to determine the boundaries of the colony, which involved laying down a parallel of latitude as well as a parallel of longitude. They had also observed the Transit of Venus in 1874, and had given some attention to the planet Jupiter, and eclipses of its satellites, and had on more than one occasion seen them through the limb of the planet.

The following papers were also laid on the table, and taken as read:—Observations of the Satellites of Saturn, and of the companion of Sirius, made at the United States Naval Observatory, Washington, by Prof. A. Hall; Ephemerides of the Satellites of Saturn 1885–86, and Ephemeris of the Satellite of Neptune 1885–86, by A. Marth, Esq.; On Daylight Occultations of Aldebaran in 1885, by Mr. J. R. Hind.

**New Secondary Battery.**—At a recent meeting of the Berlin Physical Society, Dr. Kalischer described a new secondary battery, intended to overcome the disadvantage of the usual accumulators—namely, that the sheet of lead used as anode was very soon destroyed. This object he is said to have attained by adopting a very concentrated solution of nitrate of lead as electrolyte, and iron as anode. The iron on being immersed in the solution of lead became passive, and resisted every corroding effect of the fluid; in other respects the peroxide of lead on the electric charge became deposited at the anode as a very firm coherent mass, enveloping and protecting the iron on all sides. The charge was continued till the greater part of the nitrate of lead was decomposed, a condition which was marked by the occurrence of a greater development of gas at the anode. At the beginning of charge all development of gas must be avoided, or otherwise the peroxide of lead, or, more correctly, the hydrate of peroxide of lead, became covered with bubbles. As cathode a sheet of lead was used, but it was attended by two disadvantages. In the first place, the lead during the charge, separated itself at the cathode into long crystal threads, which soon passed through the fluid and produced short closing (of the current). In the second place the nitric acid, which remained in the fluid after the separation of the lead, acted very powerfully on the sheet of lead. Both disadvantages Dr. Kalischer avoided by amalgamising the cathode. This accumulator of iron, concentrated solution of nitrate of lead, and amalgamised lead yielded, after the electric charge, which could be carried out without any special preparations, a current of about 2 volts; after about six hours' discharge, however, the electro-motive force sank to 1·7 volt, but, on the battery being left to itself for twenty-four hours, it became a little increased. According to the measurements hitherto taken, the functions of this accumulator were satisfactory. An attempt to substitute sulphuric manganese for nitric lead in this battery did not answer the purpose, as the peroxide of manganese separated itself, not in a continuous layer, but in loose scales.

# SCIENTIFIC NEWS.

THE scientific world learnt on Monday last, with some surprise and with much regret, that Prof. Fleeming Jenkin was dead. His intimate friends knew that his health was in far from a satisfactory state; but few anticipated so untimely a termination to a career which has been of the greatest service to practical science. The deceased professor was born in 1838 at Stowting Court, Kent, and pursued his studies at Edinburgh, Frankfurt-on-the-Main, Paris, and Genoa; and after taking his M.A. degree, he entered himself as an "apprentice" in the locomotive shops at Marseilles, whence he passed to Fairbairn's at Manchester in 1851. It will be seen that Fleeming Jenkin had of necessity acquired a good deal of experience before he was 21, and the very variety of his educational training enabled him to attain a position at an early period in the life of a scientist. In 1857 he had charge of the electrical testing of the first Atlantic cable during the progress of its manufacture; and in 1865 was appointed professor of engineering at University College, London—a post he held until he became the first occupant of the chair of engineering at Edinburgh, a professorship which he held until his death. The loss of such a man in the prime of life, just as his scheme of telpherage or electrical transmission, is about to be put into practical work, is to be regretted, for his many-sided experience would have been of great value in determining several questions which are attracting much attention.

Prof. Robert von Schlagintweit, the eminent ethnographer and geographer, died on Saturday in Giessen at the age of 52. The name of the deceased is chiefly connected with the journey of scientific investigation made by him in 1854-57 in Central India and the Himalayas in conjunction with his brothers Hermann and Adolphus. The expedition was fitted out at the expense of the King of Prussia and the British East India Company, and added many important and interesting facts to our knowledge in the domains of geography, meteorology, geology, and ethnology. An account of the journey was published in English under the title of "Results of a Scientific Mission to India and High Asia." Prof. Robert von Schlagintweit also travelled in North America, and wrote several shorter works on his experiences there. For several years previous to his death he had filled the post of Professor of Geography at Giessen.

The Rev. R. Harley, F.R.S., is retiring from the principalship of Huddersfield College, after a long and distinguished career as a teacher of mathematics.

It is stated that for the professorship of chemistry at South Kensington, vacant by the resignation of Dr. Frankland, there are a large number of candidates, amongst them, Prof. Ayrton, of the Technical Institute; Prof. Dewar, of Cambridge; Prof. Hartley, of Dublin; Prof. Odling, of Oxford, and Prof. Thorpe, of Leeds. The emolument or salary, according to Whitaker, exceeds £1,600.

The conversazione of the Royal Society was held last week at Burlington House, when many objects, scientific and mechanical, were displayed in the several rooms, and were inspected with evident interest by the guests as they passed from room to room. Among the mechanical contrivances which appeared to excite the chief interest was Tate's calculating machine, exhibited by the inventor, by means of which eight figures can be multiplied by eight figures in the space of about 15 seconds. There were also many entomological and botanical specimens under microscopes exhibited, as well as samples of Edison incandescent lamps exhibiting molecular shadows and transparent deposit of copper.

It may interest a few to learn that the Council list of proposed Fellows was duly elected. The following are the names; Major Baird, R.E.; P. H. Carpenter, D.Sc.; Sir A. Clark, M.D.; A. A. Common, F.R.A.S.; Staff-commander E. W. Creak, Prof. E. Divers, Dr. H. Hicks, W. M. Hicks, M.A.; F. R. Japp, Ph.D.; Dr. A. M. Marshall, Prof. H. N. Martin, D.Sc.; C. O'Sullivan, Prof. J. Perry, Prof. Sydney Ringer, and S. H. Vines, D.Sc.

At Christiania, Herr A. Olsen, an optician, has erected a large refractor in the Great Park, and the public can make observations of the celestial bodies on payment of a small fee. An attendant gives explanations. Herr Olsen's object is to foster a love of observational astronomy.

A good instance of what can be done when there is the will, is supplied by Mr. Roberts in his late report on the Cambridge Local Lectures. He tells a story of two miners at Backworth, Northumberland, who, after their day's work, walked about five miles in order to attend a course of lectures on chemistry given at Cramlington. That meant a walk of ten miles in order to gain a little knowledge. But these miners went further still; they took copious notes, and formed a class at Backworth, which numbered seven, and to them they delivered, as best they could, the lecture they had heard on the previous night, repeating such of the experiments as the simple apparatus and reagents they were able to purchase enabled them to do. The lecturer attended one of their meetings at the end of the term, examined the students, and found they had acquired a sound knowledge of the subject so far, and the Backworth Students' Association—all miners—is now an institution, small, it is true, but containing the right material. They want to buy a microscope, for the use of the proposed summer class, and would doubtless like to see a qualified lecturer a little oftener. These Cambridge Local Lectures would have collapsed last Christmas if the Rev. T. J. Lawrence had not collected about £150, mostly in Cambridge, which was forwarded to the Miners' Committee, for the expenses of lectures to be delivered in the larger villages or small towns.

During the past ten years 600 courses of Cambridge Local Lectures have been delivered, with an average attendance of 100 students at each course, and the various towns have subscribed a total amount of upwards of £25,000 towards the expenses. In order to give greater continuity and system to the local examinations and lectures conducted by the syndicate of the University, it is proposed to grant to students in any town where there is no affiliated college, all the privileges granted to those who attend the lectures of the syndicate, under certain guarantees of regularity of study.

Mr. Mellard Reade's presidential address to the Liverpool Geological Society has been reprinted in the form of a pamphlet entitled "Denudation of the two Americas." The essay may be regarded as a sequel to the address in which he discussed the effects of chemical denudation as a geological agent. He insists strongly on the importance of applying quantitative methods to the study of geological phenomena. In the present paper he calculates the amount of solid matter removed in river-water from the surface of some of the principal river-basins of America. Mr. Reade thinks that the matter which exists in chemical solution in river-water has more importance as a factor in the reconstruction of the earth than is generally recognised by geologists.

The balloon contest at the Alexandra Palace is to take place some day this month at 5 p.m., but the balloons must be deposited in the "shelter" which has been erected for forty-eight hours before the start. The prize offered by the members of the Aëronautical Society is £25 for the nearest certified approach by actual descent to a given goal, and that is supplemented by the Alexandra Palace prize of £25 if the aëronaut descends within two miles of the goal.

At a meeting of the Leicester branch of the Amalgamated Society of Railway Servants held last week, attention was directed to letters in the engineering and mechanical papers relating to iron and steel crank axles, when a resolution was agreed to—"That this meeting sees no reason to alter the decision come to by the debating committee, as we are still of opinion that iron axles are far preferable, and more safe to the public and railway servants."

At the meeting of the San Francisco Microscopical Society, May 13, President Mouser in the chair and a large company present, Dr. J. H. Stallard demonstrated the method of cutting thin sections of delicate animal tissues by the so-called "freezing process." The section-cutter used by the doctor was the "ether spray microtome," in which the tissue to be cut is placed on a small zinc receptacle, into which, by a simple contrivance, a continuous spray of ether is injected. The rapid evaporation of this creates such an intense degree of cold that the tissue is frozen solid in about one minute, and then can be readily cut by a section-cutter sliding over two horizontal glass plates. The piece of tissue having been thoroughly soaked in a strong gum solution does not show a crystalline structure when frozen (as would be the case if it were permeated only with water), but cuts like cheese. It is claimed as a special advantage that very delicate organs, such as the retina, lung tissue, &c., which are so liable to be torn by the ordinary process of imbedding in paraffin or other fats, can be readily cut by the freezing method without being damaged. The tissue employed in the demonstration was a specimen of morbid liver, in the state known as "cirrhosis," and upon examining the sections under the microscope, the abnormal development of connective tissue and the characteristic fibroplastic corpuscles were well shown. Mr. Henry C. Hyde called the attention of the meeting to a subject of great practical importance to microscopists—viz., the comparative advantages and disadvantages of the various forms of "Camera-lucidas" or drawing prisms. Specimens of the Wollaston, Beale Neutral Tint, Nachet, Zentmayer, Grunow, Swift, Zeiss, and Schröder prisms were exhibited, and their respective peculiarities of structure and performance concisely and clearly set forth. An animated discussion followed, and great interest was shown in the subject. On May 21 the Society held its annual reception, and Irving Hall was thronged with an assemblage of delighted visitors. The members vied with one another in putting before their visitors the most attractive objects; but a slide exhibiting the electric spark seems to have been the chief novelty. It was shown in the collection by Mr. C. W. Banks. The terminals of eight fine wires from an induction coil were brought almost into contact, on a specially-prepared vulcanised rubber slide. The electric current, in leaping from one terminal to another, presented a most beautiful appearance. A halo of light played about the end of each wire, while a stream of richly-coloured violet light of ever-varying intensity connected each pair of terminals. By interposing a film of soot, the current was apparently deflected from a straight into a zigzag course, while a brilliant shower of intensely white sparks shot over the field of view. Mr. A. H. Breckenfeld exhibited the beautiful rosette-form crystals of kinate of quinia, by polarised light, and also two slides of gold dust, the first being from river sand, showing, in its rounded grains, the effects of the wear of water and sand, while the other (sweepings from coin trays) showed the characteristically flat scales which are the invariable result of the attrition of gold coins.

Herr Bohlig has discovered that boiling water will dissolve alkaline silicate from new glass vessels. It is not a new discovery, but Herr Bohlig has ascertained the amount, and finds that in two seconds 100 cubic centimètres of boiling water in a new flask dissolved as much alkaline silicate as would neutralise ·1cc. of solution of oxalic acid containing ·1 gramme per litre. From old glass vessels no appreciable amount of silicate is dissolved.

Some time ago Mr. Bayley showed that when drops of various solutions are allowed to fall on to filter paper, the salt which was in solution in many cases remains in the centre, and a water ring extends around it. Mr. J. U. Lloyd has extended these observations and a notice of them has been given in the *Chemical News*. He has observed the distances to which various substances in aqueous solutions extend on pieces of blotting paper, dipped into the solutions, before they are left behind by the water. Great differences were noticed in the length to which different salts thus travelled. Mixtures of salts were also examined; in some cases one salt passes on, leaving the other completely behind. Thus a solution of quinine and berberine sulphates was separated by the method described; the former salt passed on through the paper after the progress of the latter had quite ceased. Dilute sulphuric acid behaved similarly; pure water alone passed onwards. In the case of simple salts dissolved in water, the rule appears to be that the more dilute the solution the quicker is the separation into salt and water.

At a recent meeting of the Paris Academy of Sciences a paper was read "On a Method of Determining and Recording the Charge of Electric Accumulators," by MM. A. Crova and P. Garbe. The authors claim to have discovered a means of determining and automatically recording the exact amount of energy stored in accumulators, and so regulating the discharge as to be able to ascertain the quantity still held in reserve at any given moment. The apparatus used were of the Planté type as modified by Faure.

# LETTERS TO THE EDITOR.

*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

*All Cheques and Post-office Orders to be made payable to* J. Passmore Edwards.

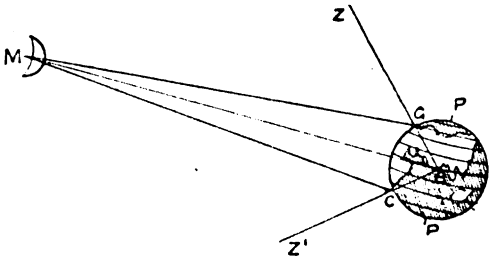
⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

## OH, WATER COMET!—FINDING THE MOON'S DISTANCE—WHAT IS "CREATION"?—TIME AND DIVIDING OF TIME—COMING ROUND—TESTS FOR A 5in. OBJECT-GLASS—A LARGE TELESCOPE FOR THE ROYAL OBSERVATORY—THE NEW TIME-TABLES OF VENUS.

[24365.]—Did "J. D. S." (letter 24312, p. 301), who talks about comets being icebergs!! ever hear that an overwhelming proportion of the comets so far examined by the spectroscope, have been found to be composed of some form of hydrocarbon, and that in the very rare cases in which a different spectrum has been exhibited, no trace of aqueous vapour in any form has ever been seen? In the existing state of our knowledge an icy or watery comet is sheer nonsense. Besides, how long would it be ere the vapour of water in space would seriously retard the planets in their orbits, and perceptibly shorten their times of revolution?

Inasmuch as "Essex Clod" (letter 24315, p. 301) has obviously a sufficient rudimentary idea of plane trigonometry to enable him to understand the method of determining the Moon's distance from the earth; I trust that the following description of the mode of proceeding will render it intelligible to him.



Here E represents the earth and M the moon; and G and C the observatories at Greenwich and at the Cape of Good Hope respectively, which, to simplify my explanation, are supposed to be on the same meridian. Very well, then: the observer at Greenwich notes the angular distance of the moon from the zenith; that is, the angle Z G M, while the man at the Cape simultaneously observes the angular distance of the moon from his zenith, Z′ C M. Hence evidently we get at once the angles G M E and C M E; in other words, the parallaxes of the moon at G and C respectively. Of course, the latitudes of the Greenwich and Cape observatories are accurately known, as is the angle G E C = their sum, the length of G E and C E radii of the earth being also rigidly ascertained; so here we have all the data needful to calculate G M, E M, or C M. In practice the problem is rather more complicated, as Greenwich and the Cape differ something like an hour and fourteen minutes in longitude, and an allowance has to be made for the motion of the moon during that interval. Moreover, the earth not being spherical, her radii differ in different places; for which reason the equatorial radius is taken as the unit in the final computation of the lunar parallax. Her distance once ascertained, the determination of her size follows as a matter of course.

As "Creation" is apparently a very elastic term, as employed by "H. B. F." (letter 24329, p. 304), I should like to ask him whether an Albino, born of normally constituted parents, is "created"; and, further, whether the same thing can be predicated of the curiously-changed forms of mollusca which descend from salt-water species, as the water from physical causes becomes merely brackish, or *vice versâ?*

The letter of "Lavant" (24333, p. 304) might have been epitomised in the dictum of the dustman *re* Emigration: "What I say about Hemigration is this 'ere. It's no use a man a hemigratin' unless he's got lots of money: and if he *has* got lots of money, wot does he want to leave Hingland at all for!" Surely this is scarcely a caricature of the arguments (?) of your correspondent.

Since Mr. Bird (reply 54698, p. 305) fails to give any reference to the letter or letters of mine on which he is so severe, I rather fail to follow him, the more especially as I do not remember commenting on the American misuse of the word "around." At any rate, that word is a solecism in more than one of his quotations from English writers. "He will then perceive above and around him a vast concave hemispherical vault"; and "Agencies at work around us," are perfectly pure and good English; while, on the other hand, "revolving around the sun," and "the equatoreal telescope turning around its polar axis," are extremely ungraceful, if not absolutely ungrammatical, forms of expression. Besides, two wrongs do not make one right. Finally, in expressing my gratitude to Mr. Bird for his kind advice to "read English works on astronomy," I would humbly venture to express my belief that I am familiar with the contents of every one worthy of perusal that has been published in this country (to say nothing of Newcomb's, Holden's, Chauvenet's, Loomis's books, &c.), and that if your correspondent will favour me with the name of one that I have *not* read, I will address myself to its perusal straightway.

In reply to "H. A." (query 56774, p. 311), the *minimum visibile* of a 5in. object-glass is Argelander's 12·7 magnitude (this lies between Smyth's 15th and 16th mags.), and its theoretical separating power for a pair of equal stars each of the 6th mag., is 0·91″. Knowing this, my querist can select objects for himself from "Celestial Objects for Common Telescopes," as tests for his instrument. In every case in which the object given in Webb appears in the "Bedford Catalogue, "Smyth's magnitudes, are retained, *vide* pp. 212 and 213. "H. A." may try ξ Scorpii, τ Ophiuchi, 110 Herculis, δ Cygni, $\epsilon^1$ and $\epsilon^2$ Lyræ (for the stars between the two pairs); the nebula 57 M. Lyræ, for stars on preceding edge, and for one following it. None of these (save perhaps 110 Herculis) are actually crucial tests; but it requires a good object-glass to show them.

It is very much to be hoped that Mr. Christie will obtain the necessary funds from the Government for the construction of the 28in. achromatic, on the need for which he insisted at the conclusion of his report at the recent Greenwich Visitation (*vide* p. 319). Albeit the National expenditure has recently "advanced by leaps and bounds," when one reflects how wickedly money has been wasted for the benefit of the ring at South Kensington, it does seem as though £3,500 might well and legitimately be devoted to the provision of an instrument worthy of the Royal Observatory, and which would certainly be employed for the purpose of advancing astronomical science, and not merely the interests of any person or persons. In a case of this sort, it does behove England to be on an equality with other nations in her instrumental appliances, and I trust to hear soon that the suggestion of the Astronomer Royal has been acceded to.

In let. (24356), "The New Time," p. 325, Mr. Hopkins quotes from a former one by "Conservative," concerning the inconvenience of a series of observations of phenomena of Jupiter's satellites being noted as occurring some on one day and some on the next. I wonder whether Mr. Hopkins ever heard of a solar eclipse beginning before noon and finishing after it; and if so—employing the present astronomical day of the *Nautical Almanac*—how he proposes to surmount this identical difficulty then? Referring again to your Report on p. 319, I would ask Mr. Hopkins to read, mark, learn, and inwardly digest what is there said on this subject. "The change from astronomical to civil reckoning has also been made in all the internal work of the Observatory, and has been carried out without any difficulty," &c.

In reply to "J. H. T." (query 56816, p. 333), I know of no later or better tables of Venus than those of Le Verrier.

**A Fellow of the Royal Astronomical Society.**

## THE REV. PREBENDARY WEBB—SUN-SPOTS.

[24366.]—Like your excellent correspondent "A Fellow of the Royal Astronomical Society," it was with feelings of profound grief I read the paragraph beginning your "Scientific News" (p. 275) announcing the death of the Rev. Prebendary Webb.

As I happen to be one of those mentioned by your correspondent, "who feel that in Mr. Webb they have lost a personal friend, albeit they may never in this life have seen his face," I may be allowed to add a few words about our departed friend, having enjoyed his confidence during a correspondence of nearly 14 years, and I looked on myself as a humble pupil of his in observational astronomy, for in my earlier beginnings he most kindly assisted me with invaluable hints and suggestions, and helped me over many difficulties with his experience of half a century. I am sure that many amateur observers over the world have, in the same way, received his kindly help in matters which could not well be inserted in his "Celestial Objects for Common Telescopes"—otherwise it would have proved a cumbersome volume indeed. Although his time was much taken up with attending to astronomical studies, I believe he conscientiously attended to his parochial duties through a largely scattered parish.

In September last he lost his dear wife, whose demise he announced to me in a most affecting letter, too sacred to touch on here, and her death, no doubt, hastened the departure of the loving and gentle spirit of one who had nearly reached a decade beyond the allotted span of life mentioned by the Psalmist. His loss will be greatly felt by astronomers and observers throughout the world, and the void will not easily be filled. On whom will his mantle fall?

Mr. D. Booth (letter 24314, p. 301) refers to a very large sunspot observed on May 25, and the portion he describes as the "nucleus" is evidently what is known as the umbra, or Dawes' "cloudy stratum," in which the late Mr. Dawes detected a black spot, or nucleus proper, using his improved eyepiece (vide *Monthly Notices* R.A.S., Vol. XII. p. 169). The sunspot mentioned by Mr. Booth is probably the one I observed on May 31, when past the sun's central meridian. It was divided by one of the well-known "bridges," and it was interesting to me as being one of the few spots in which I have seen the black nucleus with the ordinary Hodgson prism eyepiece. I remarked that the nuclei were not central in the umbræ, but were on the *s. p.* sides, and were quite black, whilst the umbræ were in comparison with the bright photosphere, like the crape-ring of Saturn relative to the bright ring. I did not notice any colour in the umbræ; but the violet tinge mentioned by Mr. Booth as seen on the 25th might be caused by the outstanding spectrum of the o.g., or if the image were put slightly inside of focus.

However, there are observations on record of the umbræ being seen slightly coloured, as cited in Webb's "Celestial Objects" 4th edition. Two large and interesting spots are at present crossing the sun's disc.

Belfast, June 9. **Isaac W. Ward.**

## NOTES ON SOME RED STARS.

[24367.]—In letter 24339 (p. 322) the Rev. T. E. Espin directs attention to certain red stars from Birmingham's catalogue. As I happen to have also observed some of these objects during the past season with my 11¼in. Calver, my notes may be of interest for purposes of comparison.

B. 135 Gem. Ruddy orange. March 1, 1815.

B. 148 Aur. Orange-red, very fine colour. Jan. 24, 1885.

B. 165 Mon. Really fine colour, nearly crimson. Feb. 9, 1885.

B. 166 Can. Maj. Orange. Feb. 2, 1885.

B. 248 Hyd. Deep red, good colour, but low. March 7, 1885.

B. 277 Virg. Almost scarlet, really splendid colour. April 11, 1885.

B. 328 Boöt. Orange-red, about 7½ mag. April 19, 1885.

B. 448 Lyr. Fiery red, almost crimson—superb colour. May 10, 1885.

B. 458 Lyr. Pale red, about 8½ mag., poor colour when compared with the previous object. May 10, 1885.

In addition to the foregoing, here are a few others in which I have found the colours good. The positions are taken from Birmingham's catalogue, and they are for epoch 1880.

B. 4 And. 0h. 13m. 34s.: + 44° 2·6′. Nov. 29, 1884. Almost vermilion, fine colour, though small.

* B. 94 Lep. 4h. 54m. 9s.: − 14° 59·2′. Dec. 14, 1884. Magnificent colour, vivid ruby; about 8½ mag.

B. 120 Tauri. 5h. 37m. 53s.: + 24° 22·0′. Jan. 10, 1885. Fine colour, like a bit of live coal; about 8 mag.

B. 121 Tauri. 5h. 38m. 30s.: + 20° 38·1′. Jan. 10, 1885. Fine orange-red, pretty good colour.

B. 123 Aur. 5h. 40m. 25s.: + 30° 34·8′. Jan. 11, 21, 1885. Fiery red; estimated 8 mag.

† B. 228 Leon. 9h. 41m. 7s.: + 11° 59·2′. March 15, 1885. Fiery red, splendid object; about 8 mag.

B. 521 Cyg. 19h. 53m. 18s.: + 43° 56·0′. Jan. 6, 1885. Small, but splendid colour—like a drop of blood.

B. 592 Cyg. 21h. 38m. 18s.: + 37° 28·0′. Jan. 7, 1885. Orange vermilion, rich colour.

* Also R. Leporis. † Also R. Leonis.

There is one object which I failed to identify as a *red* star—B. Add 27 Gem. (6h. 12m. 6s.: + 23° 19′). On March 1, 1885, I looked carefully for it, and made the following entry: "white—no coloured star here." I feel curious to know whether Mr. Espin or anyone else has seen it.

With regard to 60 Leonis, the entry in my notebook stands thus: "greenish yellow—5 mag.—March 22, 1878." And for 61 Leonis: "fine orange—5 mag.—March 13, 1878." I think the discrepancy concerning the first-named object is probably due to one of two causes—either to "personal colour equation" on the part of Schmidt (and it cannot be denied that this celebrated observer had a partiality, like Sir W. Herschel, for red tints), or to a real change in the colour of the star itself, and this, despite its seeming improbability, I am almost convinced does occur in some cases that have come under my own observation. It is, however, of little use to compare observations made by various observers at different times, without knowing more about their individual peculiarities in the estimation of colour. Of course, those made by the same observer on different occasions are less likely to be affected by this source of error. Still, it is much to be desired that some instrumental method of registering star colours could be devised, which would do away with the present uncertain state of things.

June 12. **W. S. Franks.**

P.S.—Since the foregoing was written, I have looked for B. 437, but without success. I saw the white star mentioned by Mr. Espin, but there is no red star near the place, unless very small indeed. It might be a long-period variable, possibly; but more likely the position given by Secchi is in error.

**W. S. F.**

## B. 147.

[24368.]—With reference to Mr. Espin's remark on this suspected variable (letter 24339), I may say that some years since I suspected that there was some confusion in the observations of B. 147 and LL. 12104 (H.P. 1189), and early in 1883, when collecting materials for my catalogue, I wrote to the late Mr. Birmingham on the subject, and in his reply, dated 24th May, 1883, he said that he had then no time to look up his notes, but would do so as soon as possible. I never heard from him since. He added, however, "I have no doubt of the variability of 147 Red Cat." On March 12, 1885, I estimated it 7·6m. in a clear, moonless sky (see p. 413 of my catalogue), my comparison stars being W.B. 536 (6·7m. Gould, which lies about midway between B. 147 and H.P. 1189) and LL. 12214 (7·0 Gould). On that date I estimated B. 147 about six steps fainter than the latter star. I could not have made any mistake in the identification of B. 147, as it is a tolerably isolated star, lying about 2° *n.f.* the 5m. star 10 Monocerotis.

June 15. **J. E. Gore.**

## H (G.C.) 2091 — THE SEPARATION OF DOUBLE STARS—TESTS FOR 5in. REFRACTOR — RED STARS — DOUBLE STARS.

[24369.]—I am much obliged to Mr. Tarrant (letter 24271, p. 276) for the care and trouble he has taken in looking up H (G.C.) 2091. I have found since writing letter 23999, the following observations of this interesting object with the Harvard refractor: "1868. January 24: Star 14 mag, nebulous and north of star 11 mag. Place of nebulous star with respect to the other 9 82°: 17·12″. No third star."

May I ask "A Fellow of the Royal Astronomical Society" where I can find Dallmeyer's formula, to which he refers in letter 24307, p. 300. I can only find the title of one paper of his in the Royal Society's Catalogue of Scientific Papers, and the formula in question is not in that one. Apropos of the diameters of star discs, I should like "F.R.A.S." to read Mr. Stone's paper in *Monthly Notices*, XXVI. p. 45; and Professor Pritchard's remarks thereon on page 47.

Unquestionably, Dawes's formula for the separating power of a telescope needs revision, as I have already suggested in the English Mechanic for July 14th, 1882 (letter 20263). Σ. made many experiments with artificial double stars at Dorpat, and he says of the separating power of the 9·56in. refractor, "Isdem stellis ita vero dispositis, ut centra 0·385″ et peripheriæ 0·085″ distent, in telescopio nostro stellam conspicimus duplicem distincte sejunctam." The climate of Dorpat is by no means favourable for astronomical work, and the o.g. was mounted in a deal tube on a wooden stand, and would certainly be inferior in defining power to a modern first-class o.g. of the same aperture. Surely an object-glass by Clark, for instance, properly mounted and erected in the highlands of California or Colorado, might be expected to perform better than the Fraunhofer at Dorpat. Dawes's formula applies to sixth-magnitude stars, as seen with an aperture of 1in., when the atmospheric circumstances are *moderately* favourable, and I am not aware that he used any larger refractor than his own of $3\frac{6}{10}$in. aperture when making the experiments upon which that formula was founded. He says, "As the diameter of the discs does not increase in proportion to the power, the separability of all magnitudes is nearly the same, provided the state of the air is such as to bear well the increase of power." This is certainly an oversight, as though a good 4½in. would separate two 6 mag. stars one second asunder, yet no 4½in. in existence would split a pair of 11 mag. stars at that distance.

"H. A." (query 56774, page 311) will find the following objects good tests for a 5in. refractor. The stars given are either all in Webb, or are naked-eye objects. As Franks has found that a 5in. refractor is about equal in light-grasping power to a 6½in. silvered-glass Newtonian, he can also examine the light tests given on page 188. The mags. are expressed in Σ's scale.

DIVIDING TESTS.

| | | | | |
|---|---|---|---|---|
| 35 Con æ | 5 0, 7 8, 9 0 | 67·5°, 125·1° | 1·58", 28·79" | deep yellow, azure, azure. |
| P XVI. 270 Oph. | 6 7, 7 9 | 156 0 | 1·23 | white, blue. |
| Σ 2289 Herc. | 6 0, 7 1 | 234 0 | 1·19 | deep yellow, deep green. |
| Σ 1606 Can. Ven. | 6 3, 7 0 | 340·3 | 1·20 | white. |
| Σ 2049 Herc. | 6 5, 7·5 | 211 9 | 1·13 | white. |
| Σ 2054 Drac. | 5 7, 6 9 | 359 7 | 1·16 | yellow, deep blue. |
| Σ 2244 Oph. | 6 9, 7 1 | 272·7 | 1·05 | white. |
| 21 Oph. | 6 2, 8 0 | 161·6 | 1 00 | white, blue. |
| P. XIX. 108 Drac. | 7 0, 8 1 | 342 0 | 0·94 | white. |

DEFINING TESTS.

| | | | | |
|---|---|---|---|---|
| 21 Sagittarii.. | 5 2, 8 5 | 292 6° | 2·11" | reddish gold, reddish blue. |
| Σ 2041 Serp. | 7·3, 10 0 | 1·5 | 2·58 | yellow, deep blue. |
| δ Cygni. .... | 3 0, 7 9 | 320 6 | 1·68 | yellow, sea green. |
| 68 Herculis .. | var. 10 2 | 61 8 | 4·41 | yellow, indigo blue. |

SPACE PENETRATING TESTS.

| | | | | |
|---|---|---|---|---|
| ι Ursæ Maj.. | 3·2, 10 5 | 355·9° | 9·4" | |
| 74 Oph ...... | 5·0, 10·8 | 285·6 | 27·9 | |
| β Cygni...... | 3 0, 5 3, 11 0, 10·8 | 55·5, 340·0, 33·0 | 34·5 62·1", 108·4". | Several other distant *comites.* |
| γ Aquilæ .... | 3·0, 11·0 | 267 8 | 50·2 | |
| 56 Aquilæ .... | 6·0, 11 8 | 77·8 | 46 7 | |
| 110 Herculis.. | 4·5, 11 8, 12·5 | 91 0, 95·5 | 61·1, 44·7 | |
| 54 Sagittarii.. | 5 5, 11·5, 8 0 | 294·5, 41 7 | 35 8, 45 6 | |

It is extremely difficult to give any formula for ascertaining the light-grasping power of any telescope, as that depends so much on the observer, and scales and light ratios differ so widely.

With Dawes's formula (*Monthly Notices*, XI. p. 189), the *minimum visibile* with a 5·0in. achr. would be about 11·1 Σ.; with Johnson's (Radcliffe Obsns. XII. Appendix), the faintest star would be 11·8 mag.; with the formula given in Newcomb and Holden's "Astronomy," p. 419, this would be as low as 12·5 Σ. "F. R. A. S." has given Carrington's and Pogson's formulæ on p. 77 of the present volume of the ENGLISH MECHANIC. Struve himself fixed the *minimum visibile* in the 9·6in. at Dorpat at 12·4 mag. in his scale, which, according to Newcomb and Holden or Pogson, would be the faintest visible in a telescope of exactly half that aperture; the faintest visible in the Dorpat refractor being 13·9, according to their formula. I have no doubt that such an observer as Mr. Ward would see a 12·5 mag. Σ. without much difficulty in a 5in. achromatic, indeed, he has discovered stars nearly, if not quite, as faint as this, with 4⅓in. aperture; but so much depends on the eyesight and experience of each individual observer, that any tests of this kind are unsatisfactory. The mags. of Σ's objects in Mr. Webb's book are given in Σ.'s scale.

Mr. Espin (letter 24339, page 322) will find observations of some of the red stars referred to by him in the first volume of the Washburn Observations, pages 161–163. 60 Leonis is given correctly in Schmidt's paper, "Ueber die Farben der Fixsterne" (*Ast. Nach.* No. 1902), but he does not actually say it is red; but only includes it in a list of reddish yellow stars, the four first of which are ι Ceti, δ Andromedæ, *a* Cassiopeiæ, and β Ceti. I have no doubt that Secchi's place of his new red star is in error, as such mistakes are very common in Secchi's double-star observations. The error may amount to an hour or more in R A, or 10° or 20° in Decl. The place for 1880 0 of Secchi's star from his data in "Le Stelle" would be 18h. 15m. 5s. + 25° 1 9′, exactly the same as Birmingham gives.

I am glad that Mr. Gaudibert (letter 24342) has succeeded in finding the cause of his certainly somewhat puzzling observations. I felt sure that something must have been amiss, as his success in seeing such very difficult pairs, while he failed to perceive much easier ones, was inexplicable. I presume that the observations in letter 24342 were made *before* he adjusted his mirror. The following are the latest observations of the stars he mentions:—

Gledhill 430. Σ. 1781. Eng. 264 5° : 1·36" : (7ⁿ) 1883 97 nearly equal.

The suspected double appears to be W B. (2) XII. 1086, the place of which for 1885 0 is XIIh. 55m. 58s. + 21° 53′ 25". It is not known to me as a double star. Bessel and Argelander both rate it 7·0 mag.

γ Coronæ. The position angle was not very different from 120° in June, 1882, according to Do.'s elements, but the distance was certainly under 0 15".

β 612. Hall gives 63 3° : 0 21" : 1879 48. β 619. De. 174·0° : 0 38" : 1878 46. $\mu^2$ Boötis. The angle is now about 110°, and the distance 0 85".

Gledhill 465. Σ. 1879. Eng. 209 4° : 0 31" : (7ⁿ) 1883·55. Gledhill 466. O.Σ. 285. Single Burnham, 15½in. power, 750, 1881·50. Gledhill 467. Σ. 1883. Eng. 259 0 : 0·88" : (5ⁿ) 1884·43. ξ Boötis. The angle is now about 263°, and the distance 3·5′. Gledhill 469. O.Σ. 287. Pe. 307·4° : 0·71" : 1883·50.

Gledhill 470. O.Σ 288. Seabroke 193·7° : 1·34" : 1880·55. Gledhill 494. O.Σ. 298. Sch. 7 5° : 0·33" : 1882·47 "ovale decisa." This is now wider. Doberck gives a period of 63 80 years, Dolgorukow of 70·26 years.

June 15th. **H. Sadler.**

## DISTANCE OF THE MOON.

[24370.]—SURELY "Essex Clod," letter 24316, can perceive that if the moon, on a certain day, appears from Colchester to pass south of a certain star, while she is seen, say from Capetown, to pass north of that same star, if both observations were accurate, their comparison would give us the ratios of both her diameter and distance to the distance between Colchester and Capetown. This is known to a furlong, and considerably exceeds her diameter.

In no month are any of the stars that she occults from us, occulted also from the Cape. Not only is she constantly hiding, from intermediate countries, stars that we see well north of her, and the Cape sees well south of her; but often does she eclipse the sun from Mediterranean or North African places centrally, and even totally, while neither is touched by eclipse here in England, nor in Cape Colony. The total eclipse, for which our astronomers visited Upper Egypt some years ago, was such a case. **E. L. G.**

## ASTRONOMICAL.

[24371.]—I HAVE no doubt every astronomical reader of the "E. M.," to whatever country he belongs, has felt the deepest sorrow in reading of the death of Mr. Webb. For my own part I fully endorse the paragraph, so very true, of "F.R.A.S.," in No. 1654 of your Journal. Through unfortunate circumstances I have been deprived of the privilege of his personal acquaintance, when, some years ago, we sought each other, without success, both in London and in Belgium. His "book" and some private letters from him will not fail to endear his souvenir to my heart. May I be permitted also to express my deepest sympathy for those he leaves behind.

If Mr. E. Holmes (letter 24310) will look at τ Boötis with a low power, I think he will not fail to see the *comes*. I held it steady last night, with about 100 on my 8½in. mirror; clouds not far.

In my letter (24342), B = β = Burnham, line 10, middle column, a full stop after "close."

**M. Gaudibert.**

[24372.]—MR. GAUDIBERT, some time ago, ascribed my failure to elongate γ Coronæ to my want of experience in observing close double stars. Apparently, from letter 24342, his success was due to bad adjustment of his mirror. It is fortunate he has found this out at last, for his elongations of pairs far beyond the theoretical limits of his aperture fairly staggered many observers. I could not understand how it was he failed with stars I saw, and succeeded with those quite beyond my eye and instrument. It is satisfactory to find he has had the courage to declare he has been wrong, which some of us might have hesitated to admit. If he will forgive one so inexperienced as myself giving advice to so practised an observer, I should like to tell him he need never be in doubt a second whether his telescope is in perfect adjustment or not. When he has made it as near as he can, let him point to a bright star; and when he has focussed with a high power, let him draw out his eyepiece so as to enlarge the focal image to a small ring of light. If there is the smallest imperfection, one side of this ring will be brighter than the other, looking like a ring with a badly-shaped star as an edge. But having found out his error, why has he gone on to elongate β 612 0·19"? His mirror must still be out a trifle.

His following sentences are to me a little mixed up.

I have twice estimated γ Coronæ this year near the P.A. Mr. Gaudibert gives. It is said to be double in the Bermerside refractor. Perhaps their o.g. is out of adjustment also. I am in a bad position, and possibly—nay, certainly—not provided with such perfect means; but I do not believe any 9in. instrument can possibly show it double at present, unless out of adjustment.

Will Mr. Gaudibert kindly say how he sees ζ Böotis at present? Does he get a disc of star in distance betwixt the components, or are the discs in contact? The measured distance puts it within reach of a 7in. instrument; but of course the mag. of the components is against the separation. Such an excellent mirror as Mr. Gaudibert's will, of course, surpass mine, but I can only just separate the components. Is not φ Draconis very close just now? Like Mr. Gaudibert, I have to remove my telescope every time I use it; but I long ago came to the conclusion it was a distinct advantage so to do, since it forced me to pay attention to the adjustments, and has given great command over them.

**Edwin Holmes.**

## LARGE METEOR.

[24373.]—A BRILLIANT meteor flashed forth from near to the star η Boötis on the 11th inst. at 21h. 42m. (new time), and took a direction of, almost, direct north to south for about 15°. It travelled slowly, and its duration was about five seconds. Its colour was similar to that of the star Vega, and it exceeded that star in magnitude by at least six times. It had no train of fire in its rear, and after the whitish light had disappeared, there was left, for an instant, a ruddy coloured orb travelling in the same path of the meteor.

5, Rownsley-street, Leeds. **D. Booth.**

## A NEW TELESCOPE FOR GREENWICH OBSERVATORY.

[24374.]—I NOTICE that, in your report of the Greenwich annual visitation (p. 319), the Astronomer Royal points out the necessity for a larger telescope at the Royal Observatory. It does seem anomalous that the oldest establishment of its kind in the world, and the official representative of the richest nation on the face of the globe, should be left behind in its instrumental appliances by many other Governments, and even by private individuals. Yet this is indeed the case, much to our national discredit. If we showed the same zeal to be foremost in science as we are in war, we should be more likely to avoid those inglorious struggles which bring feelings of shame and humiliation to every right thinking Englishman. If any other Power builds a monster gun or unwieldy ironclad a little bigger than our own, there is instantly a chorus of howls from our bellicose pessimists, and this nation is straightway doomed to destruction unless we beat them in turn. But with regard to our scientific priority, that is entirely a different matter, and we are content to play second fiddle to any other nation from whom we can borrow a scientific idea. Even Russia, whom we affect to despise as a semi-barbarous Power, leaves us hopelessly in the rear with respect to the instrumental equipment of her national observatory. About the cost of such a telescope as proposed by the Astronomer Royal there is, I think, some mistake in the figures, as £3,500 seems a remarkably low quotation for a 28in. refractor. Grubb's price for a 27in., complete, is £7,000, and I have reason to believe that his prices are considerably below those charged by the well-known American firm of Clark and Sons. Suppose we put it at £10,000, and an item like this would be a mere bagatelle to the richest Government on earth, who can throw away millions of money on warlike preparations which are worse than useless. And is the collective scientific enterprise of a vast nation like ours to be outdone by private persons, as at present it is? Let us hope not, for our own credit's sake. Whilst Republican Governments do not hesitate to apply public money for similar objects—and they spend it much more liberally than we do, too—it should not be said that Her Majesty's Government begrudge the paltry sum asked for by the Astronomer Royal in order that the Greenwich establishment may be as well provided with instruments as those of other countries.

**W. S. Franks.**

## THE RADIOMETER.

[24375.]—ALTHOUGH much has been written upon the Radiometer, there is one factor in relation to it which appears to have been hitherto quite overlooked—namely, the hygrometric influence of the atmosphere. The opinion generally entertained is, that the rays of heat, whether from a luminous source, such as the sun or a lamp, or from a non-luminous one, such as iron heated below redness, hot water, &c., act *directly* upon the instrument, being transmitted by the interstitial ether of the air and of the highly attenuated molecules within the bulb, and the light or heat waves corresponding to such radiations being rendered sensible by the absorption of them, and consequent radiation, by the blackened surfaces of the rotating vanes. It is, of course, implied that the shorter light-waves are thus converted into the longer heat-waves. This view of the phenomena would probably be correct if the air through which the rays of heat pass were a strictly homogeneous medium, or simply composed of nitrogen and oxygen, for then it would be almost perfectly transparent to thermal radiations, and there would consequently be no sensible absorption of them in passing through it; but it must be remembered that such is never the case, the air at all temperatures being more or less charged with invisible aqueous vapour, and containing also smaller and variable quantities of carbonic acid and ammonia (the latter gas being likewise one of the most powerful of the gaseous absorbents of radiant heat); but, taking into consideration only the aqueous vapour, it has been proved by Professor Tyndall to exert so much potency as an absorbent of radiant heat that, though its average amount in the atmosphere is less than 0·5 per cent. were it to be entirely withdrawn from it, all vegetation upon the earth's surface would probably be destroyed by cold even in a single night.

It is clear then, I think, that the rotations of the radiometer can in nowise be regarded as indicating the initial energy of the radiations acting upon it, whether solar or terrestrial, inasmuch as the secondary radiations from the aqueous vapour, though theoretically equal to the absorbing, can never represent the latter fully in amount, much energy being inevitably lost in the surrounding space.

The radiometer must accordingly, I conceive, be regarded as under the influence of *two* sets of radiations—the primary, or those unabsorbed by foreign gases or vapours existing in the air or other medium through which they pass; and the secondary, or those absorbed or intercepted by such gases or vapours, and which are given out again by them, and thus serve to act indirectly upon the instrument.

How far the revolutions of the radiometer could be made available in meteorological observations for ascertaining the comparative amount of aqueous vapour in the atmosphere, according to this principle of secondary radiation, is, perhaps, impossible to predict; but, as through perfectly dry and pure air heat-radiations of all kinds pass, as Prof. Tyndall has shown, with hardly any appreciable absorption, and if the quantity of radiant heat when absorbed be, generally speaking, proportionate to that of the invisible vapour in the air, we seem to have a direct relation established between the secondary radiations and the movements of the instrument. And here, I may mention, that I have occasionally in damp and cloudy weather found my radiometer comparatively active, although the solar light, under such conditions, has to the eye been very weak. **W. H. O.**

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## "MIND AND MOTION."

[24376.]—The Rede lecture by Mr. Romanes, of which a summary is given in the "E.M." might naturally be expected to work on the lines of a reconcilement of the old and new modes of thought, when we consider the place where it was delivered. The method of defence adopted by the cuttlefish and his ink-bag is well known, and has often been taken as a model in such reconciliations.

But probably all Mr. Romanes' statements are not to be taken seriously, but must be considered merely as morsels of jam for reclacitrant children, who have to take nasty medicine.

It appears from the lecture that "Physiology necessarily leads to materialism." This result, however, is to be corrected by an appeal to metaphysics. "All our knowledge of matter and motion is merely a knowledge of mind-modifications"; whence the conclusion is drawn that, so far as we are concerned, mind exists before matter. This is certainly a complete *non sequitur*, even if intelligible.

It cannot mean that matter and motion have no objective existence, being merely mental phenomena; because in that case the conflict with materialism would be nothing else than the laborious churning of a vacuum. Nor can it mean that while matter really existed before mind, that the reverse is the case "so far as we are concerned," which is meaningless.

Nor can it mean that our minds existed and reasoned before we had bodies, much less before the existence of any matter at all, and if mind existed before matter, matter must have come into existence spontaneously, for according to Mr. Romanes, mind cannot produce matter any more than matter can produce mind. It is to be regretted that the reasoning demonstrating the deceptive character of physiology should be so obscure.

Materialism, I suppose, consists in supposing a causal connection between mind and brain action.

Spiritualism, I presume, supposes no causal connection—that is, none at all, for there can be no connection but what is causal.

The latter, according to Mr. Romanes, is almost (why not quite or more so?—is this a morsel of jam?) as absurd as the former. The doctrine of the conservation of energy is said to demonstrate this. Here, in my opinion, is another *non-sequitur.* The destruction of energy or the creation of energy would be certainly a violation of the received doctrine; but that there should be a causal connection without such changes between certain energetic conditions of matter and mind, although not included in the conservation of energy, is not in contradiction, but rather a supplement thereto.

In this matter I opine we cannot decide à priori, but must submit to be taught by observation—that is, by physiology. If (which I do not admit) physiology and conservation of energy were found in opposition, we should, indeed, be in a dilemma, for both have the same basis, namely, observation and experiment, and that alone; but if one had to succumb, it would, I think, be the conservation of energy, for the case would be similar to the theory of gravity failing to give any account of eclipses which happened when they were not predicted and never when they were. In this case we should say the theory of gravity was in fault, and not that unpredicted but observed eclipses really had not taken place because contrary to our theory.

So cogent, indeed, are the facts, that the lecturer who is arguing against the causal connection in question has to admit it in express words; but, of course, before doing this the cuttlefish's inkbag had to be emptied in making the statements that the "antithesis between subject and object is but apparent, and that brain changes and corresponding [what is meant by corresponding if there be no causal connection?] mind changes are not two changes, but one." This can only mean that subject and object, that is, all objects are one, and that there is no distinction between the brain and mind. This would imply personally to the present writer, that there is no distinction between his mind and the whole so-called objective universe, including all other so-called subjects, who would, to him, be merely objects, including Mr. Romanes himself and his lecture.

Under such circumstances, there could hardly be any dispute or any conclusion come to about anything or any form of theism.

After this the lecturer thinks it safe to contradict what his lecture is intended to demonstrate, and assert that "intelligent volition is a true cause of bodily movement, and that volition could not take place without brain action, and *vice versâ*!" This is said to satisfy the freewill hypothesis as well as the determinist. It would appear that it was only by a sort of recantation that Mr. Romanes could kill two birds with one stone, or, rather kill one bird and preserve the life of another. To destroy materialism it was necessary to show that brain action, or motion, could not cause mind, which implies that mind-action could not cause motion; but the "freewill hypothesis," which was not to be destroyed absolutely, required the possibility of this, so that a seat between two stools had to be accepted. The proverbial result of such a position need not be mentioned.

The result of considerations such as those presented in the lecture, is to lead to some new religion which will have the merit (it appears to be a merit in the view of the lecturer) of being more "vague"—that is, more unintelligible, than the older forms.

The creed of this new religion—if it is to have one at all—will not probably require for its acceptance much exercise of faith, if, as one may gather, it "must of necessity speak the language of Agnosticism." That is, it will not express a belief in anything whatever. **W. C. E.**

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## ASTATIC GALVANOMETER.

[24377.]—Several errors have slipped into the description in the last number but one of the above galvanometer. The stand should be 6in., not 8in. in diameter. After the third sentence in the second paragraph read as follows: The screws work in three equidistant holes, drilled and tapped near the edge of the stand. Two binding screws are fixed between two of these levelling screws, and opposite to the brass support described below.

97, Crawford-street, W. **G. Bowron.**

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## GAS-ENGINES.

[24378.]—I do not profess to know anything about gas-engines, and am entirely unable to discuss the respective merits of different sorts. As, however, I have been engaged in fitting one up for my own use at different times since the beginning of February, and think now that I have ascertained what may really be expected of it, and observing that there are inquiries about such a thing in the pages of the English Mechanic, I will give a few particulars of the one I have. It stands on a base of about 26in. by 22in.; cylinder upright, 3½in. bore; stroke, 10in.; weight altogether, with a single flywheel, just about 2cwt. I think a second 50lb. flywheel would improve it. Total height about 40in. or 42in. The explosion makes about as much noise (so I am told) as a Bischopp of like size would do, if there are any so small. The exhaust makes no noise at all, except at first starting cold; if the gas is properly regulated, and the hotter it gets the better.

I have had it working with a friction-brake pulling 2¼lb. at the end of a lever 15⅜in. long, and running 200 revolutions per minute, which makes an actually developed power of 4,000 foot-pounds, and that is pretty nearly as good a 1-man power as you will generally meet with. The quantity of gas consumed seems ridiculously small, as the sides of the gas bag (and a single one of about 4in. wide appears sufficient) hang down quite flabby and loose, as if the gas-supply were wire drawn before it got so far.

As I was determined that the engine should not prove a failure for want of workmanship, I made it all in superior style, taking about 200 hours over it, exclusive of the experiments that were afterwards made to ascertain its powers. Except improved ignition, it went right off at first trial as well as it does now. I could do another in half the time.

Anybody who would like to see it running can do so by applying at 100, Bolsover-street, where I myself obtained the castings, seven minutes' walk from the Langham Hotel, where it will remain probably for a month or six weeks. It has no piston-rod, no guide-bars, and no packing, and I may add, to disarm hypercriticism, not the slightest attempt at external finish anywhere, though inside as sound as a bell. **J. K. P.**

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## THE NEW TIME.

[24379.]—The plan of printing railway and other time tables in thick and thin, or in black and red, type to indicate a.m. and p.m. is, I submit, no gain, but a loss. Persons habitually using such tables might remember which type referred to fore and which to after-noon; but the great bulk of the public, aware of a difference, would be worse off than they are now, for they would be in doubt which half of the twenty-four hours was represented by the distinctive type.

What objection there can be, except aversion to change, against adopting the new time, I cannot see. Once understood, all difficulties and mistakes are at an end; the system can be mastered in a minute. Surely no one will pretend that to add 12 to 1, 2, 3, &c., to obtain the new time, or to subtract the same number from 13, 14, 15, &c., to arrive at the old is beyond the intelligence of the age.

What would anyone think of dividing the foot, not into 12in., but into, say, six left and six right, so that 3in. would be 3in. left, and 9in. 3in. right? To be shown in print by changes in type or colour.

As regards Mr. Kloen's suggestion, the Editor points out a strong objection to it—from the printer's point of view; another remains, and that is that red figures on a white ground are not easily read in a feeble light.

The adoption of the new time would do away at a stroke with all uncertainty. It assimilates civil and astronomical time; it is a broad and simple way of dealing with the question. Change of type to preserve the old is a mere tinkering of it. As soon as time tables are issued in the new time all the supposed confusion will cease, and the public will only be surprised to find that they have adhered so long to an unscientific division of the day.

**Eye-Witness.**

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## AUTOMATIC MUSICAL INSTRUMENTS.

[24380.]—I have taken in your paper since September last, and occasionally borrowed some from a friend of mine in August same year. I was glad to find some valuable information in your letters and articles touching on the automatic instrument made by Messrs. Wenham, Fryer, Child, Rock, "Vulcanite," "A. S. L.," "H. M., I. R." I am making an instrument myself on the blow system, consisting of five octaves. The reeds I am using are a set of broad bent reeds, a very powerful tone; in fact, the bellows are large enough for two sets and a half of reeds.

My first idea was of an instrument called the "Cabinetto" some years ago. I could not get a set of A. organ reeds at this time, so I used the above reeds for the purpose. I filed the plate slant at the sides to slide into the channels like the English concertina notes. The holes in the paper acted as valves. I had then to make a soundboard 3t. 4in. long by 12in. deep; the sound holes ranged from the bass ¾in. to ¼ square. The rollers were 3ft. 5in. in width to hold 600ft. of paper. The reeds were ½in. apart on the soundboard. When I got all ready for the rollers I found it would not act owing to the width of the paper, which used to tear, although the paper was a stout brown and glossy one side. So I dropped off going on with that class of instrument, which I think was very foolish of me to commence a large machine of that sort without any assistant. Hoping that I will see a sketch of some of our inventors on this subject, I wish to work the above with pallets and levers. My instrument was on the suction principle, but I see many letters in the "E. M." on this subject, and an article by Mr. Wenham. I think this gentleman's style would correspond with the 5-octave instrument that I intend to make, also thanking all our writers for their valuable letters on the matter, hoping that I will, after my great failure, receive some benefit from their ideas.

**Thomas Pugh.**

90, Great Homer-street, Liverpool.

## THE BREAKING OF AXLES.

[24381.]—I am extremely glad to notice that this important subject is now engaging the attention and consideration of your correspondents, and there can be no doubt that a full and fair discussion will bring to light much valuable information. "Midland Driver," p. 325, refers to steel axles, and asks for the mileage of each.

Upon reference to a statement drawn up by the Midland Railway Company to September 25th, 1884, I find that between January, 1874, and September, 1884, 172 steel crank axles, made by Messrs. Vickers, Sons, and Co., were put into service. Eight have been "broken," one (No. 73) taken out "defective," the others being at work.

| No. of engine. | Date put in service. | Miles run before failure. |
|---|---|---|
| 829. | 9 Jan., 1875. | 303,535. |
| 61. | 22 May, 1875. | 238,468. |
| 809. | 23 Jan., 1875. | 233,503. |
| 823. | 20 June, 1874. | 218,573. |
| 1104. | 18 Nov., 1874. | 150,984. |
| 63. | 31 July, 1875. | 131,603. |
| 1. | 19 Feb., 1876. | 47,447. |
| 9. | 26 Feb., 1876. | 37,524. |
| 73. | 29 April, 1876. | 27,132. |

With reference to "Midland Driver's" question relating to the crank axles taken out in the shops, I find that during the year 1883 the Great Northern Company took out 15·5 per cent. of defective axles, none being broken when running.

On the Midland Railway 2·4 per cent. broke when running, and 8·7 per cent. were taken out in the shops.

There can be no doubt that all railway companies are giving much more attention to periodical examinations than was formerly the case, and from several lines I have statements showing that this extra care is fast reducing the proportion of axles broken when running, and the number taken out in the shops is correspondingly increased.

**Clement E. Stretton,** Hon. Mem. A.S.R.S.

Leicester, June 13.

## CRANK AXLES.

[24382.]—One cannot read the letter of "Original Lockstitch" (24331) without seeing that he must have come to a rather hurried conclusion that it is impossible to find which way the grain is. No amount of hammering can destroy the grain, and Messrs. Linney and Lawson have shown how important it is to have the grain in the proper direction. Where do cranks break? is a question that "Lockstitch" has raised. 19 out of 20 go through the web, like the Penistone one; the 20th goes either in the crank-pin or any other part. The web is the fatal spot.

Perhaps "Lockstitch" would give the number of that Midland engine that he failed to detect the flaw on; as we might some of us remember the facts, and give some reasons for the same. Was it a steel or iron crank? There is a way, with an instrument, to find if a bar of iron is solid. Will any of "ours" refer to it in full?

**Iron Crank.**

[24383.]—Having read with interest several observations as to crank axles, a few notes may not be unacceptable. I was employed some years ago in a locomotive factory, and had opportunities of seeing fractured crank axles just taken out of the various engines. I kept a diary stating particulars of each fracture with a sketch of the exact part, and well remember of the twenty-five or thirty I had thus booked 90 per cent.—in fact, almost all—were fractures in the web or jaw of the crank. It was the general opinion of our best smiths that the iron was not so well solidified in the blocks forged for the cranks. I agree with one of your correspondents that the grain or fibre of the iron must to some extent be the short way of the iron in the web, and prove to be the inferior part of the forging. Hooping is no doubt an excellent thing. It will be obvious to most people that all crank shafts, marine or locomotive, are subject to a severe strain by the engines racing in the former, and surging in wet weather of the latter; in each case the jerk or grip of the work coming upon the lever of the shaft so suddenly as to deteriorate the nature of the iron in time.

West Hartlepool. **H. Casebourne.**

## HOW SHOULD CLOCKS STRIKE?

[24384.]—This question, on which you allowed me to make the following suggestion many years ago, seems quite independent of "the new time"; but yet, if rightly solved, would soon effect that superseding of "a.m." and "p.m.," which the "twenty-four o'clock" plans vainly aim at; and not only so, but simplify our way of expressing time-appointments much more. Your American correspondent, Mr. Woodside (letter 24345) makes now an approach to the same proposal. He makes his clocks strike only hourly, and only up to six, when they recommence, reducing the strokes per diem from the usual 156 to 84. It is impossible, he thinks, to make a mistake of six hours; but surely it is equally so, in all but the dead of night, to err by four hours. Why not, then, as I proposed, adopt from the mariners the full method into which the necessities of ship-life long ago drove them? Once an hour is not often enough to address the ear; but our "quarter-jacks," if not superfluously often, are at any rate ridiculously imperfect, by assuming every hearer to know what precise hour last struck. The half hour is the right interval at which to strike, as sailors discovered and settled centuries ago.

Now observe that all our public appointments are at either hours or half-hours. Even the starting of trains from their main termini will rarely be any exception to this. We do practically, then, in all our towns, make half-hours the general units, and appoint every meeting by these; or, as sailors say on shipboard, by "bells," only instead of their simple phrases "five bells" or "seven bells," we stick to our cumbrous "half-past two o'clock," and "half-past three o'clock."

Suppose Mr. Woodside now were to make his clocks, and persuade civilised Boston to make theirs, strike exactly like the mariners', half-hourly, and counting only up to eight (our present 12, and even 10, are absurdly high to count). The sailors compendious "eight bells," "two bells," &c., would soon supersede our cumbrous nomenclature in his "hub" city, as it long ago did in all ships. But of course they must, in print, distinguish the six watches by initials. Say *c* for cock-crowing, *m* for morning, *f* for forenoon, *a* for afternoon, *e* for evening, and *n* for night. Then observe how fully a single letter and single figure will suffice for all public appointments, and how much of our present printing they supersede.

*f* 7 instead of "11.30 a.m."
*n* 3 " 9.30 p.m."
*e* 5½ " 6.45 p.m."

or "a quarter to seven, p.m."

The power of the striking part of a clock need not be increased, as the odd numbers or the half-hours may be omitted in both the night watches, and the even numbers from the later one, reducing the daily strokes to 164, as easy nearly as the present 156.

Where a clock has quarter-jacks, of course retaining the use of all the bells will enable it amply to distinguish the new striking from the old. But where there is but one bell, the strokes should be *in pairs* (as sailors call them), far easier counted than when single; and only the one, at half-past 12, could ever be mistaken for the old "one o'clock."

Allow me a word on our "railway time," now carried in America to the *reductio ad absurdum* of *four* railway times—false time everywhere but on four particular meridians!—and a break of an hour whenever a train passes, who can tell where? at hundreds of petty stations. Assuredly the Celestials—if not wise enough to keep, as they have, the flowery land undefiled as yet by a railway—would have avoided this monstrous blunder. All that we ever needed, or Americans either, was two editions of the train-tables, one for officials and one for the public. The present ones ought, from the day Exeter was reached, or even Bristol, to have been confined to the hands of railway servants, and a translation of them printed for the public, by merely altering each figure from railway time to true local time. To aid in setting travellers' watches, the station clocks might have had a double minute hand, as was often proposed. However we shall make Greenwich time and Dublin time each serve for a whole island, and having set the Americans no example, they will have sooner or later, to discover this for themselves.

**E. L. G.**

## MATHEMATICS AND SCIENCE.

[24385.]—The letter of last week's issue on "Cramming in Physico-Mathematical Science" suggests a few remarks on the position which mathematics occupies towards science, and on the best way of acquiring a knowledge of those methods of calculation which are of importance to the scientific worker.

As our knowledge of a science becomes accurate and defined, and the mutual dependence of facts and theories is evolved, the value of mathematics as a weapon for the expression of these relations, and their numerical estimation, becomes more and more apparent. It is true that frequently the demand made on our powers of calculation may not overstep the bounds of arithmetic; but often the most elaborate processes of reasoning have to be brought to our aid if we are to attack a difficulty with success, and then we often find that the limits of our knowledge are determined by the limits of our mathematical penetration.

In astronomy, light, sound, &c., there are many interesting inquiries which can only be successfully promoted when the mathematics required have been first developed. The vortex theory of atoms progresses slowly for the same reason. Our advance in these, as in many other branches of science, awaits the advance of our methods of calculation.

The ordinary mathematical curriculum is so severe that most men shrink from it. What is wanted is a course of mathematics expressly designed for students of physical science, apart from those who wish to cultivate mathematics for itself. A year devoted to such a course would probably be more effective than three passed in going through the conventional stages where much time is given to subjects and parts of subjects, which are seldom of use in ordinary physical problems. Such a course need in no way be deficient in logical sequence. Many parts of algebra, trigonometry, co-ordinate geometry, and the calculus might thus be avoided without appreciably affecting their practical value for all scientific purposes.

It must not be forgotten that there always remains a very large number of persons who have neither the time nor the inclination for mathematical studies, though they may suffer great inconvenience if they are not to make use of the results of other people's. It is hard to be debarred from the use of formulæ because the proof cannot be comprehended, and there is no reason why this should be so. There is often a perfectly logical way of regarding formulæ as short summaries of fact which experiments show to be correct. Indeed, of all the calculations made the large majority are done by those who merely work by rule of thumb. Our ships are navigated over the whole world on this principle. Half a loaf is better than no bread, and in like manner a formula without the demonstration is better than no formula at all.

**Lewis Edmunds.**

10, King's Bench-walk.

## LEGAL REPLIES.

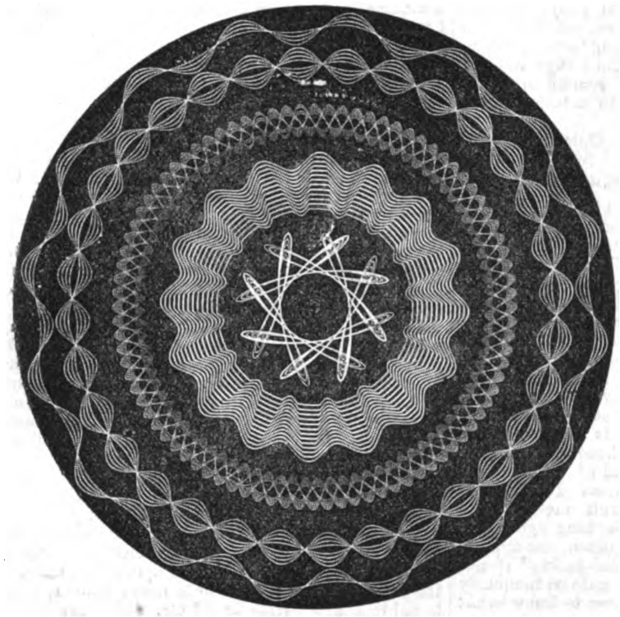
[24386.]—Lease (56641).—The lease should be conveyed, or, as it is properly called, assigned, by the mother to her daughters. I presume the widow has proved her husband's will, and so has the legal right to deal with the property. The assignment can either be by separate deed or by indorsement upon the existing lease. The former is generally the better plan. It should be properly drawn up, and as the stamp duty would only be 10s.—there being, I presume, no consideration but "natural love and affection," as we say—the cost might not be more than two or three guineas beyond the stamp, unless, of course, there is anything special in the matter.

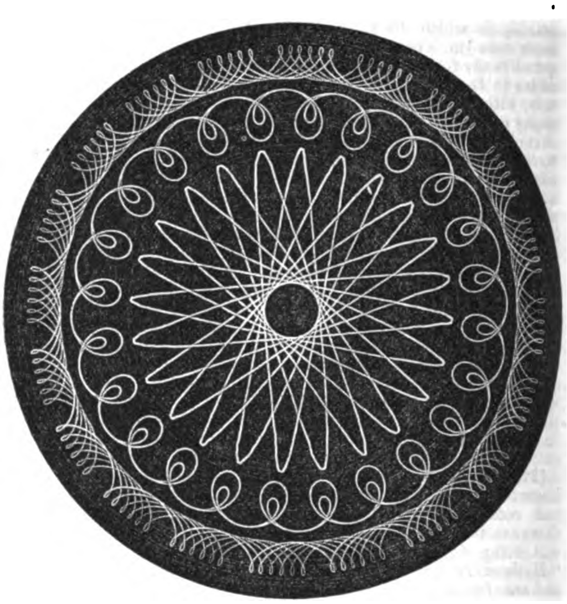
(56717.)—Will—Legacy—Age 25.—If A. by his will bequeathed a legacy to B., upon his attaining the age of 25, that is a properly valid bequest, and it will not vest or become payable until B. does attain that age. As far as I can judge without seeing a copy of the will, the executors can have no power to pay over the bequest until the legatee attains the age prescribed. The querist is, I think, quite mistaken in his information and his view of the matter. Although 21 years is often usual, a testator is quite at liberty to say that a legacy shall not vest until the person to be benefited attains the age he names—25, or even 75. It may be that this testator thought B. would be better able to manage a large fortune if he had four years' more experience.

(56726.)—Claim to Property.—I should advise this querist to consult the London solicitors having charge of the case; but without knowing more of the matter and seeing some papers, I cannot possibly help him further.

(56728.)—Agent—Default.—An agent can never be prosecuted for embezzlement, which applies only to clerks or servants. But sometimes an agent may be proceeded against as a fraudulent trustee. In this case, however, I do not think the querist has any other than the civil remedy of an action against his collector for money received on his account.

[56736.]—Partnership Agreement—Sta
If this agreement is not a deed—i.e., is not





seal, it only requires a 6d. stamp. If it is under seal, then it requires a 2s. stamp as a deed. If there are two copies, one would need a 10s. stamp, and the other only 5s., as a duplicate, if stamped at the same time. There is no *ad valorem* duty in question, and the 2s. 6d. stamp is wrong either way. The amount of capital has nothing to do with the point. **Fred. Wetherfield**, Solicitor.

2, Gresham-buildings, Guildhall, London.

## LOOPED FIGURES BY GEARING.

[24387.]—IN Vol. XXXV. our old friend "O. J. L." gave us some idea of what might be done by simple apparatus upon an ordinary lathe in his articles on "Looped Figures by Gearing." These suggestions led me to make certain small additions to my lathe, by means of which I was enabled to utilise the change wheels to rock a small ornamental slide-rest, and so produce various curves, some of which you printed on page 300 of Vol. XXXIX. Our friend's welcome reappearance in print reminds me that I have two more blocks which illustrate some further powers of the apparatus, some of which were quite unsuspected when the apparatus was made.

If you are good enough to print the blocks I now send, our friends will see some further illustrations of the rose-engine movement in one of them, and in the other they will see that by slightly altering the disposition of the parts, I have been enabled to produce cycloidal and trochoidal curves similar to those produced by the cycloidal chuck or by the epicycloidal cutting-frame. In all these patterns only the cast change-wheels of an ordinary Milne's slide-lathe were used. I may say that Mr. Milne has the few patterns required for the apparatus, with liberty to cast from them, and very good castings he sent me. Cut change-wheels would, of course, do better.

**F. A. M.**

## LATHE WITH VERTICAL SLIDE.

[24388.]—I NOW send you a cutting from the *American Machinist* of March 7th, describing a beautiful little lathe arranged with the vertical slide for milling, which I have so often advocated. The lathe is only 3½in. centres; but it is expensive, and it appears to be a kind of large watch lathe. It looks strong and (shall I say?) more English than most American work. I expect that before long an engineer's lathe will be considered incomplete without a vertical slide.

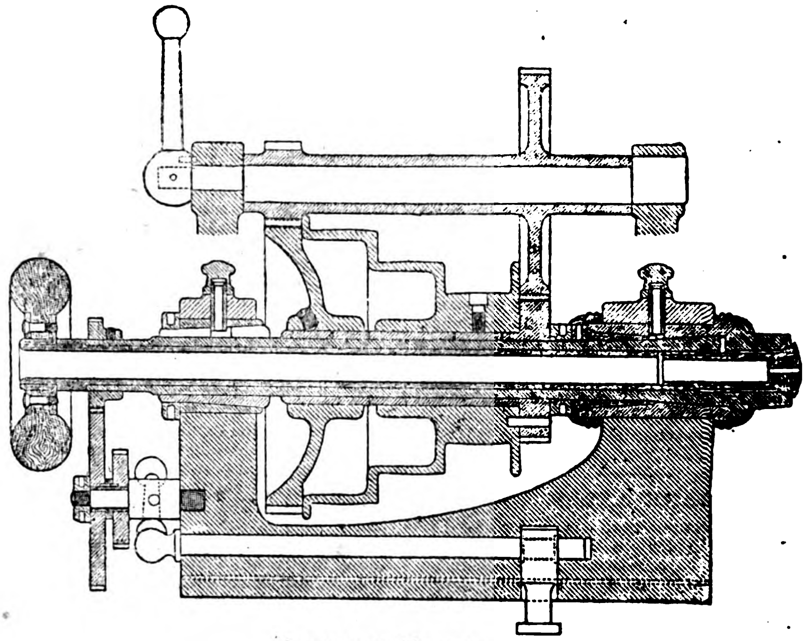
I have seen one of H. Walz's lathes, and consider the work very good and cheap; the method of raising guide-nut and releasing traversing mandrel by one movement of a handle is very convenient.

**F. A. M.**

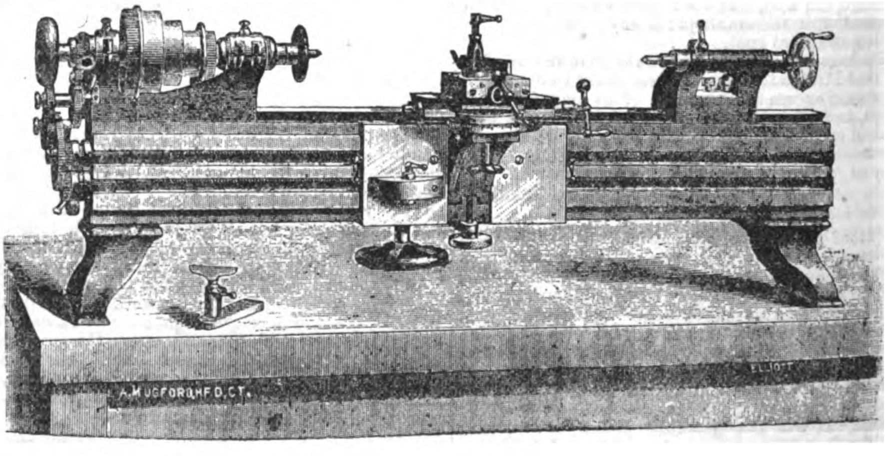
### SMALL UNIVERSAL ENGINE LATHE.

From the engravings which we present it will be seen that in the design of this lathe a radical departure has been made from the stereotyped plan of making small engine lathes—copies in miniature of larger ones. The construction is such that it will swing in line with the cutting tool as ordinarily used, a diameter about equal to what will be swung over the carriage of a commonly-constructed lathe of twice its nominal capacity.

As will be seen, the carriage may be run the entire length of the bed without coming in contact with either the head or tail-stock. The carriage is provided with a compound rest, which can be set at any angle, and which has direct vertical adjustment of 2in. Both the cross and angular feed screws of the compound rest are provided with micrometer heads reading to thousandths of an inch, the zero marks of which are adjustable to any fixed position of the slides, so that in many cases the micrometer arrangement may be used for sizing work instead of calipers or gauges, and at a good deal of saving in time. A T rest is furnished with the lathe, which is used in place of the compound rest when hand-tool work is being done.



SECTION OF HEADSTOCK.



The carriage is provided with every requisite adjustment for temporarily converting the lathe into a milling machine. If desired, a small milling machine vice is furnished, which can be screwed to the upper slide of the compound rest.

The lathe is provided with two leading screws, which are always ready for use, and are so situated as to be entirely protected from chips and dirt. One of these is a "precision screw," and is intended for use only for cutting fine and accurate screws. Both screws are geared alike, and will cut from 4 to 160 threads per inch, and from 8 to 80 per centimetre. The change gears are placed upon the stud and swinging arm instead of on the stud and screw, as is commonly done. When metric threads are to be cut, it is only necessary to substitute two translating gears—one on the screw and the other on the swinging arm—for those used for ordinary threads.

The lower part of the tail-stock is clamped to the bed by means of a cam; the upper part has a gibbed slide and clamp to set over for long tapers.

The lathe swings 7in. over bed and carriage, and is made with various lengths of bed from 42in. up. The hole through spindle is $\frac{6}{10}$in; largest hole through spring chuck, $\frac{4}{10}$in.

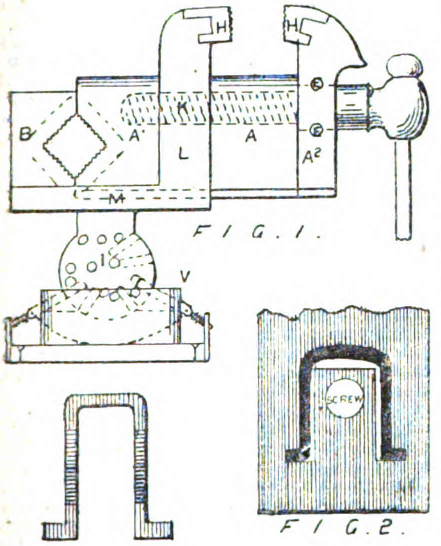
Larger spindles and chucks are made if desired. As will be seen from an inspection of sectional view, the spindle may be removed and another one substituted, or the boxes be replaced with others, without disturbing the running parts. In the sectional view the back gear is, for convenience, shown above the spindle, instead of in its actual position.

The workmanship on these lathes is excellent. The spindles and bearings are hardened and ground, and nothing but scrapers used in fitting sliding parts.

The Balloon Manufacturing Company, Hartford, Conn., are the manufacturers.

### COMBINED BENCH, PARALLEL VICE, AND TUBE VICE.

[24389.]—THINKING it would be of interest to your readers, I take the liberty of inclosing herewith a rough and rather inaccurate sketch of a combined bench, parallel vice, and tube vice, with special adjustment, recently patented by myself. If any of your readers like to make one for their own use they may. It will be seen by the globe I (which should be proportionately larger), that adjustment may be made to almost any angle and position, the holes bored in the globe fitting a ½in. steel rod, marked J. The teeth of the two vices and the screw are of steel, the other parts are of malleable iron. The screw K fits jaw L (Fig. 1), and is protected by cover A, which is also a dog of tube vice. L M and B are in one piece. A, $A^1$ and $A^2$ are in one piece also. Screw is fitted to *a* by means of groove and pins E. $A^1$ is the double jaw of tube vice (Fig. 3). Next week in the Sale Column I will advertise castings for this vice, and also the article complete. W. Bundy.



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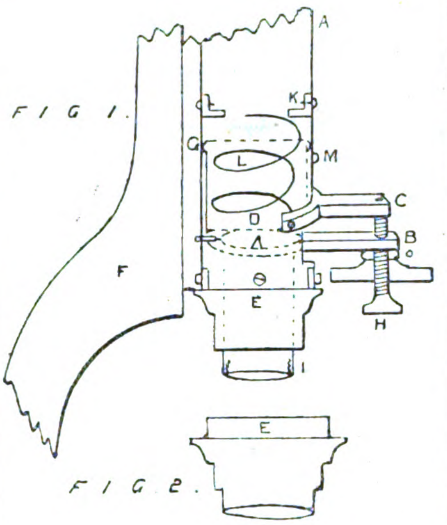
**Test for Copper and Lead in Wine.**—A new method for testing the freedom of wines from cupric and plumbic salts has been described by H. Hager in the *Analyst*. The wine is mixed with half its volume of a clear solution of caustic soda, which may contain carbonate. If the liquid remain clear after boiling, neither copper nor lead is present. A turbidity with colouration points to the presence of copper. About six cub. cent. of this solution are poured into a test tube, a piece of tinfoil introduced, and the whole heated for half an hour on the water bath. If lead and copper be absent, the foil remains perfectly bright; whereas if in the presence of a trace of one of these metals it becomes dull and grey for lead, and brown or brown-black for copper. This reaction may be applied to all cases when other metals are not present, and the solution remains clear after the addition of alkali.

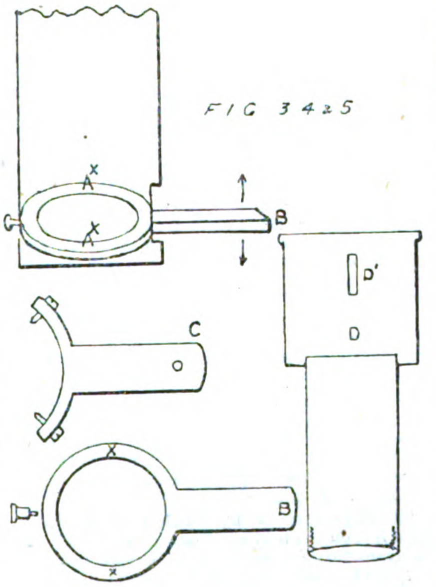
# REPLIES TO QUERIES.

◆

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[55819.] – **Microscope Fine Adjustment (U.Q.)**—"Sempervivo" will find this the form of adjustment he requires. It looks rather intricate; but a careful look at it will make all clear when the principle is seen. It can be made so that the milled head can be on the right, left, or middle. Fig. 1 is a sectional view, Fig. 2, 3, 4, and 5 the several parts. The dotted lines show the inside tube. A screw of about 60 threads to the inch should be used for the adjusting screw. All the castings can be supplied if "Sempervivo" does not want to make the patterns at the microscope maker's. I mean the actual makers, not the shop-tician. Shall be pleased to explain any part that is not clear.





A, body of microscope; B, lever for lifting objective tube; C, right angle piece for holding screw H; D, cylinder fitting body and lower casting *d* at I; E, casting for lower fitting; F, crane arm of microscope; G, solid brass block soldered to body; I, tube screwed to universal size; K, diaphragm to resist spiral spring L; D′, small slot to fit screw *m*; H, milled head; O, loose collar clearing screw; P has a tube soldered into the castings as shown. The sketches are as near actual size as possible, with the exception of the diameter of the tubes. $\updownarrow$ B indicates a play of ⅛in. up and down.—MENISCUS.

[56257.]–**Telescope Stand.**—I should advise "Omega" to procure a piece of scaffold pole 6in. or more in diameter, and not less than 9ft. long. (I presume that he has a garden, else, I should think that he would not want a cheap firm stand for his telescope). Dig a hole 3ft. deep and insert one end of pole in, hammer the earth all round the pole every few shovelfuls that are thrown in, until the hole is filled. If pole is not perpendicular give it a strong pull the way you want, and then pound away at the earth on same side to which it leaned. After a few such operations the pole will be firm enough for a telescope of double your aperture, especially after there have been a few showers of rain and the ground has got well set. Get a proper vertical and horizontal motion from an optician's. You will be best suited with one like those used with the claw table stands, and have it fastened to a piece of gas-pipe about 1ft. long. Now "let" a hole into the top of your pole in the garden that will hold the gaspipe in a horizontal position, half the gaspipe must project above the hole in the pole. Now procure sufficient lead that will make a cap for the top of pole, let it be concave at the top, and (of course, you will have it to mould); underneath let it have a groove that will fit the half of gaspipe which protrudes above the groove in the pole. Two holes must also be cast in the lead, or bored afterwards, directly opposite each other, and opposite the centre of the groove in the lead. These holes are for thumb-screws to screw the lead cap firmly on the top of the pole and to hold the gas-pipe tight. The thumb-screws will not be above 4d. each. Lead, the heavier and better, which should not be more than 7d. (I am reckoning at the rate of 1d. per lb.); gas-pipe not more than 6d.; scaffold pole, 9ft. long, not more than 1s. 6d. The vertical and horizontal motion to be screwed to your telescope I cannot speak definitely about; but that should not exceed 7s. 6d., so far as I am a judge of workmanship. I have a 3in. refractor, which I place upon a similarly constructed stand to what I have given here, and it has answered my purpose so far. For a cheap, firm stand it should suit "Omega."—D. BOOTH.

[56332.] – **Optical.**—I am sorry I did not see "Glatton's" reply before. The difficulty of the question is due to the thickness of the glass. Neglecting this, the result is easy to find. To find the mean position of $b$ for values of $\phi$ between 0° and 45°, we have, neglecting the thickness of the glass, $\sin. \delta = \mu \sin. \phi$, ∴ if $\phi = 45°$, $\theta = \sin.^{-1}\left(\frac{\mu}{\sqrt{2}}\right)$. Putting $\mu = \frac{3}{4}$ for rays passing from water into air we get $\theta = 32° 1'$. Also in this case, $D b = D P = B D \tan. \theta = B D \times \cdot 62528$, ∴ $B b = B D (1 - \cdot 62528) = B D \times \cdot 37472$, and when $\phi = 0°$, $\theta = 0°$ and $B b = 0$, ∴ mean value of $B b$ is $\cdot 18736 \times B D$ for values of $\phi$ between 0° and 45°. If the ray incident on D X is at an angle equal to the critical angle, $b$ will coincide with D, and for greater values of $\theta$ the ray will not emerge.—T. H. L.

[56475.]—**Nitrate of Iron.**—This query refers to what is pretty generally guarded as a trade secret. To save it getting into the U.Q. list Henry Holmes will find my address advertised this week.—W. JESSE LOVETT.

[56526.]—**Stained Floors.**—Scrape the parts and restain; or apply paint, and varnish that when dry.—DECO.

[56538.]–**Ink for Black-edged Note Paper.**—Use printers' ink, with extra strong, quick-drying varnish, and apply round the edge while the bulk of the sheet is protected by a stencil.—T. P.

[56542.]—**Staining Deal Floors.**—Try permanganate of potash.—DECO.

[56555.]—**Prof. Langley on the Solar Rays and the Atmosphere.**—Why should "R." think it "opposed to previous experience" that more heat should be obtained from the solar beam in a rare atmosphere than a dense one? Does not the sun brown the traveller's cheek on Mont Blanc, while in the valley they all shiver with cold?—S. P. T.

[56559.]—**A New Gum.**—Probably gum Kauri, but the "authority" is doubtful, as it is no more than a newspaper item.—C. K. T.

[56574.] — **Bearing Grease.**—Does "Inquisitor" want to sell the grease at the price named, or to make it at that cost?—ESSAR.

[56575.]—**Galvanometer.**—Is this query asked seriously? What is the use of a galvanometer if it is entirely concealed from view? Cannot querist manage to reflect the movements so that they can be read?—NUN. DOR.

[56579.]—**Pumps.**—This is a peculiar query, surely. What American pumps, and what principle does the querist suppose is employed different to all other deep-well pumps.—NUN. DOR.

[56604.]—**Differential Equations.**—It is true, as stated by "H. H.," that the differential equation in question occurs in the mathematical theory of electricity, although I should prefer to speak of the capacity of a conductor, or rather condenser, rather than the capacity of a circuit, and the current need not be alternating. In fact, to every such equation in the theory of heat there is a corresponding one in the theory of electricity. There are three or four quantities in each, which correspond to one another, as follows:—

| | |
|---|---|
| Heat. | Quantity of Electricity. |
| Temperature. | Potential. |
| Specific Heat. | Capacity. |
| Radiation. | Escape of Electricity. |

The differential equation is to be found in Clerk Maxwell's great treatise on "Electricity and Magnetism," who there states that it corresponds to the problem in the theory of heat I mentioned. —W. C. E.

[56620.]—**Steam Carriages.**—I thought the quotation from Reuleaux would clearly explain what was implied by the word "rails." It means some smooth, hard surface, such as the granite tramway laid down in the Commercial-road, E., leading to the West India Docks, or the asphalte in Cheapside. Flanged wheels are altogether beside the question, because it is a *sine qua non* with a steam carriage, that it shall be readily and perfectly steered. What "Progress" means is really a steam tramway. "Gwyllm Maesgwym" says my reply is "very one sided," but as he supplies the other side, it does not matter, only I should like to know where he finds anything believable about a steam carriage running 35 miles an hour. Expect it must be the same one that ascended old Highgate-hill (one in nine), and came down rather more quickly than it went up; but perhaps "G. M." will give chapter and verse for his statements. If I understand him, he traverses the dictum of Reuleaux, and "ventures to doubt it in toto." But what does he mean by "none were used by Gurney and Dance":—none what? He seems to have forgotten that Trevithick was a quarter of a century in advance of them, and that there were at least a dozen others equally as successful, and one (Hancock) certainly more successful. It is true that for a time heavy tolls were levied on Gurney's and on Dance's carriages, and the road was covered occasionally with a coat of soft gravel; but, so far from the success of their carriages being "indubitable," they failed like all the others, because of the enormous cost of repairs. Heaton Brothers, of Birmingham, did as much as anybody (with the exception of Hancock) to make steam carriages successful; but, after spending upwards of £2,000, they had the courage to acknowledge that to obtain an average speed of ten miles an hour the expenditure would exceed the receipts. The *Birmingham Journal* for April 12, 1834, was "authorised to state" that the experiments had not proved satisfactory, and that a meeting of shareholders would shortly be called. So far as I can find, neither Gurney nor Dance ever published a balance-sheet, or explained how much they had spent in repairs. I am much afraid that our friend "G. M." has relied upon Dr. Lardner's statements, or upon some work having the same origin.—Nun. Dob.

[56620.] — **Steam Carriages.** — With the Editor's permission, I shall be glad to enlist the attention of Mr. A. H. Bateman, whose remarks in No. 1,055, p. 329, of the "E.M." for 12th June, point him out as one suited to the production of a tricycle with accessory power beyond mere pedalling. I fancy the "motor tricycle," patented by Sir Thos. Parkyns, aimed at too much for attainment in the present state of motive power; and, as indicated by Mr. Bateman, had the steam power been sufficient to drive the machine up hills, it would have been positively dangerous on the level from the excessive speed possible. But pedalling on a level hard road is really a pleasure, and need not be fatiguing; on a falling gradient it may be very little or *nil*, to proceed at a pleasant speed; it is only the heavy adverse gradient, or slightly adverse gradient with a badly-surfaced road, that tries the rider; therefore, the desideratum is auxiliary power for perhaps one-third of the distance traversed. This would reduce the expenditure of extra motive power to one-third, consequently, save two-thirds of the fuel and water (if water) required. But that is not all the saving. In the "necessary qualifications" enumerated by Mr. Bateman, considerable extra weights for machinery and water are both contemplated; but query—are these necessary? In a former communication which you did me the honour of inserting, I offered some suggestions on this subject, in which the use of gas-engine power as an auxiliary to pedalling was advocated, provided such engine could be driven by the vapour of some hydrocarbon, and the usual "movements" of an engine simplified by shifting of the valves when required by the action of the pedals alone. This would reduce the "engine" to little more than a piston and piston rod, acting upon the driving-wheels' axle by a species of clutch action, to convert reciprocal into rotary movements; in fact, by making use of all the existing parts of an Omnicycle (except the hill-climbing gear, which might be dispensed with). The piston should be capable of being thrown in and out of gear readily as required. Of course, I am not able to suggest all the details; it requires somebody familiar with engines and engineering work to do that to best advantage; but in this direction I feel convinced that the additional weight required need not be serious.—Gamma Sigma.

[56650.]—**Lead-burning.**—Mr. Davies does not understand why I should try to put him right when he says the vitriol sold by druggists will not do for lead-burning. I say it will, and does every day, answer well. Mr. Davies keeps harping about his book. I have never seen his book, did not know there was a book, and he should remember that there are thousands of readers of your good publication who cannot buy all the books that are published, and hundreds of your readers who have not seen either his book or your back numbers, nor have the chance of seeing them. No doubt Mr. D. is very clever and kind, and I hope he has reaped his reward by the sale of his book. He asks what I would have him think when I speak of using clean zinc, free from paint and wire? Well, I would say that any lead burners, except mere learners on a bench or in a plumbing shop, would know that there is plenty of painted zinc with wire worked in it in the shape of ventilators and watering-cans that are often bought for lead-burners to work up, and I advised "Young Beginner" to shun the dirty stuff until he is more practised; as to throwing the dirty gas away, as Mr. Davies makes me say, I said nothing of the sort. I advised "Young Beginner" to make nothing but clean gas, and, by the way, how does Mr. D. make out that the gas is dirtier the first half-hour than after? This is contrary. Will any kind reader of our valuable magazine please to inform me how to have soap free enough for domestic use from lyes. I manage it now by finishing on common salt brine; but as this adds to the time and the expense, I am anxious to go the shortest way to work, as I am convinced there is a readier way than having this extra process or change of salt brine.—Henry Holmes.

[56673.] — **Mechanics.**—Thanking the correspondents who have taken so much pains to clear up my difficulty, and "M. R. C. S.," &c., for most interesting suggestions on the forming of four triangles by four straight lines, my difficulties as to the question in mechanics still remain, and which I will endeavour to express more clearly. I have not done much in solid geometry; but I was certainly under the impression that taking any four-sided pyramid it can have only one sphere described around it; therefore when Todhunter wrote "one of the described spheres," I cannot understand what he means. "Hemisus" says if all the forces are like, the centre of parallel force is at the centre of the inscribed sphere: this I reasoned out myself; but he says, if I understand, that, if unlike, the centre is at the centre of a described sphere. Now, suppose we have a tetrahedron, A B C D, and suppose force at A unlike the other forces, then it would seem to me that the centre of parallel forces ought to fall beyond the base opposite to A at a distance, if $p$ be straight line joining A to centre of base, equal to $\frac{1}{2} p$; now the centre of the described sphere must fall on $p$, as I see. Thanking "Hemisus" for his attempt, could he or someone else clear these further matters up?—J. C.

[56676.]—**Hardening Jaws for Chucks.**—I am obliged to Mr. Bundy for the information he gives, and for his kind offer to do the work for me. Having made the jaws, however, I am desirous of finishing them. Will Mr. Bundy say what amount of potash should be used in a given quantity of water, and what the temperature of the water should be; also whether the jaws should remain any length of time in the water.—Alfred West, Bridlington Quay.

[56679.]—**Supported Beam.**—In the original question, page 268, it is evident that "no tendency to break" refers to horizontal, not to vertical or shearing, strains. "Bacchus" is not quite correct, page 329, for there is no shearing at the centre of the beam.—J. S. C.

[56682.]—**Struck by Lightning.**—The "old scale left on the bottom of one of the feet" in this distressing case seems to indicate something of the nature of induration (less in degree) in the other parts of the body affected by the lightning stroke. In such case it would seem to me that applications tending to soften rather than to harden the flesh are indicated for relief, if not for permanent cure—as warm bathing. I am the more inclined to write thus on learning that the pains are acute when storms come on. Such pains are often ascribed erroneously to rheumatism, when they arise, I think, from atmospheric action on parts previously affected by rheumatism, or by other causes permanent, or leaving permanent effects, as in this case. It is quite certain that disturbances of atmospheric pressure, which storms indicate, are followed by re-arrangement through the bodily system, as well as externally. The air thus entering from without or escaping from within the body encounters resistance in hardened parts, and would make itself felt in parts left in irritable condition by previous disease. I have again and again on such occasions acted on the conviction in my own case that such pains are not rheumatic, and have been right. I advised a poor woman a short time ago to soften her feet by soaking in warm water, having this cause of suffering in my mind. I forgot the circumstance when I saw her a few days after; but she had not, the relief had so speedily and surely followed. I am not a medical man, but an observer only. I am careful, however, to keep back such statements as the above until conjecture has been followed by facts which recall it in a convincing manner again and again. Permanent cure may not, perhaps, be expected in such a case; but while I would recommend careful study of the whole of that passage in Job xxxiii. 14-30, I am strongly reminded by the 25th verse how much the habits of our life tend to induce premature old age, than to prolong or enable us to recover the freshness of youth. Everything tending to promote a healthy circulation of the blood will tend to soften and restore the flesh to a healthy state, such as moderation in eating and drinking, cleanliness, promoting free perspiration and exercise in whatever form it can be best taken. It is a case, I think, in which medicine may be of some little use, but wholly below such arrangements for healthy living as the fear of God and good sense teach.—J. M. Taylor.

[56743.]—**L. and N.W. Railway.**—Simple engines are at present the most popular with the drivers, owing to the scarcity of compounds, there being only about 40 in existence. Possibly it depends in a great measure upon the work which the engines have to do. The home of the engine Cornwall is at present at Whitchurch, and invariably runs local trains:—Whitchurch to Crewe, Crewe to Chester, Crewe to Stafford, and is this week running 5.20 p.m. train from Manchester to Crewe viâ Stockport.—Wild Rushes.

[56744.]—**Softening Water.**—I have seen a "Water Purifier" made by Gray and Sons, of Leadenhall-street, and although not a chemist, I managed to get water from 20cc. down to 2cc., Wanklin's soap test. I have been told that this apparatus is supplied with a set of nozzles properly calculated to regulate the proportion of the water and reagent, and thereby dispensing with a chemist. I believe this is one of the principal features. These nozzles could be altered to give any result, if necessary, but will probably be at their best when supplied. The apparatus is something like a coarse filter, but has the peculiarity of cleansing itself automatically. I think Wanklin's soap test is the easiest to work with, and cheaper than Clark's, and should be measured by an ordinary burette.—Kcalbred Naxela.

[56744.]—**Softening Water.**—An apparatus for this purpose is described in the *Journal* of the Society of Chemical Industry for May last. The patent number is 6,213; April 10, 1884. The apparatus is to be employed for the purpose of mixing lime-water or other liquid or liquids for use in the said process, or for mixing such liquids with lime or other solid matters. A hollow standard, capable of revolution on its own axis, and provided near its bottom with a hollow, perforated arm standing out at right angles, is placed in a tank, preferably near the floor, so that the apparatus may be immersed in the materials to be acted upon. At the top of the standard is an arrangement by means of which a stream of water can be injected under pressure, together with a quantity of air drawn in through apertures. The air and water pass down the hollow standard and along the arm until they reach the perforations through which they escape, causing a more or less violent agitation of the liquid by which the arm may be surrounded. The apparatus may be placed in the centre of a tank, or two or more of them may be placed in one tank, motion being given to them by suitable contrivances. In place of a stream of water under pressure, air may be forced from a pipe through the hollow standard. I believe there is a firm in London whose sole business is the working of the "Porter-Clark process"; no doubt they would advise "J. T. C." The best test of the hardness of water is to estimate its soap-destroying power. This is done by adding to it a "standard" solution of soap (i.e., a solution of known strength), and noting the quantity required before a lather is produced on shaking. "J. T. C." should ascertain, once for all, the hardness of his water. There would be a certain definite proportion of lime necessary, and corresponding to this degree of hardness, and this quantity would be kept to without alteration.—Chromio.

[56746.]—**A Disagreeable Noise.** — Great benefit will be derived by putting the anvil on a bed of indiarubber, say, 4in. or 5in. thick, let in the ground, taking care to prevent the hot scales getting near the indiarubber. If this does not suit your purpose, then persuade the lady to remove.—Wild Rushes.

[56746.] — **Disagreeable Noise.** — Get four pieces of cork about 4in. square, as thick as you can. Make them a little hollow, so that the surface will bear on each corner, and a groove on the other surface for the wheels, if required; or try indiarubber. Be sure and keep the bed from touching the walls.—Alexander.

[56770.]—**Putty.**—I have made it two or three times with the same materials as you used, and had no fault whatever to find with it. Reduce the whiting to powder, mix with oil, work well, and there is no fear the putty will be right. The rabbet or check for holding the glass should be primed before putting the glass in; it makes the putty stick.—David Stephen.

[56780.]—**Camping Stoves.**—I always use methylated-spirit stoves, as I consider they are best, although many of the oil stoves made are good. If you sleep on board your boat, you will require an "anchor lamp"—a lamp showing a clear white light all round—hung from the forestay or from a line made fast from the top of the mast to the bows. If you sleep in a tent, this lamp could be hung from the roof without danger of setting the tent on fire, as they are comparatively cool, burning sweet oil, and having no interior funnel, and for the same reason a similar lamp would do for the cabin. These lamps vary in price from 3s. to 10s., according to material and workmanship, and should only be purchased from a ship chandler, as similar lamps are made by tinsmiths, which are so easily blown out that they are worse than useless. —James M'Cash Govan.

[56783.]—**Problem.**—I do not think the answers given to "Trophy's" question are correct. The first supposes a mistake in the question, and, therefore furnishes an incorrect answer. The second makes $x = 800$, $y = 80$, $z = 160$ gallons. Now, if $M$ = time A. take to empty hold, then A. pumps $x + My$ in doing so, $My$ = amount of water brought in by leak. A. will pump $\frac{x + My}{M}$ gallons per hour = $z$ in answer. A. in 3¾ hours will pump $\frac{x + My}{M} \times \frac{15}{4}$ gallons, $\frac{15}{4}$ hours being time taken to empty hold, both working together. Now this, according to question, is 10 gallons more than A. did pump out. Now, by question, A. worked for 13⅓ − M hours, and in that time would pump out $\left(\frac{40}{3} - M\right)\frac{x + My}{M}$ gallons; and this quantity is stated to be less by 10 gallons than the previous; thus—

$$\left(\frac{40}{3} - M\right)\frac{x + My}{M} = \frac{x + My}{M} \times \frac{15}{4} - 10.$$

Putting—

$$\frac{x + My}{M} = z = 160, M = 10, x = 800, y = 80,$$

we get 160 = 177, which is clearly wrong. The values I get are $x = 120$, $y = 12$, $M = 10$, $z = 24$, which seem to me to satisfy all equations obtained from the question.—J. C.

[56788.]—**Agglomerate Battery.**—I have been troubled in the same way, and found the cause due to the contact between the lead cap and the carbon being faulty. I found mine out by testing with a piece of copper wire held against the carbon instead of connecting to lead cap. I put mine right by melting off old caps and casting on new ones.—Egbokg.

[56795.]—**To Mr. Wimshurst.**—To answer the questions of "W. B." would take more space in your columns than would be reasonable. Moreover, even then, owing to the absence of knowledge, the subject would be left quite open; but if "W. B." turns back your pages to January, 1883, he will find your descriptions of the machine, and have as good a working hypothesis as perhaps can be obtained. Unless the two sectors in line across the plates be brought into perfect metallic contact with each other by means of the brushes and rods, the machine will not obtain excitement, and when excited, very little resistance can be put into this circuit between the brushes without losing the excitement; therefore, I think he would not obtain either the spark or charge of any great value by connecting these rods to an insulated prime conductor. My system of using the current from the brushes is to add a length of vulcanite to form part length of the neutralising rod.—James Wimshurst, 4, The Grove, Clapham-common.

[56796.]—**Boiler.**—To "Invicta."—Your boiler, 9in. square and 20in. high, would need before using it for steam, to be fitted with stays. I should fit these in by drilling holes, so that three stays were fitted. The holes must, of course, be arranged vertically, so that the stays pass one another. I should make them of ½in. round iron with the ends screwed; by passing them through the holes nuts can be screwed on the ends with cement or a lead washer under each nut to make the joint. When these stays are in so that the flat sides are relieved of pressure, a stay should be fitted to the boiler to stay the ends. This would be best done by two stays, as they would miss the other cross stays. When you have all secure you might, supposing the plates are good and not wasted by the welding, be safely able to run at, say, 25lb. pressure. I prefer, with a welded generator and of square section, to be well on the safe side. If all be perfect, no doubt a very much higher pressure would be safe. But, unless I saw and satisfied myself as to the soundness of all parts, I would prefer to be well within the limit of safety. I should fix such a boiler in a brick setting vertically, the fire being in front and carried round with a shell flue. Such a boiler would supply steam for an engine either 1¼in. bore by 3in. stroke, or 2in. bore and 4in. stroke. I should carry the water line up to 14in., thus leaving ample steam room. Safety-valve should be to allow ample area, $\frac{13}{16}$in. in the clear bore, not the outside of valve: this would give a fraction over half a square inch. Let the joint or point of resistance be ¾in. from the centre of the valve. Length of lever from centre of point of resistance to end 5in. Let the weight be 2oz., and steam should blow off at 24lb., whilst the weight of lever and valve will at least increase the pressure another pound, thus giving 25lb. to blow at. —Invicta.

[56798.]—**Filter.**—Taking the fall into account, the flume will not give more than 40 gallons of water per minute—i.e., 960 gallons per diem (24 hours). The filter which I should say would suit "Backwoodsman's" purpose will be such a one as is used by waterworks companies, which is composed as follows:—18in. puddled clay, 5ft. of ordinary small stones, known as "metal," 3ft. of gravel, 2ft. of sand. In the clay is laid the exhaust troughs, covered with larger boulders, to keep the way clear. Such a filter will filter 500 gallons per 24 hours per square yard, and will cost about 15s. the square yard. If the above heights are too great, reduce the metal to 3ft. 6in., and gravel to 2ft. 6in. If this filter will not do, "Backwoodsman" might use charcoal filters, but they will be expensive.—Boolie.

[56806.]—**Foci of Lenses.**—The focus of all converging lenses, which are the bi-convex, plano-convex, and meniscus forms, can be found easily enough. Thus, by holding the lens you want to find the focus of in the light of the sun, and moving it to or from a sheet of white paper or a whitened wall, at a point a distinct and sharply-defined spot of light will be seen. The distance of the lens from the image thus formed is the focus. You may also employ a lamp or gas-jet, and from the image of it in the same way get the focus; but in that case the lamp or light should be not less than 20ft. away. Divergent or concave lenses are not so easily dealt with, as they do not bring the rays to a point or visible focus. One way is to ascertain exactly the size of the concave lens. Supposing it to be 1in. diam., then draw on a piece of paper a circle exactly 2in. diameter. Now pin the paper on a wall facing the lime, and hold the concave lens at such a distance from the paper that the circle of light passing through it just fills up the 2in. circle on the paper. The distance apart of the paper and the lens would be its focus. There are other ways of finding the focus, but I consider this as simple as any. A converging achromatic is dealt with in the same way as the simple magnifying lens, and the concave the same, the only difference being that the resultant focus is that of the combination, and not that of either of its components. The cement used for achromatic lenses is usually Canada balsam. One well-known telescope o.g. maker used to use a cement of equal parts of oil of cassia and either Canada balsam or castor oil.—Invicta.

[56807.]—**Buttons and Buttonholes.**—Would not some sort of a light spring clip do instead of the button-hole?—Cymro.

[56811.]—**Surface Condensers.**—To "Invicta" and Others.—Two forms, giving equally good results, are available for you to choose from. One is that of two tubes of the same length, but one, say, 1in. less in external diameter than the other; the smaller being placed inside the larger, and the annular space at each end closed, an annular condensing chamber is formed, which would be found exceedingly effective; the whole condenser being placed in a tank a little larger than itself. Or a core of tubing of sufficient length may be used in a similar tank. In either case the equivalent condensing surface of 30ft. of 1in. pipe per horse-power is sufficient. As to the volume of cold water, about one gallon of cold water per minute is needed for each horse-power, with a surface condenser and low-pressure steam, such as you mention. Air-pump may be of such dimensions that it is one-third the area of the steam cylinder, the stroke being that of the steam cylinder. For such low pressures I should allow 38 to 40 square inches to each horse-power on the piston.—Invicta.

[56812.]—**Terrestrial Telescope.**—You can easily get a new flint lens fitted, if the instrument is worth it, by sending the remaining lens, with the broken one, to any good optician's.—Invicta.

[56813.]—**Fracture of Water-Gauge Tube.** —The reason these ideas have entered the mind of the querist is probably owing to a heavy supper, which has produced a very vivid nightmare, and thus given the semblance of reality to a disordered imagination. I have often cleaned glass gauge-tubes in the way mentioned, and have sometimes even scraped them clean with a bent wire. I once worked a boiler with a wire up the tube to collect incrustation and prevent it lodging on the inner surface of the glass. My glasses wear out, but they never break.—Bacchus.

[56815.]—**Tank.**—I should prefer the outlet-pipe in the bottom to the siphon. Theoretically the siphon would not deliver the same volume of water per minute as the simple outlet. And beyond this a siphon quickly loses a part at least of its power of discharge. So that both in theory and practice a discharge-pipe on the bottom is preferable.—Invicta.

[56817.]—**To Mr. Wenham.**—The arrangement for equalising the wear of the guide screw adapted by Andrew Muir to his lathe, consisted of a flat bar attached at one end by a bolt to the slide or saddle, and at the other resting in a bearing from the outer end of the lathe-bed. This bar carried the usual form of handle and clip nut, which could be clamped and fixed on the bar in any part of its length. The object of this addition was to distribute the undue wear that would otherwise occur in one spot on the guide-screw, by constantly cutting short screws, such as taps. Of course, if very long screws were to be cut, requiring nearly the whole traverse, this arrangement would not be needed; and if in the way, could at once be taken off, and the primary clip-nut employed as usual. Both clip-nuts might be set in gear at the same time without interfering with each other; but I am not aware that this was ever practised.—F. H. Wenham.

[56818.]—**Spherical Aberration.**—Yes. The distance between the lenses produces an effect upon the spherical aberration which is even more conspicuous than that produced upon the colour. I have within the last week received from a very skilled artist what I believe, to be a fine telescope of 3½in. aperture, constructed with the special view of correcting spherical aberration by adjustment of the distance between the lenses. I hope soon to be able to send, with our Editor's kind permission, some account of its construction and performance.—W. G. P.

[56819.]—**Pickle for Brass.**—"J. H. D." will find this method answer his purpose: First, wash the article in a solution of caustic soda and dry in hot sawdust—this will remove all grease; then dip for a few seconds in the following solution: 15 parts by weight of oil of vitriol, 15 parts of nitric acid, and 3 parts of common salt, which must be well dried in an oven; then mix all three together, and stir with a glass rod. Afterwards wash the article in hot water, and dry as before. This will produce a good dead colour, which can be brightened by scratching or burnishing.—Edward Antipessent.

[56820.]—**Commutator.**—A commutator is for reversing the current in the primary, which reverses the poles of the electro-magnet, which, in its turn, alters the direction of the secondary current. You need not expect 1in. spark: you should be quite content with ¼in. spark, if you get that. With a ½in. spark you will be able to light up a 12in. vacuum tube. It is for reversing the current when lighting up vacuum tubes that the commutator is necessary. Two one-quart bichromates is heaps—one would do.—C. L.

[56820.]—**Commutator.**—The commutator is an extremely useful addition to an intensity coil, although it cannot be regarded as one of its essential parts. For a coil the size of yours it would be better to have one, and I should advise accordingly. The commutator has two very important purposes: (1) To change the direction in which the current flows through the primary, and consequently changing the direction of the current in the secondary circuit also. Hence it acts as a current-reverser, and is very useful in many experiments. (2) It may not only be used as a reverser, but also as a current-suspender. Presuming it is made of a cylinder of ebonite or ivory, with springs pressing upon plates of brass on two opposite sides of the cylinder; if the cylinder be turned one quarter of a revolution, contact will be broken, as the springs will rest upon the ivory or ebonite between the two brass plates. This enables the arrangements for the secondary current to be made without the chance of receiving an unpleasant shock. If the insulation is good, the manner in which you have built your coil should suffice; but do not be disappointed if a 1in. spark is not obtained. A condenser will be necessary, its size being in proportion to the battery-power you propose to employ, and best ascertained by experiment.—Bobadil.

[56825.]—**Mechanical Question.**—I think that "Student" has made a slip of the pen, and that in his given case "similarly supported" should be "horizontally supported." This change would make the case be consistent with the strength of fir as given in Molesworth's Pocket Book. Of course, the beam when supported with an inclination of 60°, will carry twice the weight that it would do when horizontal. The required depth of the first-mentioned beam is 3·534in.—Dubliniensis.

[56825.]—**Mechanical Question.**—Resolve the weight into two components, parallel and at right angles to the beam. Neglecting the former for the latter we have—

$$W \cos. \theta = 2{,}240 \cos. 60^\circ = 1{,}120\text{lb.}$$

Let $x$ = required depth, bearing in mind that the strength of a beam varies inversely as the length, directly as the breadth, and as one depth squared we have the proportion—

$$1 : \frac{2x^2}{10} : : 450 : 1120$$

from which—

$$x = \frac{\sqrt{112}}{3} = 3\ 63\text{in.}$$

This is not providing a factor of safety.—David Stephen.

[56826.]—**Loss of Power.**—If the ½ ton mass be moved to and fro by a bar worked by a crank connected with a sufficient fly-wheel, the energy expended in communicating kinetic energy to the mass will be exactly repaid during the retardation of the mass; so that we have to think only of the work done against friction. In the present case the coefficient of friction is about ·032; so that the resisting force of the friction is about ½ ton × ·032, or 35·84lb.; and the work done per minute is 573·4 foot-pounds. If the mass be moved to and fro without a fly-wheel, or some equivalent appliances, the question cannot be answered without knowing the velocity imparted to the mass at every stroke.—Dubliniensis.

[56827.]—**Loss of Power.**—The coefficient of friction may be taken as $\frac{1}{10}$. The distance weight moves per min. is 16ft., therefore the work lost in overcoming friction $= \frac{2{,}240 \times 16}{2 \times 10} = 1{,}792$ ft.-lb. per min. The work done on a body of $w$ lb. to give it a velocity of $v$ ft. per sec. is given by the formula $\frac{w v^2}{2g}$. This is also the measure of work done against the body in order to stop it. Taking the greatest velocity double its average velocity, we shall have $v = \frac{16 \times 2}{60} = \frac{32}{60}$, and the work done in the eight starts and stoppages will be

$$\frac{1{,}120 \times \left(\frac{32}{60}\right)^2 \times 8}{2 \times 32} = 39\ 82 \text{ ft.-lb. per min.}$$

—David Stephen.

[56832.]—**Steam.**—To get the number of cubic inches in the cylinder, multiply the diameter by $\pi$ ($\pi = 3{\cdot}14159$), and multiply this (the area of the cylinder cover) by 72in. (stroke). This will give the total number of cubic inches in the cylinder. Steam is cut off at ⅕ of stroke, ∴ only ⅕ cylinder full is used at each stroke, so that the capacity of cylinder × ⅕ = amount of cubic inches of steam used per stroke.

Diam. = 32. Area = 32 × 3 14159 = 106·81406 sq. in.
106·81406 × 72 = 7,690·61232 cubic in. in cylinder.

$$\frac{7{,}690{\cdot}61232}{5} = 1{,}538{\cdot}122$$ cubic in. of steam per stroke used. To find the amount of condensation water required by one of the old-fashioned condensers, multiply temperature of steam by ·019, when the product will be the number of gallons of water required per minute per h.p. Temperature of steam at 35lb. = 280°; 280 × ·019 = 5·12 gals. per min. per h.p.—Boolie.

# UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

Since our last, "Meniscus" has replied to 55819.

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56315. Anemometer, 135.
56316. 8in. Spark Coil, 135.
56319. Expansion Valve, 135.
56325. Gyroscope, 135.
56330. Soluble Oil, 136.
56333. Scale Scoops, 136.
56343. Electrical, 136.
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56347. Centre of Percussion, 136.
56348. Colouring Terracotta, 136.

56507. Engine Query, p. 222.
56514. Chemical—Peroxide of Hydrogen, 222.
56523. Finishing Silver Plated Goods. To "Goldsmith," 222.
56525. Cyclist Tour in Scotland, 222.
56528. Bending Box Spade Handles, 223.
56531. Gramme Dynamo, 223.
56536. Special Run, 223.
56540. Westinghouse Engine for Flour-mill, 2.3.
56552. Gas-engine. To "R. A.," 223.
56554. Ordnance Factory, Enfield, 223.
56556. Heating Surface in Vertical Boiler, 223.
56564. Pocket Battery. To Mr. J. E. Chaster, 223.

# QUERIES.

[56831.]—**Removing Zinc from Tin Solder.**—I have some tin solder which contains some zinc. Would any reader oblige by giving a method for the removal of zinc in it?—Penwith.

[56832.]—**Engine Query.**—I have a pair of valve laths, but I cannot tell the whereabouts of the piston by their use. Of course I know there are machines for such use, but I should like a rule to work on for marking the laths without a machine.—Num Skull.

[56833.]—**Horizontal Engine.**—Could any of our readers kindly assist me with a horizontal engine. I have cylinder 1½in. bore, 3in. stroke, also a flywheel 6in. diameter—or say where I could see a detailed drawing? and oblige—Alexander.

[56834.]—**Sundials.**—Will some correspondent refer me to a work on the graduation of sundials?—Rosicrucian.

[56835.]—**Copying Drawings.**—Some time ago I had a formula given me for copying drawings, composed of ammonio-citrate of iron 15 drachms, red prussiate of potash 10 drachms, distilled water 16oz. I have mixed up the solution and painted it on a sheet of paper, and have both put the drawing on top and underneath the paper under glass, but cannot arrive at any result. Could any of "ours" enlighten me as to how to go to work by giving full particulars?—W. R. A.

[56836.]—**Telescope.**—"E. R. H." wants to utilise a 5in. achromatic lens, for a direct-vision astronomical telescope. What length of tube, and what kind of eyepiece would be needed?—E. R. H.

[56837.]—**Drill Chuck.**—Will "T. F." please to inform me if the Little Giant drill chuck (he recommended a fortnight ago) will hold twist drills down to ⅛in.?—T. H. and S.

[56838.]—**Telescope.**—I have a tourist telescope, achromatic o.g., 2in. dia., 24in. focus, with which I want to use a stronger eyepiece, without doing away with its present one. How can the right distance between the two sets of lenses be found? And would it be well to shorten the tube to that distance, and have a band inside with thread, to restore the tube to its present length?—Eyepiece.

[56839.]—**Automatic Steering Gear.**—I wish to fit an automatic steering gear to a 2½ft. model yacht, to make the rudder port and starboard, once every minute. I suppose it will have to be done with spring and train of wheels. Could anyone oblige with description and drawing of same?—Tiller.

[56840.]—**Rubber Stamps.**—I have a machine and appliances for rubber-stamp making, and can make any name when the impression is taken from type. I am anxious to make signature stamps. Will some fellow-reader kindly say how I must proceed?—Autograph.

[56841.]—**Accumulator.**—Will some kind correspondent give the rule to find the weight required on column of water, the height of which is 36in. by 18in. dia., with a discharge tube, 1in. diameter, inside at bottom of accumulator, to give 50lb., 100lb., and 150lb. pressure per square inch? Also to find the power required to keep up the supply of water in accumulator, and how to find the required thickness of metal of cast-iron accumulators to stand the several pressures given?—One Anxious to Learn.

[56842.]—**Lathe Query.**—Will Dr. Edmunds or Mr. Hines please say of what material the laps are composed that are used for finishing screws in lathe as referred to in letters recently in the English Mechanic? As with a lead lap it is difficult to retain a sharp edge for getting in corners, I suppose it must be some kind of soft brass or bronze.—W. B. S.

[56843.]—**To Mr. Wetherfield.**—I have a little boy who is nearly old enough to be sent to school. Instead of sending him to school in this place (to learn slang expressions and impudence), I should be very glad if you would inform me whether I can legally keep the child at home and educate him myself until he is old enough to be sent to a proper school? I hold an appointment in the Civil Service, and have, therefore, previously passed a competitive examination held by the Civil Service Commissioners. I ought, therefore, to be able to set aside any question that might arise as to my ability to educate my child in elementary subjects.—Ecossais.

[56844.]—**Mathematical.**—If the centre of a circle be the pole, shew that the polar equation to the chord of) the circle which subtends an angle 2B at the centre is $r = c \cos. B. \sec (\theta - a)$ where $a$ is the angle between the initial line, and the straight line from the centre which bisects the chord. Deduce the polar equation to a straight line touching the circle at a given point.—Conic.

[56845.]—**Coil Springs.**—I should feel much obliged if any of your numerous readers could assist me by a description of the successful method, to enable me to manufacture springs, something like a large clock spring. I propose to employ steel 8in. wide, by 17 B.W.G. thick, and 28ft. long, and when it is coiled to say 9in. diameter. I want it on a 2in. diameter shaft, to take say 11 revolutions, and sustain a weight or traction of 300lb. I can have any temper or quality of steel from good reliable makers, but it is not possible to get anyone to undertake the manufacture, so that I am obliged to undertake the work myself.—Bouclier.

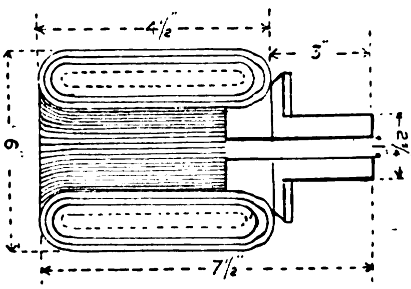
[56846.]—**Connecting Electric Bells.**—I have two electric bells with separate circuits, and I make the ringing of one complete the circuit of the other, so that the latter should ring until stopped. That is accomplished by means of an arm resting against hammer of first bell. The falling arm is insulated, but by its weight, the hammer of the bell on which it rests falls down, completing circuit of inner bell, without the outer one being rung. On the other hand, if the falling arm is made lighter, it will not press with sufficient power on falling, to make a perfect contact. If the falling arm is set too delicately, it will slip past the hammer (by reason of its weight, as explained): if more firmly set, it prevents the outer bell from ringing. Is there no other way of connecting these two bells? Should be very grateful for information as to methods of making the ringing of one bell start another.—Ignorant.

[56847.]—**To Mr. Lancaster or "Rob. Cru."**—I am about to make a telescope, and should like to know whether an achromatic object glass, 2½in. in diameter, with a 40in. focus, will be better than a ditto 2¾in., with a 50in. focus. Which would make the best telescope?—Focus.

[56848.]—**Grinding Pearl Barley.**—I have a mill for making pearl barley, and when working, a large quantity of very fine dust is flowing through the building, which is most disagreeable and unwholesome. There is a loft above this place, into which I think of driving the dust. Would any of your readers kindly help me?—X. X.

[56849.]—**Sewing Machine Motor.**—I have just made one of these, castings by Cuttriss and Co., of Leeds, style B1. The makers of castings say they are guaranteed to drive a small sewing machine. I use 6pt. Bichromate cells, and find armature starts off at a good speed, but very soon slackens until it stops. Without doing any work it will go on for a long time, but connecting it with sewing machine, it soon stops. If I disconnect the battery, and connect again in about five minutes, the motor works all right for another short period. Can any reader inform me where I am wrong? Is it in the winding, or battery? I should be pleased to forward it to be tried if any kind friend would take pity on a—Beginner.

[56850.]—**Dynamo.**—To Mr. Bottone.—Will you please help me in the following? I am making a dynamo with Gramme armature, and as my ring is finished, I want to know how to get the best effect. The dimensions of ring are as sketch. It has 672yds. of No. 16 B.W.G. wire, wound in 56 sections; and its resistance is 4·93 ohms approximately. Now, I want to know whether, with suitable F.M.'s, I could run 10 20c.p. lamps in parallel, with dynamo wound as series machine, or would it be better to run the arc light, and wind it as a shunt? My experience in this branch of electricity is rather limited, and I should feel obliged if you would give me any assistance you can, as to amount of wire, &c. I propose to use about 1 h.p.—Ignorant.



[56851.]—**Small Motor Castings.**—Having purchased a set of small motor castings, I find one F.M. to be a ¼lb. heavier than the other, the pattern being also different. Before finishing, I should like to know if the motor would be as good (other things being equal) as one where the F.M.'s are alike, *i.e.*, would one heavy and one light F.M. cause armature to rotate?—An "E.M."

[56852.]—**Quart Size Bunsen Cell.**—To "Sigma."—If "Sigma," or some other competent electrician, would answer me the following questions, I should be extremely obliged:—Note—fumes, trouble and expense of working, well known to inquirer, and expense no object. 1. To produce one arc light from the whole 50 cells, which would be the best way to arrange them, also what thickness of carbon rods in lamp? 2. Suppose two arc lights, what best way to arrange each 25 cells, and what size of carbon rods in lamp? 3. Using the whole 50 cells for incandescent lighting, about how many 20c.p. lamps will they render fully incandescent, also what will be the best way to arrange cells for this purpose? 4. What size of main leads? Distance from battery to lamps in each case, about 20yd.—Experimentalist.

[56853.]—**Writers' Cramp.**—I have been suffering from writers' cramp for many years, and have consulted many doctors, with no good results. No one in this country has found a complete cure for the disease. In the latter end of last year, a German (a Mr. Wolff by name) came over to this country, who professed to cure this disease. I went under his treatment, and improved a little, but on beginning to write constantly, I immediately became worse and now I can't write at all. I should like to know if any have been so cured by Mr. Wolff's treatment that they can write easily and well daily. I hope that any who have been perfectly restored themselves, or know of any that have been so, will kindly reply to this inquiry. —W. G. S.

[56854.]—**Valves in Compound Condensing Engines.**—May I ask some reader for an explanation of the action of the valves in compound condensing engines. It is a subject of much interest to many besides myself, and would be much simplified by sectional sketch.—Boolie.

[56855.]—**Inorganic Chemistry.**—Will some successful candidate advise me as to what are the best books for home study, in order to pass the Honours Inorganic Chemistry (S K.)? I cannot conveniently attend lectures, or I should prefer that. I have passed the two earlier stages.—Boolie.

[56856.]—**Engine Query.**—If 400 tons be raised 10ft. in six minutes by a steam engine, wherein the area of the piston is 400 square inches, the mean pressure of the steam on the piston is 25lb. on the square inch, the length of stroke is 4ft., and the number of double strokes made in a minute is fifteen, what proportion of the power applied to the piston is lost in the working of the machinery?—Goodeve.

[56857.]—**Diminished Power of Engine**—When the reversing lever of a locomotive is moved towards the central position, after being pulled over, the power of the engine is diminished. Why is this?—Goodeve.

[56858.]—**Horse Power of Engine.**—If the boiler of an engine gives out every minute 100 cubic feet of steam which propels the piston with an average pressure of 50lb. on the square inch, what is the h.p. of the engine?—Goodeve.

[56859.]—**Vertical Galvanometer.**—Culley says, "When testing, if no better instrument is at hand, use the ordinary vertical detector; but its sensitiveness is much increased if it is laid on its back." Twice lately I have been so placed, so put the instrument on its back with the N. end of the needle pointing north; but its readings are not to be relied on when so placed. The needle seems to move forward in a jolting fashion, and then suddenly remain fixed, for instance, unplugging 30 ohms did not move the needle back at all, whereas when upright, it moves over 9deg. It is an ordinary best quality detector, wound for high and low resistance, and is only a few weeks since new. Can anyone tell me why its movements, when horizontal, are so uncertain, and the best way to remedy same?—M. M. I. Sc. S.

[56860.]—**L. and N.W.R. Compound Locos.**—Will some of your correspondents, connected with the L. and N.W.R. tell me whether the high and low pressure cylinders of the compound loco., Marchioness of Stafford, in the Inventions Exhibition, are in any way coupled together so as to keep the low-pressure crank at right angles to one high-pressure crank and opposite the other? No coupling rod is shown in the two-page drawing in *Engineering*, May 1st.—Crumby.

[56861.]—**Eccentric on Crank Shaft.**—An eccentric is to be placed on a crank shaft at an angle of, say, 110deg. in advance of the crank. Would some reader describe the way in which they would proceed to mark off its position?—S. S. N.

[56862.]—**Scraping Metal Surfaces.**—Will some kind reader tell me the proper shape and method of using a scraper for trueing up and frosting metal surfaces, or can I get a book on the subject?—E. C. B.

[56863.]—**Flexible Material for Winding round Piston.**—Can any reader kindly inform me of any material, very flexible and strong, which will wind once round a piston 1·6in. diameter and pull out straight again as often as required? The pull upon the free end of this band is to communicate rotary motion to the piston. The width of the band not to exceed 1·6in. Something like the steel measuring tapes lately come into use should do, I think.—C. D. D.

[56864.]—**Safe Making.**—Wanted some practical hints on iron safe making, and a recipe for fireproofing mixture.—W. Bundy.

[56865.]—**Bolts and Nuts.**—Wanted information as to the making of bolts and nuts.—W. Bundy.

[56866.]—**Hand Drilling.**—Wanted hints to make a good easily made hand-drilling machine, double motion drill up to about ⅜in.—W. Bundy.

[56867.]—**Gas Engines.**—To "J. H" and others.—Supposing the gaseous charge was served by means of a cam once every revolution, would the suction only of the piston be sufficient to charge the cylinder with gas? Further, would an electric spark ignite the gas? Would a current of pure cold air be sufficient to cool the cylinder without the aid of water? If three ignitions were to take place on the outer stroke instead of one, would it not equalise the speed and power to a greater degree? What would be the heat of the cylinder of a gas-engine if the water supply were stopped, and if heat would be sufficient to vapourise paraffin oil? If a mixture ⅓rd paraffin vapour, ⅓rd coal gas, and ⅓rd steam, were introduced into cylinder in place of coal gas, would it give greater power at less expense? Further, is coal gas in a heated state more effective than when cold?—W. Bundy.

[56868.]—**To Chemists and Metallurgists.**—Will any of our chemical or metallurgical friends be kind enough to give some method for the estimation of cuprous oxide ($Cu_2O$) in metallic copper? I believe such estimations are occasionally performed in copper works and assay laboratories. So far as I have looked I can find no directions for such work in the books accessible to me. Perhaps our courteous friends Mr. Green or Mr. Allen or some other gentleman, will kindly notice this inquiry. Metallic copper contains, usually, arsenic and antimony and also traces of other elements. Supposing we take a weighed quantity of copper and estimate the above in it, to estimate the percentage of these volatile elements, could sufficient data be procured by roasting a weighed quantity of copper in a finely-divided condition to oxide ($CuO$), and taking into consideration the loss of weight ensuing from the absence of the arsenic and antimony, which would, I presume, escape on strong ignition of the copper. Is such a process workable?—Laudanum.

[56869.]—**Grey Acetate of Lime.**—Could any of your correspondents inform me how much grey acetate of lime could be made with the acid from a ton of wood such as black birch?—Marshall Reid.

[56870.]—**Potter's Kiln.**—To Mr. S. Arlidge.—Would Mr. A. kindly either publish or send me sketch, to scale, of kiln, and say about probable cost of building, and if it has proved a success, and also diameter of same? Also state if the kiln would be suitable for doing white or other glazing (bricks) in, and if it would be suitable for burning red brick? I do not quite understand if the kiln is a down or up draught, but I think it is the latter. How many ordinary bricks would it hold? Address published.—Thos. Plunkett.

[56871.]—**Whitewash.**—I want a good bright whitewash that will not rub off and will stand the weather. I have seen a very hard bright whitewash, but cannot get to know how it is done.—J. H. W.

[56872.]—**Coil**—A friend of mine has just completed an intensity coil for shocking purposes, but finds, from some cause or other, that it will not act. The primary consists of two layers of No. 16 c.c wire, and the secondary six layers of No. 28 c.c., each layer carefully paraffined and separated from the next by a sheet of paraffined blotting paper. The wire of both coils was found to be continuous when tested by a galvanometer. The battery power is two Daniell cells, each a pint capacity, which is powerful enough to work a contact breaker. All the connections are properly made. Perhaps some of "ours" may be able to offer some suggestions, for which I will be thankful.—Cymro.

[56873.]—**Terrestrial Eyepiece**—I have four lenses belonging to a pancratic terrestrial eyepiece, but do not know at what distances to place them apart nor where the diaphragms should be. Their foci are as follows: 1st lens (eye lens), 1⅜in.; 2nd lens, 2¼in.; 3rd lens, 2⅝in.; 4th lens 2¼in. The focus of o.g. is 38in., and aperture 2⅝in. Please say whether there is any rule dealing with pancratic eyepieces as there is with astronomical oculars, and how is the power calculated?—Cymro.

[56874.]—**Estimation of Magnesia.**—Will some of our friends kindly inform me what deduction, if any, should be made in estimating the weight of magnesia in, say, 100 parts of phosphate of magnesia obtained by precipitating magnesia from solution with phosphate of soda?—Chemical.

[56875.]—**Thymol.**—Can some chemical friend inform me if a solution of thymol can be made miscible with water? I have tried a solution in alcohol, but when mixed with cold water separation takes place, and the thymol rises to the surface.—Novice.

[56876.]—**Reflectors.**—Will any of "ours" kindly tell me the best plan for making the tube for the same, for a 9in. say? Would it be best to make it in lengths the width of a sheet of iron? I thought of making a cylinder of wood to bend it on. Any hints as regards the constructing of the barrel would oblige—Nigrum.

[56877.]—**Coil Winder.**—Will someone who has had experience with above kindly describe an efficient form of it as automatic as possible? Should description occupy too much space, will advertise address and pay all expenses?—W. G. F.

[56878.]—**Mineral Water.**—In the preparation of mineral waters, I use a quantity of citric acid, but a friend informs me that I might substitute this by acetic acid as a cheaper medium. Would Mr. Grey or some other intelligent reader say if this is so, and what proportion should I adopt in order to obtain an equivalent strength of acid?—Mineral Water.

[56879.—**Ferrotype Photograph.**—I have a ferrotype photo which, by some accident or other, had some water spilt on it, and on my wiping the plate some parts of the picture turned black as if it was smeared with ink. Could any of our readers kindly tell me what I could do, so as to remove these black stains, and make the photo. the same as it was before?—Misfortunate.

[56880.]—**Pyroligneous Acid.**—Could some of your subscribers give me specifications of retorts and fittings for the manufacture of pyroligneous acid? The retorts I propose would be 9ft. long and 4ft. diameter. I should like to know the thickness of metal used, and how the doors and ends are luted, also specification of condenser, and also the still and pans required for making grey acetate of lime?—Chemist.

**The Prevention of Yellow Fever.**—Dr. Domingos Freire, in a recent communication to the *Rio News*, gives an account of the inoculations practised in Rio de Janeiro with the attenuated liquid culture as a prevention against the dangers of contracting yellow fever. From Dec. 22nd last up to March 22nd of the present year, 1,109 persons of different nationalities, and whose ages ranged from one month to sixty years, were submitted to subcutaneous injections in the deltoid region of the arm with the said liquid. All, with the exception of one or two cases, experienced elevations of temperature, varying from 37½° C. to 40° C., frontal headache, pains in the articulations, general indisposition, and, in some, slight epigastric oppression—symptoms which ceased after from twenty to forty hours, and without any medical intervention. In many cases these injections were practised in houses where, a few hours before, deaths had taken place from yellow fever, nevertheless in the cases specified, and under disadvantageous hygienic circumstances, not one single serious accident is said to have happened. Most of the inoculations were performed in the presence of two medical men commissioned by the Spanish Government to specially study yellow fever in Brazil.—*Lancet*.

From a list just published, it appears that during the past year 152 boiler explosions occurred in the United States, by which 254 people were killed on the spot, and 261 others injured, many of them fatally.

The New Guinea Company of Berlin, incorporated on May 17, is preparing to send out, in the course of the present year, scientific expeditions to Kaiser Wilhelm Land and the islands of the Bismarck Archipelago.

A new insect, ravaging the vineyards to even a greater extent than the phylloxera, has appeared in great numbers in some parts of Roumania and Bessarabia. A scientific commission has been sent out to investigate the matter.

There has just been launched from the Low-Water Ship-building Yard of Sir W. G. Armstrong, Mitchell, and Co., a steel paddle-steamer, which is the first of three the builders have in hand for the River Thames Steamboat Company. The vessel, which is named the *Rosalind*, is 100ft. long, 14ft. beam, and her draught of water is 2ft. 9in. Everything is being done to make this line of passenger steamers attractive.

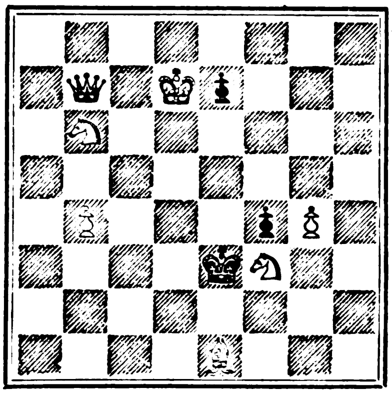
## CHESS.

◆◆◆

All Communications for this department must be addressed to J. Pierce, Langley House, Dorking.

### PROBLEM DCCCCXLIV.—Check.

*Black.*



*White.* [7+3

White to play and mate in three moves.

### Solution to 942.

| *White.* | *Black.* |
|---|---|
| 1. B-R 7 | 1. K takes K P (a) |
| 2. Kt-B 2 | 2. Anything |
| 3. Q or Kt mates | |
| 2. Kt-B 5 &c. | (a) 1. K takes B P (b) |
| 2. Kt-Kt 5 &c. | (b) 1. P takes P |

### NOTICES TO CORRESPONDENTS.

Correct solutions to 941 by F. O'N. H. (For a block position, first move too obvious.—It is, however, more than this.—Ed.), E. Stanley Follwell (rather difficult; Q-Q Kt 2 admits of five or six variations, no duals).

To 942 by F. O'N. H (not too easy, but quite easy enough), R. A. Bennett, A. S. Olver (pretty).

To 943 by E. S., A. S. Olver, R. A. Bennett.

F. O'N. H.—In solution of 940, variation (e) it should be 2 Kt-Kt 5 (ch). We think you have scarcely done justice to 941.

V. S. Pochin.—No mate in your solution if 1.———B-K Kt 3.

A. W. Orr.—942 is quite correct.

J. H. W. C.—It should have been 2Kt-Kt 5 (ch); K-B 4, 3. Q-B 6 mate, if———2 P takes Kt, 3. Q-Q B 7, mate.

Game played in Mr. Nash's tourney, between Mr. Russell (White) and Mr. Gerahty (Black).

(Scotch opening.)

1. P-K 4, P-K 4 / 2. Kt-K B 3, Kt-Q B 3 / 3. P-Q 4, P takes P / 4. Kt takes P, Q-R 5 (a) 5. Kt-Kt 5, B-Kt 5 (ch) / 6. P-Q B 3, Q takes K P (ch) / 7. B-K 3, B-R 4/ 8. Kt-Q 2, Q-Kt 3 / 9. Kt-B 4, P-Q R 3 / 10. Kt-Q 4, K Kt-K 2 (b) / 11. Kt takes Kt, Kt takes Kt / 12. P-Q Kt 4. B-Kt 3 / 13. B takes B, P takes B / 14. Kt-Q 6 (c), K-K 2 / 15. Kt-B 4, R-K sq (d) / 16. Kt takes P, K-B sq (dis ch) / 17. B-K 2, Q takes P / 18. Q-Q 6 (ch), K-Kt sq / 19. Castles, Q takes B P (e) / 20. Kt takes R, R takes B / 21. R-Q 2, R takes R / 22. Q takes R, Q takes Q / 23. K takes Q, P-Q 3 / 24. R-K sq, Kt-K 4 / 25. K K 3, P-K Kt 4 / 26. Kt-B 7, B-Q 2 / 27. R-K 2, P-B 4 / 28. Kt-Q 5, K-B 2 / 29. K-B 2, P-B 5 / 30. R-Q 2, B-B 3 (f) / 31. Kt-B 7, K-K 2 / 32. Kt-Q 5 (ch), K-K 3 / 33. Kt-B 7 (ch), K-B 4 (g) / 34. R takes P, Kt-Kt 5 (ch) / 35. K-Kt sq, P-B 6 (h) / 36. P-K R 3, Kt-B 3 (i) / 37. P-B 4, K-K 4 / 38. R-K 6 (ch), K-B 4 / 39. K-B 2 (j), P-K 5 / 40. R takes Kt (ch), K takes R / 41. P takes P, K-Kt 4 / 42. Kt-Q 5, K takes P / 43. Kt-B 6 (ch), K-B 5 / 44. Kt takes P, K-K 5 / 45. Kt-Kt 5 (ch), K-Q 5 / 46. P-Kt 5, P takes P / 47. P take P, B takes P / 48. Kt takes P (ch), K-B 6 / 49. K-K 2, K-Kt 7 / Drawn game (k).

### Notes by Mr. Gerahty.

(*a*) An unsafe defence.

(*b*) B-Kt 3 probably better.

(*c*) If Kt takes P, Black would be able to castle in a move or two, and prepare for attack.

(*d*) I preferred this to the natural move, P-Kt 4, as being more attacking.

(*e*) An effort to save the exchange would have given Black a bad game, and this move gives him two Ps for the exchange.

(*f*) The B appears to be better posted here than at K 3, being valuable for attacking and defensive purposes.

(*g*) Surrendering the P to get the K into support of the advancing Ps.

(*h*) If Kt takes P / P checks, K-B sq / B checks.

(*i*) Still preventing Kt takes P.

(*j*) Preparing for R takes B, followed by K takes P.

(*k*) Mr. Russell thinks Black might have won by an early advance of Q R P.

## ANSWERS TO CORRESPONDENTS.

⁂ *All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

### HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

⁂ Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, June 17th, and unacknowledged elsewhere :—

C. P. WHITE.—Col. O'Hara.—Gestrum.—B. of T.—J. Boggis.—R. Collyer.—W. G. Penny.—Barnett and Foster.—Tee Bee.—F. Stones.—J. C. L.—Subscriber.—Little Dorritt.—C. A. W.—Souter.—F. C. P.—T. L.—J. Jones.—A. H. and Co.—Rev. R. L.—De Vigne.—Settler.—B. W. G.—Old Rex.—Jura Alf.—Windy.—Structural.—B. N.—Volvox.—Pall Mall Electric Association.

**CHARCOAL FOR FILTER.** (Yes, animal charcoal is used for filtering water, but it is not necessary. See the description by Prof. Guthrie of his "penny water cleaner" on p. 61, No. 965. It consists of a large flowerpot, filled with bits of clean well-burnt brick.)—**INQUIRER.** (Must first know what the eruptions are like. A little potash would do no harm, and you can obtain that very pleasantly in ripe fruit and lime juice.)—**AMATEUR ELECTRICIAN.** (Kindly look through the indices. We really have had almost enough about electric lamps for use in private houses.)—**A RECENT SUBSCRIBER.** (See the indices, or pp. 257, 274, 317, last volume, and p. 5 of the present. There is no practical book on the subject.)—**ROVER.** (How is the steam exhausted after driving the pistons outwards?)—**DR. BRENCHLEY.** (Neison's "Boat-building for Amateurs," Gill, 170, Strand, W.C.)—**J. J. N.** (See the lists issued by the booksellers. It would be invidious to mention any one of the many books on the subject as the best.)—**A COUNTRYMAN.** (See Hints No. 4. Rope ladders, ropes with a sling, and strong tubes of canvas are all used.)—**COLONIST.** (Rubber stamps are made by taking a plaster cast of the type, and pressing into the cast a compound of rubber and sulphur, which is then vulcanised by the aid of pressure and heat, in an apparatus resembling a dentist's vulcaniser.)—**EDWIN G. CAMP.** (We have noticed that group on p. 227.)—**ENQUIRER.** (See the indices, or examine an equatoreal. You do not see the movement in the sketch sent because it is not there.)—**ELECTROTYPE.** (See the indices. They are produced by what is known as the zinc process.)—**DIZZINESS.** (If "different doctors" have failed to give relief, how is it expected that a query in our columns would help? The answers would probably be "bile" in the one case and "hard wax" in the other.)—**BACCHUS.** (In any of the newspaper guides—Mitchell's or Sell's.)—**CEMENT.** (Marine glue, shellac. If vulcanised, clean the brass thoroughly and cut a fresh surface to the rubber, which slide on. Weight down for a few hours, and it will probably adhere with sufficient tenacity.)—**MILK.** (Salicylic acid, we believe, is used.)—**ANOTHER ANXIOUS ONE.** (Given many times. Glue one part, glycerine four parts; sufficient whiting to colour it, and a few drops of carbolic acid.)—**SANITARY.** (Animal charcoal is made by submitting bones to a red heat in closed vessels, so as to exclude the air. So far from being a waste refuse, it is a commercial product.)—**W. S. F. S.** (The phonograph has been described several times. In No. 683 you will find full directions for making one. A patent agent will supply you with the number and date of Edison's specification on payment of his fee for the search.)—**LONG SIGHT.** (You will find the advertisement in No. 1048. The prices given are—Power 4, 50s.; 7, 82s.; and 10, 181s. The 7-power in brass is 39s.)—**CHARLES BEAVIS.** (See indices and recent numbers, and read up the subject. For your purpose a battery would be cheapest in the long run, unless you have a steam-engine to drive the dynamo.)—**GEO. WHEELER.** (We have not a copy of the Latin Version by us; but no doubt the clergyman of your parish has a copy.)

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⁂ It must be borne in mind that no Displayed advertisements can appear in the "Sixpenny Sale Column." All advertisements must be prepaid; no reduction is made on repeated insertions; and in cases where the amount sent exceeds One Shilling, the publisher would be grateful if a P.O.O. could be sent, and not stamps. Stamps, however (preferably halfpenny stamps), may be sent where it is inconvenient to obtain P.O.O's.

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Advertisements *must* reach the office by 1 p.m. on Wednesday, to insure insertion in the following Friday's number.

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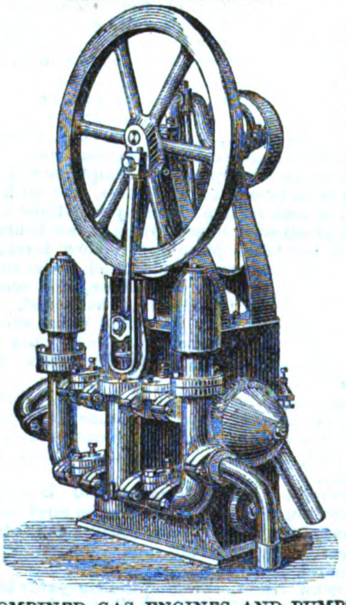

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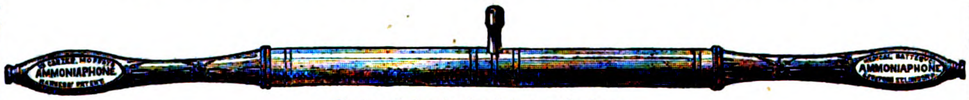
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THE DOCTOR'S VERDICT.

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THE MEDICAL BATTERY COMPANY, Limited, 52, Oxford St., London, W.

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*Advertisements are inserted in this column at the rate of 6d. for the first 16 words, and 6d. for every succeeding 8 words.*

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**C. Pilkington**, 32, Sackville-street, Piccadilly, W., Magic Lantern Artist and Photographic Colourist.

Magic Lantern **Photograph Colouring**, finely and artistically done, 12s. per dozen. Special terms to the trade on application.—C. Pilkington, 32, Sackville-street, W.

**American Organ**, by Bell, first make, having beaten all others in competition; grand tone, 4 sets reeds, 11 stops, patent grand expression and knee swell, 17 guineas; free trial.—W. Hands and Co., Bedford.

**Character Read by Lines of the Hand**. Chart explanation, 7d.—H. Wyke, 21, North-street, Taunton.

Odd **Spiral Springs** made to order. Mattress Springs, 9d. per dozen.—James Parish, 52a, Bard-street Park Sheffield.

**Batteries** (to the trade).—Pint Bunsen's, Bichromate Daniell's, 8s. per doz. Other sizes in proportion.—Below.

**Electro Motors**, 14s., 24s., 78s. per doz. List free.— J. Hanks and Son, Seaforth, Liverpool.

**Electro Motor**, free 2s. 3d., with Battery, 3s. 6d Model Engine, 1s., free. Not approved money returned.—Below

**Batteries**.—Bunsen's, Daniell's, Bichromate, 1s. each in box, 1s. 6d., post free.—Hailey, Novelty Stores, Seaforth Liverpool.

4in. **Slide-Rest**, unplaned, 7s.; ditto, planed 16s. 6d. Perfect Castings from newest patterns.—William Gladstone, 18, Lovatt-street, Stafford.

**Harness Oil**, best, 3s. 6d. per gallon.—PINNELL Brothers, 214, Whitechapel-road.

Powerful **Electro Motor and Medical Coil**, perfect order, carriage paid, 3s.—W. K, 71, Vine-street, Coventry.

Vols. XIII. to XX. "**English Mechanic**," 2s. each, good condition, monthly parts.—G. Wessley, Waterloo-road, Aldershot.

**Treadlé Saw Bench**, all iron, fence and angle guide, good condition, £6.—98, King's-road, Camden-road, N.W.

**Launch and Other Engines**, Boilers, Propellers, Lathes, and all kinds of machinery cheap.—S. Smith, 11, West-street, Soho, W.C.

**Patents, Designs, and Trade Marks**.—Special terms quoted to English Mechanics referring in their enquiry to this column.—F. M. Rogers, 21, Finsbury-pavement.

**Brass Scrolls** to Design, Tube Bending, &c., Copper and general Brass Work (medium size) turned and finished. Terms moderate.—Write Portsous, 32, Brewer-street, W.

**Fistula** cured without operation.—Electric Herbal Ointment, free for 13 stamps.—Jamieson Bros., Covent-garden, London.

**New Time**.—Alter your Clocks and Watches. Twelve Sets of figures, with instructions, 6d.—Wheeler, Preston.

**Water Motors**, for sewing machines, organettes, window advertisements, 32s., 42s. List one stamp.—Wheeler.

**Fan Castings**.—Improved Registered Designs; sets 4in., 3s.; 6in., 4s.; 8in., 5s. Drawings, 4d.—Wheeler, Engineer.

**Water Motors**.—Complete one horse-power. £9 Half, £6; Quarter, £1; Eighth, £3.—Thomas Wheeler, Preston.

**Gas Engine**, 3-man, Barker's Patent Universal, good as new, £28. All my extra fittings.

Also Patent **Band-Saw Machine**, on stand, two saws, hand or power.—10, Darby-road, Folkestone.

**Arc Lamps**, very simple, work with small dynamo, 100 c.p., carriage free, 6s.—Hasgood.

**Wheatstone's Bridges**, accurate, 3s. 6d., carriage free.—W. Hasgood, Hazlebrook, Buccleuch-road, West Dulwich, London, S.E.

**Standard Ohms**, 2s. 6d. each. Delicate Galvanometers, astatic, 5s.—S. Bottone has a few for Sale.

**Am-meters**, indicating up to 8 amperès, 5s. Voltmeters, 5s. Model Electro-Motors, 5s.—S. Bottone.

**Wheatstone's Bridges**, accurate up to 1,000 ohms, 5s each, post free.—S. Bottone, Stanley-road, Carshalton.

3in. centre **Lathe Heads**, several for sale, cheap, new.—C. Pool, Tool Maker, 30, Hockley, Nottingham.

3½in. back-geared **Heads**, hardened double coned, steel mandrels, phosphor bronze bushes.—Pool, as above.

Steel **Name Stamps**, 3d. per letter. Figures (set), 2s. 4d. Letters, 6s. 4d. per post.—E. F. Baldwin, Robinswood-hill, Gloucester.

**To Joiners**.—Remaining stock of small Ironmongery bought cheap. Brass cupboard knobs, blind racks, buttons, escutcheons, hinges, holdfasts, 180 latches, complete (3d each). 19 good door locks (cost 2s. 6d. each), for 35s.; padlocks, &c. Particulars on receipt of stamp.—J. N. D., Tuxford, Notts,

100-light self-regulating **Dynamo**, two 30-light Machines, one 5-light fine Brequet Hand Machine, several Motors, and large stock of Woodhouse and Rawson 20 c.p. Lamps, Cable Switches, &c. Low prices; all warranted.—Prices, testimonials, write, Warne, 39, St. John-street-road, E.C.

**Orange Champagne**.—How to make this delicious beverage equal to champagne at 3½d. per gallon. Recipe, 7d.—Below.

**Horehound Beer**.—How to make excellent Horehound Beer at 3d. per gallon. Recipe, 7d.—Below.

**Black Beer**.—How to make this excellent Beer at 8d. per gallon. Recipe, 7d.—Below.

**Vinegar**.—How to make the best Vinegar at 8d. per gallon. Recipe, 7d. All four, 18d.—James Hall, 17, Allhallowgate, Ripon.

**Lathe**, self-acting. 5⅜in. centre, with change wheels, £9. Boiler, vertical, full 1-horse, £6; Launch Boiler, 3-horse, £9; Combined Engine and Boiler, 2-horse, £17.—79, Dudley-road, West Bromwich.

"**Engineering**" for the year 1877, price 10 shillings, "Cassell's Technical Educator," 7s. 6d. The above are all complete, ready for binding.—J. S. Bonnaad, 18, Holgate-road, York.

**Galvanometer**, suspended Astatics four circuits, for strong or weak currents, handsomely got up, silver-plated, with glass shade, 30s.—A. Mathieson, Glebe-street, Falkirk.

**Parallel Vice**, 3⅜in., solid steel patent box screw, as new, cost 27s., price 18s. 6d.—Hawkins, Towcester.

3¼in. **Lathe**, American hollow spindle, 30in. bed, on iron table stand, with polished ash top, 3-speed wheel, fret saw attachment, and sundry chucks; cost £6 15s., price £4; perfect as new.—H. D. Hawkins, Towcester.

**Pianofortes** by all makers at 25 to 35 per cent. discount.—Dauncey, Stroud.

**Pianoforte**.—A good Pianette, walnut, warranted 14 guineas.—Dauncey, Stroud.

"**See-Saw**" **Waltz**, post free, 1s. 4d. All music at one-third marked price, post free.—T. W. Dauncey and Son, Music Sellers, Stroud, Gloucestershire.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
*FRIDAY, JUNE* 26, 1885.

## TOOLS AND CUTTER-BARS.—IV.

BEFORE speaking of the very necessary and important matter of grinding and shaping cutters, I will reply to the recent query of a correspondent who asked what depth of cut can be taken. Not caring to rely upon my own experience with a light ½in. bar, I requested my kind friend and ally, "J. K. P.," to put matters to the test, feeling that his dictum would satisfy most of our readers, if not all. The result is most satisfactory—to wit, a shaving over 2ft. long, cut from a 1⅝ bar of ordinary rolled iron, the depth of cut 1-9th of an inch, the feed 80 to the inch, and the remark is added: "I have no doubt I could cut 70 to the inch in another and a stronger lathe." There is, in fact, no reason why a cutter securely held in a bar should not do as much work as if it formed the end of a cranked tool, which, with its holder, it actually becomes; and it is because such a cutter being a straight bar is easier to grind than a cranked tool that these bars are so convenient. But in addition to this advantage is the unquestionable one of facility in adjusting the height and position of the cutting edges, and the bar which does this the best is the one that should bear the palm. The question of grinding cutters naturally occupied the attention of Mr. Haydon at a very early period of his experiments; but it was "J. K. P." who, I believe, solved the difficulty in such a way as to give the double-edge system a fair chance of acceptance with practical mechanics. No gimcrack contrivances would do. The ordinary shop grindstone must be pressed into service with some simple and easy method of controlling the angles as the grinding proceeds. Gauges for the pocket might be added, but so far as possible the workman must be as independent of these as if he were grinding an ordinary solid lathe tool. The method that suggested itself to "J. K. P." was the use of a board resting on the bearers of the grindstone, of such thickness as at once to give to the tool the requisite clearance on its lower faces. The angle desired for this purpose could thus be obtained without further measurement, or special attention on the part of the workman. But in order to obtain a given angle, even in this way, the cutter must be raised to a certain height in the sling; and the higher it is placed while the shank lies upon the before-named board or rest, the greater will be the clearance given to the cutter, provided the rest raises the tool above the level of the centre of the axis of the stone. This will be seen on reference to Fig. 39, where A represents the grindstone, and B C D the level of its centre. Then the spaces between the dotted lines may represent tools *a*, *b*, *c*, *d*, *e*, lying end on, at various heights for grinding. All above the axis will be more ground towards their lower surface—i.e., with more clearance, each as it stands higher, and all below will be ground nearer the upper surface—i.e., with less clearance.

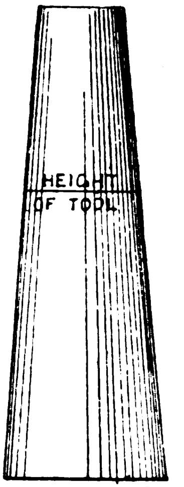

FIG. 43

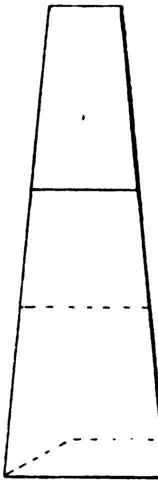
FIG. 44

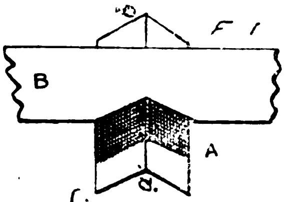

FIG. 45.

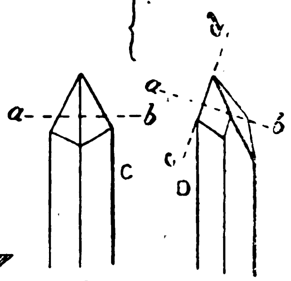

FIG. 46.

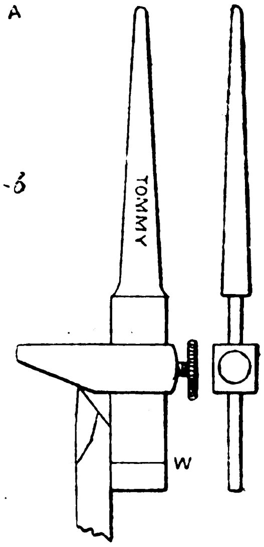

FIG. 42

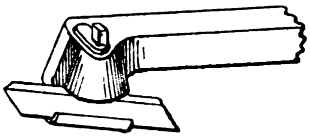
FIG. 47

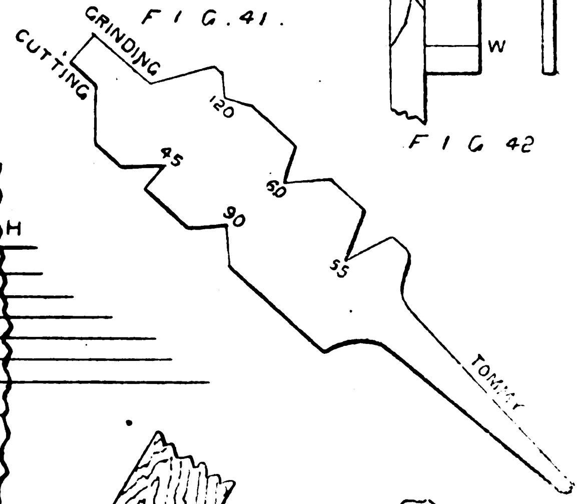

FIG. 41.

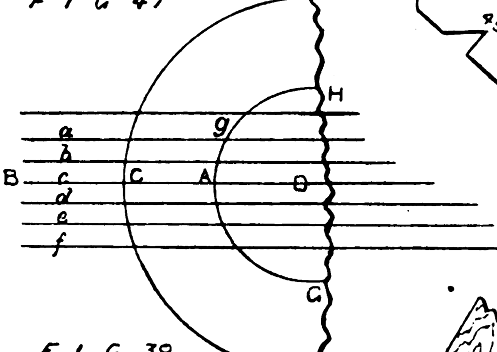

FIG. 39

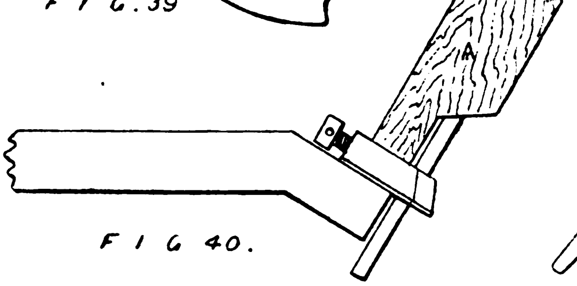

FIG. 40.

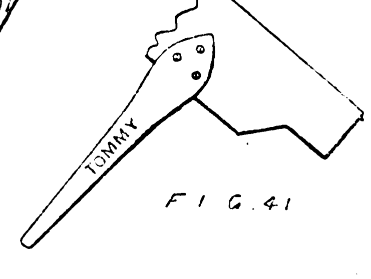

FIG. 41

Hence, in arranging the grinding block or board (say, 3in. wide), matters must be so arranged as to insure the correct position of the tool. It may be necessary to cut down the water-trough or bearers, and then to fit the block; but in any case, it will be a matter of experiment to find the correct height or thickness of block, and also the height to which the cutter must be raised above the sling of the bar. When this has once been ascertained, a very simple gauge will insure such height being kept; and when it is thus determined how high the cutter must stand to get a clearance of 3°, nothing will be easier than to increase or reduce it at pleasure. Some one asked, in a recent number, whether the wear of the stone would not upset the calculations as to the clearance angle. To answer this, I have added the circle H A G to represent such worn stone, and the effect is evident. The tool *g* has plainly more clearance than *a*. But until considerable wear takes place, this is of very slight importance, and can easily be remedied by slightly lowering the grinding block—*b*, for instance, ground on the big stone has about the clearance of *c* ground upon the small one. As, therefore, the stone diminishes in size, the grinding block needs to be planed thinner. It must be remembered that the actual clearance angle may range from 3° to 6°; so that this alteration in the thickness of grinding block need not be very often resorted to. These little theoretical difficulties are of no great importance in practice, being so easily remedied.

A very easy gauge is made by cutting a notch in the grinding block A, Fig. 40, such that when the top of the sling is placed as shown resting on the end of the board, the cutter may touch the end of the notch, supposing it to be raised to the proper height for grinding. For a perfectly new bit of steel, that has not been ground before, it is necessary to set it up a little higher in the sling, as more will eventually be ground off in all probability, in shaping the tool; but the difference will not be great. Mr. Haydon, however, was in the habit of using two gauges. A very useful combination tool is shown in Fig. 41; a gauge and tommy to fit the capstan head of the screw of the bar. I made my own of a broken flat file slightly lowered in temper and ground smooth on both sides. There is a gauge for height of tool for grinding, another for height of tool for use in the lathe, a notch of 120°, one of 55°, one of 90°, and one of 45°, the latter forming edges of 60°, and suitable for cutters to go into corners; another is added of 60°. The tool is 3½in. in length, ¾in. wide, and $\frac{1}{16}$in. thick, and answers all purposes as a pocket gauge. The burnished edges, which are rounded, give it a finish. It was probably a copy of one of Mr. Haydon's; but I have had it some years, and am not quite certain. Of the next two, however, Figs. 41 and 42, I can say positively that they are by the above named amateur, and although useful as adjustable gauges, that can be accommodated to different lathes, I prefer the simpler one already drawn. Only the movable gauge might have two marks for grinding and cutting, as W. and others, for larger lathes.

Now in this there is nothing complicated. Any workman could make such gauges, and if not combined with the tommy, they can be cut out of tin or zinc with even greater ease, as can also (Fig. 43) the cone gauge for the clearance angle, which likewise acts as a test for height of centre, if a line be drawn for that purpose. Ordinarily it is a solid cone of iron or gun-metal turned to an angle of 3°, and large enough at the base to stand firmly upon the lathe-bed. The tool in its bar, if it is one of these, or the shank of the solid tool, is then laid on the table of the rest, and the lower faces of the cutter being brought each in turn against the cone, are thus gauged.

The point of the cutter is then adjusted to the centre line, marked here as height of tool, and can be clamped and set to work. Now it is easier by far to cut and bend a bit of sheet brass, zinc, or tin, like Fig. 44 the sides being at 3° to the perpendicular, and I think it is far easier to test the side *faces* against this thin edge than against the round conical gauge. The latter would test the front *line* easily enough, but I have already explained that this is not what is required. The conical gauge if preferred, however, will be just as serviceable if made of boxwood instead of metal, and will, of course, be easier for an amateur to make. It should be turned with the slide-rest set to 3° and carefully finished. The sheet-metal gauge has this further advantage, that the sides need not be of the same angle. One, for instance, may be 3° and the other 6°, the two extremes allowable for the clearance of metal-turning tools.

These gauges were designed before the plan was arranged of the grinding block already explained. They are, however, useful accessories, and may well be added to the paraphernalia of the workshop.

If this gauge is used with a self-acting lathe, it may be more convenient to stand it upon the saddle of the slide-rest instead of on the lathe-bed. In that case, the line of centres will be lower down upon it, as indicated by the dotted line. We have plainly, in these gauges, a choice which is often convenient. We can use the tommy gauge, and by its means set up the tool in its sling, so that when the bar is placed on the table of the rest, the tool point shall be exactly at the height of the centres, or we can obtain the same result by this cone or plate gauge when the bar is clamped on the tool-holder of the rest. Sometimes we may find the one, and sometimes the other, method preferable; but it is, in all cases, exceedingly advantageous to be able to set the tool at exactly the correct height, without having to test its action upon the work itself.

I have myself seen "D. H. G." grind a tool, set it up by gauge, and at once cut a long clean shaving without the smallest hesitation, as if it were quite impossible that the tool could go wrong, and, after duly imbibing the system, I have done the same scores of times, and so may anyone.

The two points which I have found most important in practice are the clearance and the position of the tools. In most cases, if the work is not satisfactory, it is more probable that the fault is there than in the cutting angle, which may vary a degree or two without material effect on the work. The following edge, too, must not be the sharpest; but although, if any difference exist in this way, the leading edge should be most acute, it is very questionable whether equal acuteness is not the best for nearly all purposes. In taking the measure of an angle, it is very important to make that measurement at right angles to the line which forms the meeting point of the two planes. In Fig. 45, A may represent a bit of folded paper with a gauge across it, which is intended to look as if standing up on edge, only somehow it does not. To measure the angle of the fold, the gauge must stand across at right angles to the line *a b*. C, Fig. 46, is the back of a cutter; *a b* the line of the gauge; and, taking a side view, D, *a b*, the position of the edge of the gauge must be at right angles to *c, d*, representing the line of junction of the two lower faces of the tool—the lozenge-shaped facet on the right hand being the front or top face. If the gauge is not actually up on edge, or if it is inclined in either direction, it will not give the real size of the angle. A few experiments will soon show the workman how to test all the several angles accurately. Amongst other very useful experiments upon the use of tools, is testing by actual trial upon a bar of iron the result of various positions and different angles of edge and clearance. The result will be that if any tool fails to work as it ought to do, the reason of the failure will be recognised from these experimental lessons. The tool may seem to scrape so as not to give a continuous shaving; it may chop—*i.e.*, cut too deep for a second, and then miss, and so on alternately. It may draw into cut so eagerly as to catch and break, or play one or the other of those annoying freaks so well known to the amateur; but his carefully-conducted experiments will lead him in most cases to recognise the cause of failure, and to know the cause, so as to know the remedy. I had overlooked a bar made by Taylor, and exhibited at the Inventionaries, which is on the principle of Tangye's, and of its kind, seems to offer certain advantages. The inclination of the upper face is determined by the vertical angle at which the cutter is placed, and the front or lower face is that which has to be ground. Its peculiarity is that the cutter is put in at the side, and that the tool can cut right up to a large shoulder. Fig. 47 is a sketch of one of these, which will suffice to show the nature of the clamping arrangement. There are other bars by the same Birmingham firm, slightly differing from the above, and one novel pattern for screw-cutting tools. I give the above sketch because of the method here adopted of a side clamp. I do not pretend to decide its claim to superiority over others of its class, but it seems a useful tool. **O. J. L.**

(*To be continued.*)

## ASTRONOMICAL NOTES FOR JULY, 1885.

### The Sun.

| Day of Month. | Souths. | At Greenwich Mean Noon. Right Ascension. | Declination North. | Sidereal Time. |
|---|---|---|---|---|
| | h. m. s. p.m. | h. m. s. | ° ′ ″ | h. m. s. |
| 1 | 0 3 34·05 ,, | 6 42 23 | 23 5 39 | 6 38 48·71 |
| 6 | 0 4 27·74 ,, | 7 2 59 | 22 39 42 | 6 58 31·49 |
| 11 | 0 5 12·93 ,, | 7 23 27 | 22 3 56 | 7 18 14·27 |
| 16 | 0 5 47·07 ,, | 7 43 44 | 21 18 43 | 7 37 57·05 |
| 21 | 0 6 7·90 ,, | 8 3 48 | 20 24 27 | 7 57 39·83 |
| 26 | 0 6 14·29 ,, | 8 23 37 | 19 21 39 | 8 17 22·61 |
| 31 | 0 6 5 76 ,, | 8 43 11 | 18 10 50 | 8 37 5·39 |

The method of finding the Sidereal Time at Mean Noon at any other Station will be found on p. 355 of Vol. XL.

Spots and faculæ of considerable size and beauty continue to appear upon the Sun's face.

At 11 p.m. on July 3rd the Sun is in Apogee, in other words the Earth is then at that point in her orbit which is farthest from the Sun's centre. At this instant we are 93,910,166 miles from the great centre of our Solar System.

There is no real night in any part of the British Islands until after July 20th.

### The Moon

Enters her Last Quarter at 25·6m. after noon on July 5, and is New at 5h. 15·8m. a.m. on the 12th. On this and the subsequent day High Tides may be looked for. The Moon will enter her First Quarter 19·8 minutes after midnight on the 18th, and be Full at 2h. 22·8m. in the Early Morning of the 27th.

| Day of Month. | Moon's Age at Noon. | Souths. |
|---|---|---|
| | Days. | h. m. |
| 1 | 18·6 | 2 45·1 a.m. |
| 6 | 23·6 | 6 32·4 ,, |
| 11 | 28·6 | With the Sun. |
| 16 | 4·3 | 4 4·1 p.m. |
| 21 | 9·3 | 8 2·0 ,, |
| 26 | 14·3 | 11 57·8 ,, |
| 31 | 19·3 | 2 57·6 a.m. |

The Moon will be in conjunction with Mars at 9 p.m. on the 9th; with Saturn at 11 p.m. on the 10th; with Mercury at Noon on the 13th; with Venus 3 hours later; and with Jupiter at 7a.m. on the 15th.

### Mercury

Is an Evening Star during the whole of July, and is very fairly well placed for the observer. About the middle of the month he sets more than an hour after the sun, and may be detected in the twilight over the W.N.W. horizon. His angular diameter increases from 5″ to 7″ between the 1st and the 31st.

| Day of Month. | Right Ascension. | Declination North. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 7 3·5 | 24 17·1 | 0 24·7 p.m. |
| 6 | 7 48·5 | 22 59·4 | 0 49·9 ,, |
| 11 | 8 29·1 | 20 52·4 | 1 10·7 ,, |
| 16 | 9 5·0 | 18 12 8 | 1 26·9 ,, |
| 21 | 9 36·5 | 15 14·9 | 1 38·5 ,, |
| 26 | 10 3·7 | 12 9·7 | 1 46·0 ,, |
| 31 | 10 26·9 | 9 6·8 | 1 49·5 ,, |

A Study of the above Ephemeris shows that the path it indicates begins in Gemini, extends across the entire width of Cancer, and about half-way across Leo. Mercury will be in conjunction with Venus (11′ South of her) at 2 p.m. on the 17th, and with Regulus (12′ South of that Star) at 7 a.m. on the 26th.

### Venus

Is an Evening Star during the entire month, setting, like Mercury, about an hour after the Sun. She is now perceptibly gibbous in the telescope. Her angular diameter, which is 10·2″ on the 1st, increases quite imperceptibly to 10·8′ by the 31st.

| Day of Month. | Right Ascension. | Declination North. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 7 50·5 | 22 21·6 | 1 11·5 p.m. |
| 6 | 8 16·4 | 21 12·5 | 1 17·6 ,, |
| 11 | 8 41·8 | 19 48·3 | 1 23·4 ,, |
| 16 | 9 6·8 | 18 10·3 | 1 28·6 ,, |
| 21 | 9 31·2 | 16 20·0 | 1 33·3 ,, |
| 26 | 9 55·1 | 14 18·9 | 1 37·4 ,, |
| 31 | 10 18·5 | 12 8·4 | 1 41·1 ,, |

The path of Venus begins on the boundary line between Gemini and Cancer; traverses the last-named constellation, and extends to a point between α and ρ Leonis. Her conjunction with Mercury has been spoken of above.

The night sky this month is, as far as the planets are concerned, a practical blank—**Mars**, **Jupiter**, and **Saturn** all being invisible, and

### Uranus

being pretty low down in the west ere it is dark enough to observe him. In fact, he too is beyond the reach of the ordinary observer during the last 10 days of the month, for which reason our Ephemeris does not extend beyond the first three quarters of it. His diameter diminishes from 3·8″ to 3·6″ before he gets finally lost in the Sunlight.

**Occultations of (and a near approach to) Fixed Stars by the Moon.**

| Day of Month. | Name of Star. | Mag. | Disappearance. | Moon's Limb. | Angle from N. Point. | Angle from Vertex | Reappearance. | Moon's Limb. | Angle from N. Point. | Angle from Vertex. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | h. m. | | ° | ° | h. m. | | ° | ° |
| 2 | B.A.C. 7774 | 6 | 2 37 a.m. | Bright | 108 | 99 | 3 59 a.m | Dark | 297 | 302 |
| 6 | μ Piscium | 5 | †2 40 ,, | S.S.E. | 22 | 347 | | | | |
| 18 | *m* Virginis | 6 | 10 10 p.m. | Dark | 149 | 184 | 10 27 p.m. | Bright | 179 | 215 |
| 20 | $o^2$ Libræ | 6 | 10 58 ,, | Dark | 105 | 136 | 12 1 ,, | Bright | 236 | 272 |
| 22 | 29 Ophiuchi | 6 | 10 31 ,, | Dark | 17 | 33 | 11 1 ,, | Bright | 335 | 356 |

† A near approach.

**Uranus**

| Day of Month. | Right Ascension. | Declination North. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 11 57·8 | 1 1·6 | 5 18·1 p.m. |
| 6 | 11 58·3 | 0 58·5 | 4 58·9 ,, |
| 11 | 11 58·8 | 0 54·9 | 4 39·8 ,, |
| 16 | 11 59·4 | 0 50·8 | 4 20·7 ,, |
| 21 | 12 0 0 | 0 46·3 | 4 1·7 ,, |

The exceedingly short arc thus described by Uranus while as yet he remains visible lies about two-thirds of the way from β towards η Virginis.

**Neptune**, we might have added above, is invisible too.

**Shooting Stars**

may be watched for on the nights of the 17th, the 20th, and the 29th of July, respectively.

**Greenwich Mean Time of Southing of Seven of the Principal Fixed Stars on the Night of July 1st, 1885.**

| Star. | Souths. h. m. s. |
|---|---|
| γ Herculis | 9 36 29·81 p.m. |
| Antares | 9 42 0·33 ,, |
| $\alpha^1$ Herculis | 10 28 54·81 ,, |
| α Ophiuchi | 10 48 3·09 ,, |
| γ Draconis | 11 13 19·61 ,, |
| Vega | 11 52 19·75 ,, |
| ζ Aquilæ | 12 19 20·06 ,, |

The method of finding the Greenwich Mean Time of Southing of either of the Stars in the above list for any other night in July, as also that of determining the local instant of its Transit at any other Station, will be found on p. 356 of Vol. XL.

## THE INTERNATIONAL INVENTIONS EXHIBITION.—VIII.

### Chemistry and Chemical Manufactures.

THE Chemical Department of the Inventions Exhibition is not so large, and perhaps scarcely as interesting, as the similar department has been in other exhibitions; but the contributors are, in most cases, representative firms, and the exhibits are fairly typical of the direction taken by chemical invention of late years. The stall which first claims attention is one on which are exhibited a number of samples illustrative of the alkali manufacture, and the recovery of sulphur from the vat-waste of the Leblanc process. The names of L. Mond, Jas. McTear, Brunner, Mond and Co., Bell Bros., Gaskell, Deacon, and Co., J. C. Gamble and Son, &c., appear as the joint exhibitors on this stall. Besides an interesting series of samples showing the manufacture of soda, &c., in different stages, there are some fine specimens of chlorates. A model of McTear's revolving furnace is to be found near at hand, and close by are some admirable models of the plant used in Weldon's process for the manufacture of chlorine. The most recent method of the latter ingenious chemist consists in adding powdered magnesia to hydrated magnesium chloride, fused in its water of crystallisation. An oxy-chloride of magnesium is thus formed, which, on being heated in a current of air, splits up in accordance with the equation : $MgO + MgCl_2 + O = 2MgO + Cl_2$. The hydrochloric acid, which is always produced in practice, is washed out of the gas in the usual way, and the magnesia serves for another operation. Some pretty specimens are shown in connection with Muspratt and Eschellmann's patent for manufacturing chlorates, and Messrs. Boake and Co. exhibit liquified sulphur dioxide and various metallic sulphites. Messrs. May and Baker have an interesting stand, on which are a number of beautiful specimens, including various metallic oleates, a fine specimen of metallic bismuth, and tablet camphor in large and perfectly transparent blocks. Messrs. Howard and Sons show various preparations from cinchona bark, and Messrs. Hopkin and Williams have a number of interesting exhibits, some of which are remarkable for their beauty. Among them may be specially mentioned some sulphocarbolate of zinc in crystals resembling arragonite, hydriodate of quinine in beautiful orange crystalline needles, fine colourless crystals of cantharidin, and pure urea in very beautiful needles. A very fine collection of sulphocarbolates is also shown by Messrs. F. C. Calvert and Co., who also show four brands of crystallised carbolic acid, melting at 85°, 95°, 104°, and 108° F. respectively, while the carbolic disinfecting powders range in strength from 5 to 50 per cent. of carbolic acid. We believe in the case of the stronger powders the absorbent used is kieselguhr. A remarkable exhibit is that of Messrs. Burt, Boulton, and Haywood, besides models of their improved apparatus for creosoting timber, according to which the timber is immersed in the creosote oil, heated somewhat above the boiling point of water, while a vacuum is maintained, which results in the effectual expulsion of all moisture, and, on readmitting the air, the creosote is forced into the pores of the wood in a very perfect manner. But to the pure chemist the beautiful collection of coal-tar products shown by the same firm will be of more direct interest. Among these we would call particular attention to the following specimens : —Dinitrobenzene in delicate tufts of yellowish-white needles, acridial hydrochlorate in golden or brownish-yellow scales, a magnificent specimen of anthracene, lemon-yellow crystals of dichlor-anthracene resembling picric acid, and a beautiful fluorescent solution of six drops of dichlor-anthracene sulphonic acid in one quart of water. A specimen of anthraquinone in magnificent, extremely long, delicate lemon-yellow needles should be noticed, and also one of chrysoquinone in minute needles of a deep red colour. A specimen of alizarin in orange-red needles of the colour of bichromate of potassium should also attract attention. The British Alizarin Company show a series of interesting specimens connected with their manufacture. Messrs. Brooke, Simpson, and Spiller likewise exhibit some coal-tar products, as do Messrs. Levinstein, Campbeli, and Co. An interesting collection of seaweed products, shown by the British Seaweed Company, exhibits, in a striking manner, the industry with which Mr. E. C. Stanford has investigated the somewhat unpromising subject of algin. We are glad to hear that this curious body is now used for dressing cloth and cotton thread, and is employed as a dung substitute in calico printing. The collection of metallic alginates is very complete, and well worthy of notice. Young's Paraffin Light and Mineral Oil Company, Limited, exhibit certain specimens which are rarely seen. Among others, three different compound ethers of pyrogallic acid, boiling at 253°, 265°, and 285° C. respectively, together with cymol-phenol boiling at 237°, and phlorol boiling at 220°. They also show specimens of the tar bases, tetracoline, cryptidine, iridiline, and leucoline. The same firm show an interesting collection of pure paraffins, ranging from octane, having a density of ·726 and boiling at 255° F., to heptadecane, with a density of ·803, boiling at 568° F, and solidifying at 48° F. Among their exhibits are some pretty artificial flowers moulded in paraffin wax; while a large block of paraffin attracts attention from the number of air-bubbles it contains, and which we should have thought would have prevented it from being selected as a specimen for exhibition. H. Bollmann Condy shows a collection of hyposulphates, including those of copper, manganese, barium, sodium, and potassium, and also exhibits a new disinfectant said to consist essentially of a mixture of permanganate and sulphate of aluminium, and to be capable of yielding a far more concentrated aqueous solution than permanganate of potassium will do. Among other exhibitors in the Chemical Department we may call attention to the stand of Messrs. Mackey, Mackey, and Co., Messrs. Townson and Mercer, E. Packard and Co., and others. The balances of Degrave and Co., and L. Oertling and Co., should be noticed, and the very ingenious airtight taps of Arnold Eiloart should not be passed without examination. Altogether, the Chemical Department of the Inventions is well worthy of careful inspection, and, to those who can appreciate it, will be found highly illustrative of the march of applied chemistry during recent years.

## THEORY AND PRACTICE OF PHOTO-MICROGRAPHY.—II.[*]

By MAURICE N. MILLER, M.D.

LET us now select and arrange our apparatus. We are to use sunlight—we must have a heliostat. Of the almost numberless forms of this, ranging from the most simple to the most complicated, I unhesitatingly give the preference to the simple and inexpensive instrument invented by Mr. Rutherford, and brought to our notice by one of our oldest and most useful members—Mr. D. C. Chapman. This apparatus is familiar to most of you. It is described in *Silliman's Journal*, 1863-65, and I will give the essential features. The works of an ordinary Yankee clock, with balance, are made to rotate a steel mandrel which is inclined so as to present a continuation of our polar axis. This mandrel carries the mirror. The entire apparatus can be made well and solidly at an expense of not more than fifteen dollars. It is easily adjusted, and when regulated performs with sufficient precision for the best work. Secretan, of Paris, makes an instrument on this plan, entirely of metal, which is necessarily less liable to loose adjustment by exposure than one made partly of wood. Inasmuch as we do not work except in pleasant weather, the heliostat of Chapman will remain in adjustment for a long time if properly cared for when not in use.

Time affords me no opportunity to say anything here about the adjustment or regulating of this piece of our apparatus. I cannot refrain, however, in passing, from suggesting that a great deal of valuable time will be saved by carefully regulating the clockwork before attempting to use the heliostat in actual work.

Having adjusted the apparatus, we find the proper position for it on the shelf outside our window, and by some means affix it so that we may always be sure of securing the same position. This is preferable to attempting to box it in, as the storms are almost certain to injure and alter it. The heliostat is so placed that a beam of sunlight the size of the mirror, say 4in. by 8in., is projected against the outside of our stationary window shutter at a point about one foot above the window-ledge. The mirror should be of glass silvered and not covered with amalgam. At this point in the shutter a hole about six inches square is to be made, with cleats entirely around it, inside, so that with buttons we may quickly fasten therein a piece of board, which, as we will see in a moment, will carry our secondary mirror. You will observe that the beam from the mirror of the heliostat will pass through the hole in the shutter at an acute angle, and so on up to the ceiling of the room, and this is precisely where we do not want it. We have got the light into our room, however, and if everything be working as it should the spot of light will remain unmoved for hours. But we want to bend this beam so that it may come through the opening in the shutter at right angles to the same, and so pass on through the microscope, &c. This we accomplish by means of a second mirror, also silvered, placed just outside the square opening in the shutter; this is attached to the perforated board which fits therein. This mirror must be susceptible of movement in two directions, so that we may always catch the beam from the primary mirror, and direct it with accuracy and delicacy as we desire. This is best accomplished by using the arrangement employed in the old solar microscope, and which is also used in solar photography by reflection. Suffice it to say that the mirror with its attachments is affixed to our perforated board so that when the latter is in place we may have the mirror completely under our control, as the rods which accomplish the adjustments pass through the board and terminate in milled heads inside the shutter.

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[*] A paper read before the Photographic Section of the American Institute.

Our light is at last passing through our shutter and into our room parallel with and above our shelf. The latter must be so adjusted for height that when the microscope is placed thereon and the optical body placed horizontally, the beam of sunlight may pass through the optical axis of the lenses. As to the microscope—the great desideratum is solidity. You will have noticed that this solidity crops out very frequently in my remarks. It is the natural outgrowth of the use of apparatus which the mechanician seems to think cannot combine solidity with delicacy of adjustment.

The microscope should have, first, a mechanical stage; second, a centring sub-stage; and, third, a fine focussing adjustment that does not alter the length of the optical body. The tube of the microscope should be large and short. Schrauer, of New York, makes a special stand for this work, that answers our purpose admirably. Cleats are affixed to the shelf, so that the microscope may be moved to and from the shutter, but remain fixed as far as its lateral adjustment is concerned.

Our beam of sunlight coming through the shutter we will suppose to be about two inches in diameter. Now is our time to correct one of our original defects with the first simple apparatus. The scattering rays must be picked up and be made to arrange themselves in proper order. In a short piece of tubing fastened in the opening in the shutter we slide a second piece of tubing, which, in turn, carries a plano-convex or double-convex lens of nearly the diameter of the sunbeam. I believe nothing is gained by more light; even an inch is probably sufficient, and an achromatic lens here is not only useless, but less servicable than the single glass. This lens should have a focus of not less than eight to nine inches. Immediately in front of this lens, and supported on a little stand, we place a cell containing water that has previously been boiled. This cell is best made by separating two pieces of thin plate-glass by a frame of wood one-half inch thick. Bore a hole in the upper side of the frame, saturate it with melted paraffin, and, while hot, press the glasses against either side of the frame, and keep them in place by means of two rubber bands, or by thin binding wire. This makes the most perfect and permanent cell with which I am acquainted. Just before the beam of light is brought to a focus by means of the lens, another cell should be placed, which must be filled with freshly filtered solution of ammonio-sulphate of copper. This cell may rest on a stand by itself, although a more elegant way is to attach it by a mounting to the sub-stage.

To the sub-stage is affixed a good achromatic objective. A good one-half inch objective answers an admirable purpose, although for special work the condensers of Abbé and others can be used. The microscope should be so placed that when the achromatic condenser is in proper position the cone of rays from the primary condenser, or the plain lens, may just cover the large or bottom lens of the former. This is an important adjustment, and, in order to secure it and at the same time keep the microscope stand immovable, I have added a rack and pinion movement to my primary lens.

It might now be supposed that we might place an object upon the stage and an objective on the microscope and proceed to work; but should we do so we will find that more light will reach our plate from extraneous sources than will pass through the microscope. Several methods have been devised to cut off these stray rays by means of curtains; but they are all cumbersome, unsatisfactory, and inefficient. I have devised a little arrangement which answers the purpose admirably, although it must be seen to be appreciated. I construct a light framework which completely covers the apparatus on our shelf, being of the width and length of the latter, and about 12 inches high. This frame, except the bottom and ends, I cover with heavy straw board. This, if put on wet, glued, and well tacked, will, when dry, be as tight as a drum. These sides are hinged, so that when let down completely expose the microscope and all the accessories, rendering the adjustments of easy accomplishment. One end of the frame (or box, as it now presents) is fastened tightly to the shutter, while the opposite end, through which the end of the microscope tube projects, is covered with broadcloth or velvet, with a perforation and drawing-string through which the tube passes.

Now we may place our object upon the microscope stage. The heliostat has been steadily following the sun, and our light requires no adjustment save an occasional touch of the secondary mirror. The light passes through our first cell and the water absorbs the heat and renders it safe to our valuable objects and objectives. Remove the eyepiece, and, bringing the camera frame into position, proceed to make your adjustments. We find that, standing by the microscope, the ground glass frame perhaps two feet away, the image appears very weak and faint. This is because the light is absorbed by or passes through the ground glass. Inasmuch as our preparatory, yet, final adjustments are made while we are at the microscope and not at the camera, we place a piece of white cardboard in front of the ground glass and projecting the image upon that it is seen clear and distinct. We can remove our blue cell, as we do not require it just now, and proceed with the mechanical stage to find the portion of the object we wish to reproduce. Let me here observe that a good slide of dried human blood makes a splendid object to begin upon—as it will quickly show faults of lighting. This is the time to look out for internal reflections: remove the draw tubes, and varnish the inside of the tube with good negative varnish. When it becomes tacky allow the smoke from a kerosene lamp with the wick turned up and the chimney removed to coat the varnished surface. Or line the tube with paper so varnished and smoked. So cover every surface that you regard as liable to prove troublesome.

Well, everything about the image on the paper screen appears as it should, and we are now prepared to complete the focussing, yet hardly so, for after having replaced our blue cell, shut the microscope in, and move our position to the ground glass, we find we cannot reach the milled head of the fine adjustment of the microscope. So we require to affix a little grooved pulley to our shelf which shall carry a light gum-elastic belt over the milled head of the fine adjustment. The latter should also be grooved to receive the belt. To the axle of our grooved pulley is attached a light rod which passes back to the camera. Now we can assume our photographic position and finish the focussing.

The question will be asked: "How far distant should the ground glass or sensitive plate be from the microscope?" To this question only a general answer can be given. The only thing gained by distance is amplification. And just here you must appreciate the difference between amplification and magnification.

If you desire increased detail in your picture you can only secure it by using higher power in the objective. Do not attempt to make great blurred images by removing the sensitive plate to a great distance. With your screen at a distance of two feet from the microscope stage, employing a first-class one-eigth inch objective, you may get from 800 to 1,000 diameters, ample for your first twelve months work. Indeed, I would advise beginning with a good quarter-inch objective and about eighteen inches distance.

In ordering our steps, you may have noticed that I removed the eyepiece, and I mean to keep it so removed. I have never seen an instance where the introduction of the eyepiece was desirable; and I have seen a great many errors and imperfections introduced by the employment of it. If, however, you will insist upon using the eyepiece, let me caution you—see to it, that no speck of dirt, however small, remains on either lens, for the slightest fleck of dust is sufficient to make an ugly mark on the negative. This precaution should prevail with the mirror surfaces as well. Let them be thoroughly cleaned before commencing your day's work.

Now, how long shall I expose? No earthly intelligence can answer this question for you. You will, after a time, be able to look at the image on the ground glass, and judge with considerable accuracy as to the length of exposure—and it is just this experience alone which will enable you to so judge. With our present facilities, and with moderate amplification, the drop-shutter can be used—although it is better to diaphragm down the light and expose longer. The best exposer is a little flap of velvet hanging over the eyepiece end of the microscope tube, as it may be lifted and the exposure made without disturbing the adjustments. When it is not required it is turned aside, and so held by a hook-and-eye.

Now, in what way can we modify our apparatus, and lessen the expense, without materially affecting the final result? I am perfectly assured of one thing: for results that will prove satisfactory to the conscientious amateur, I believe that the darkened room cannot be dispensed with. Anything short of this is shaky and unreliable, besides tedious, in consequence of the endless running to and fro, from the stage of the microscope to the screen of the camera. With our gelatine plates, for a very large range of work, the heliostat can be dispensed with. It is a luxury, and indispensable if very long exposures are necessary. But a great deal of work can be done with the secondary mirror alone, although the constant adjustments are tiresome. The next absolute luxury—and this is purely so—is the expensive mechanical stage. If the student is prepared to draw liberally on a very large stock of patience, the mechanical stage may be omitted. The modern glass stages, moving, as they do, easily and with ready control, answers fairly well for the more expensive attachment. The centring sub-stage for first-class work cannot be spared. Much low-power work can be fairly done with a plain sub-stage, however.

To sum up, therefore, we may say that a great deal of very fine work can be done in photo-micrography with the secondary mirror, the centring sub-stage, and an ordinary microscope stand. I should rather discourage attempts that had not these facilities in contemplation at least. Much amusement can doubtless be secured with less than I have indicated; but it is not to these idlers in science that I am speaking here.

I desire now to refer to some matters connected with our subject, more especially the outgrowth of my practical work. As to lenses. What objectives are best? I think I can safely say this: As a rule, the lens that is found to produce the very best photo-micrographic pictures will also be an excellent lens for general microscopic work. It is no longer necessary to look for lenses corrected for photography. This idea is a delusion and a snare. If you have a lens that works well on tissues, you need not be afraid to try it on these subjects in photography. If you have a lens specially made to resolve the *Amphipleura pellucida*, why try it on *Amphipleura*, and don't try it on anything else. Occasionally you will find an objective that, for some reason unknown to men and opticians, does excellent photographic work. You order a duplicate, and it is a dead failure. I have in mind an instance in which the great and lamented Tolles made three several and separate attempts to duplicate one of his previous lucky hits, and signally failed. I can—and I say it with regret—only say try. There is no certainty about it. Of one thing you may be sure: a poor, cheap lens will never make successful photographic pictures. I have a one-sixth by Miller Bros., not specially made for photography, which, they frankly tell me, they would not guarantee to copy. The most successful pictures the world has thus far seen have been made with the objectives of Powell and Lealand, Tolles, and Zeiss, although the great master of this art died before he could give a final verdict respecting many of the latter maker's lenses.

From the little I have worked with the very low-priced lower powers of this cunning optician, it seems probable that they will prove most excellent lenses for our purposes. There is no necessity, however, in importing lenses, unless it may be in certain instances where the expense is the most important item, for the objectives of William Wales, of our own city, have produced some excellent pictures, and we owe much to his patient work in the direction of producing lenses for this special work. I must, however, repeat my original opinion, that success will more generally be gotten by trying first-class working glasses than in attempting the construction of lenses specially corrected for photography. I have no special theory on the matter. The statement is made only as a result of experience with very many trials with almost every known maker. For low amplification almost any first-class microscope objective will answer. It is only when the higher powers are required that the striking difference in objectives will be apparent.

It will not be found sufficient to simply attach a lens to our apparatus and proceed, leaving the glass to work out its own salvation. The same delicate correction for thickness of cover, the same careful preparation of immersion fluids, and the same patient adjustments for illumination are required in photo-micrography as in ordinary microscopy.

The introduction of polarised light affords a method of producing beautiful results, especially in photographing rock and mineral sections. The polarising Nicol is placed between the water and the blue cells. It should have a diameter of at least 1¼ inches, and had best be made after one of the modern formulas producing short prisms, as there is always sufficient loss of light in this work without the introduction of unnecessary elements of absorption. The analyser should be as large as is possible to use comfortably, certainly sufficiently, so to cover the posterior combination of the objectives completely; if it be smaller the field is much reduced. The small polarising attachments usually supplied with observing microscopes are totally inadequate to our present needs. The field is too small and the amount of light passing through the combination insufficient.

Respecting photographic processes adapted to photo-micrographic work, it becomes me to say little to such an audience as this. The factors that produce the full detailed portrait negative are only necessary. The rapid working gelatine films will enable the present worker to enter a field that has been entirely unexplored by our predecessors armed with the silver bath alone.

It may not come amiss to say something just here about the microscopic objectives themselves. Each worker will select a field for himself. Diatom pictures, so far, take the lead. It is probable that the great value of photo-micrography in the future will be exemplified in the production of illustrations in the minute structure of living organisms, both in their healthy and diseased states—*i.e.*, normal and pathological histology. The one great feature of our productions in this line is their absolute truth to nature. The pencil of the retoucher is not here available. The pictures are not always beautiful—there is no opportunity to select a fragment here and there, and with perhaps a slight draft on the imagination, as *in the composite* picture for the wood-engraver. *For this reason* rather than the great expense, photo-micrographs have never been very popular as general book illustrations; several beautiful volumes so illustrated on anatomical subjects have, however, been widely distributed among scientists. The inestimable value of our art is already seen in the domain of bacteriological investigations; and already do we look with suspicion upon the engraved illustrations of these minute, though potent, organisms.

The same conditions that produce a beautiful view are necessary in our microscopic object. If we have an object affording plenty of clear, sharp detail in proper colour, we may reasonably expect good pictures. And just here presents one of our most serious difficulties. Microscopic objects are, as a rule artificially coloured. As a rule, however, we are not limited in the selection of our dyes; in certain work we are so hampered. Tissues are dyed or "stained" in order to sharpen the differentiation. The dye attacks one part. of a minute animal of vegetable structure very strongly, while other portions are only slightly coloured. The dyes most commonly used are those made from carmine and logwood. The aniline dyes are also used almost exclusively so in bacteria staining. Carmine-tinted specimens are tolerably well adapted to our work, although the contrasts are feeble. The very best staining for photo-micrographic reproduction for tissues in general, there being no universal process, is that obtained with properly prepared logwood solution, the sections having been subsequently tinted slightly with eosine. Many complaints come to me regarding the logwood staining, and as often employed it is valueless, inasmuch as the resultant tint is blue. This is a fault of the operator, the proper staining containing sufficient non-actinic colour to give good differentiation. For fresh tissues, especially epithelial structures, the litho-carmine with the yellow of picric acid will give good photographic contrasts. Insects and parts of the same are usually unstained, and present sufficient contrasts. The most striking popular productions will be obtained in this direction. In micro-organisms we are, unfortunately, sometimes unable to select our tint. Certain peculiarities of composition render them amenable to particular dyes, and we have little choice. Certainly strong contrasts are not to be expected with extremely minute translucent points or lines of a faint blue tint on a white ground.

America has, so far, taken the lead in photo-micrographic work. Indeed the late Colonel J. J. Woodward, in whose death the scientific world lost an enthusiastic, indefatigable, and highly intellectual worker, was almost the father of high-class photo-micrography. His publications have done more than all other causes combined to stimulate endeavour in this important branch of illustrative art. May I not be allowed to hope that you are not willing to be satisfied with simple mediocrity, but that those now commencing this work will aim, not to only equal what has already been done, but to secure results far in advance? It was in the hope of stimulating such endeavour that I consented to appear here on a subject that is of interest to only a portion of our number.

## BACKLASH IN GEARING.*

EVERYONE who has much to do with machinery is familiar with backlash; but very little has been written concerning the cause of it, or the means of getting rid of it. Indeed, direct and palpable mistakes concerning it have been made by authors who ought to have known better. For instance, Rankine defines backlash thus: "The excess of the space between the teeth of one wheel above the thickness of the teeth of another wheel with which the first wheel gears, is called play, or backlash, because it is the distance through which the pitch line of the driver moves after having its motion reversed before the backs of the teeth begin to act." This is very imperfect and inadequate. Unfortunately, the jarring and rattling of teeth, known as backlash by millwrights, is certainly not the clearance space between two teeth; nor is it met with only when wheels are reversed. If two cogged wheels properly made be run together with a steady pressure there will be no backlash, and and there will be very little noise. The cause of backlash is simply that the pressure is not uniform, and the cure of backlash can only be effected by making it uniform. The old millwright's rule, that the velocity of the rim of a fly-wheel must be in excess of that of the circumference of the millstones, went right to the root of the whole matter; and we propose to show here in a few words what are the special means to be adopted to get rid of backlash. Whether they can be applied in practice or not depends in all cases on conditions over which the engineer sometimes has, and sometimes has not, control.

No matter how heavy the flywheel of an engine may be, it never revolves with a uniform velocity. Its speed falls off as the crank approaches the dead point, and the dead point being passed, it gradually augments until mid stroke or some point near it has been attained by the piston. If the machinery driven is so light that it has not much momentum, then its speed will rise and fall with that of the engine, and there will be no backlash. If, on the contrary, the driven machinery has a good deal of weight and momentum, then there is certain to be backlash. Let us suppose, for example, that a flywheel 15ft. in diameter, and weighing 10 tons, makes fifty revolutions per minute. The average speed of the wheel rim will be 2,355ft. per minute. Let us further assume that the maximum velocity of the wheel is 2,360ft., and its minimum velocity is 2,350ft. per minute. Let the rim of the weeel be toothed, and let it gear into a wheel 5ft. in diameter, weighing 1 ton; the speed of this wheel will be identical with that of the fly-wheel, and its momentum will be too small to help the fly-wheel in any way over the dead point. Its momentum, indeed, will be only one-tenth of that of the fly-wheel. Now, let us suppose that the machinery driven is run under these conditions at a speed too irregular for the required purpose, say, spinning cotton, and that to get over this difficulty the mill-owner mounts a second fly-wheel 15ft. in diameter on the second-motion shaft. The rim velocity of this wheel will be three times that of the fly-wheel, or 7,065ft., and as the controlling power of fly-wheels varies as the squares of their velocities, this second wheel will have nine times the steadying power of the first wheel, instead of only one-tenth of it, as was the case with the spur wheel alone. What, then, happens is that whenever the chain flywheel tends to lag behind, the second motion wheel takes up the running, and the spur wheel on the second motion shaft will actually run faster than the flywheel, and will drag it, the pressure being transferred from the front of the teeth to the back, and the play existing between the teeth will permit them to hammer each other, and so backlash will be set up. The velocity of the second spur wheel will not tend to vary much over 1ft. per minute, while the velocity of the main flywheel tends to vary, as we have seen, 10ft. per minute, and the toothed spur wheel will therefore alternately drive and be driven twice in each revolution. As far as the spinning machinery is concerned, the result may be satisfactory enough, but the backlash will be intolerable. The teeth will be worn out of shape and broken. We have here, of course, a purely imaginary case, the conditions being worse than those which are usually met with in practice; but this is the best way to put an elementary truth, so that it may be readily undsrstood by those who have not much knowledge of the theory of machines. The second flywheel is seldom used out of ironworks, but the equivalent of a second flywheel is by no means unknown. Thus we meet with long lay shafts fitted with numerous heavy spur wheels, running at a high speed, and these are often quite adequate, especially when the load is light, to drag the flywheel after them twice in each revolution. When the load is heavy in proportion to the momentum of these secondary revolving masses, the backlash will be small or absent; and this is the reason that, as is well known, gearing will sometimes run with noise and tremour enough to shake a mill down, while at others it is quite quiet. In one case the load is light, in another it is heavy. Broadly stated, all revolving masses on second-motion shafts which tend to help a flywheel to equalise velocity are liable to cause backlash in spur gearing. The way to avoid backlash lies in taking measures to prevent the load driven running away from the driver.

There are, moreover, other causes which tend to the same end. A frightful source of trouble is want of balance in some part of the machinery. Some years ago a horizontol engine, indicating about 50 h.-p., was put down to drive a corn mill. From the first this engine, which worked expansively, gave trouble in the way of backlash. After much talking and thinking, the manager of the firm by whom the engine was made suspected that the fly-wheel was out of balance. The wheel was unkeyed and swung, and this was found to be the case—probably from an imperfection in the casting; and to make matters worse, the wheel was so hung as to aggravate the want of balance, retarding the wheel when the crank was near one dead point. About 2 cwt. of balance weights were cast and bolted to the rim, when the backlash at once disappeared, and no further trouble was experienced. It may seem that the means adopted were quite inadequate to the end; but it must not be forgotten that the difference between silence and noisy backlash is often very small. A very little hanging back of the flywheel of an engine may suffice to take the cog faces away from each other for a moment, and these, coming together again, will make quite as much noise as is desirable. One other cause of backlash deserves notice, and that is the whipping of long shafts. An instance came under our notice some years ago where two rows of 3ft. 8in. burr stones, fifteen pairs in each row, were driven by two lay shafts, each over 90ft. long. Fine flour could not be made with the stones furthest from the engine, because each shaft whipped nearly one-sixth of a revolution, being too small in diameter for its work. It will be seen that if a weak shaft is interposed between a driving spur wheel and a load, we have all the elements of unequal stresses between the teeth of the gearing at once introduced. It must not be supposed that backlash is confined to cog wheels; in some cases much trouble is experienced in driving with ropes, because the second motion-pulley is so heavy that it helps the flywheel of an expansive engine. The result is that the ropes surge up and down, and may be thrown off. Rope gearing has been used for driving tilt hammers in Wales and elsewhere, but with unsatisfactory results, due to the sudden flying forward of the rope pulleys when the helve trips off the wiper. It may not be out of place to add here that the heavier the flywheel, and the more expansively the engine is worked, the greater is the probability that there will be backlash. It is a favourite notion with some engineers that a fly-wheel cannot be too heavy. The truth is, however, that the wheel should always bear some definite ratio to the weight of the other revolving masses whose momentum tends to render motion uniform. To put once more an imaginary case, let us suppose that on the shaft of an engine two flywheels of equal weight were mounted, the one keyed on the engine shaft and fitted with spur gearing, the other mounted loose and driven from the shaft by a coiled spring or some such flexible arrangement. It requires no great familiarity with mechanics to see that the second, or loose wheel, would soon set up a kind of rhythmical apparent motion with regard to the first, the spring would alternately coil and uncoil as the second wheel was alternately driven by and helped to drive the first wheel; and it is also clear that the lighter either of the wheels was, the more closely would their rates of motion of rotation coincide.

We sometimes hear it said that wheels are running with a great deal of backlash, when there is nothing of the kind. There is a tremendous noise, it is true; but this is due to the bad form or condition of the teeth, and to nothing else. Wheels out of truth on their shafts, or with considerable play in the shaft bearings, cannot run silently; and it should never be forgotten that when a wheel has been properly pitched and trimmed to run with another, if that other gets broken, it cannot be properly replaced by the first wheel of the same pitch that the millowner can lay hands on. Certain firms, we may add, make the production of gearing a speciality; and our readers will find it cheapest in the long run to resort to such firms rather than go to anyone who happens to have a set of wheel patterns handy. Second-rate gearing is the most expensive commodity any millowner can use.

## ACETIC ACID FROM WOOD.

IT is well known that most of the acetic acid sold in the United States is produced by the distillation of wood, but some details of the operation may be new to our readers. The possibility of this method depends on the volatility of acetic acid and the fact that it is not decomposed at a dull red heat. Among other volatile products of this distillation are marsh gas, olefiant gas, and liquid at ordinary temperatures, benzol, toluol, phenol, &c. This distillation is usually carried on in iron ovens or retorts into which the wood is introduced. In some cases the more volatile matters, such as water mechanically obsorbed or contained as sap, are driven off by the application of a lower degree of heat, and in others this is not considered necessary. In some factories wood is treated both for its volatile products, such as acetic acid, benzole, and creosote, and free access of air until carbonised, which is predicated when the smoke given off becomes bluish instead of dark and heavy. The air supply is then shut off and for charcoal. In these the charge is ignited with in place of a clean combustion the decomposition desired by the manufacturer is effected. The yield of acetic acid, as well as of liquid products, with the exception of benzole, in general, is less when the wood is rapidly charred. In operating upon refuse wood, such as sawdust, spent dyestuff, and tan bark, retorts of special form are necessary, as the application of heat is almost immediately followed by the formation of an exterior coating of hard carbon, which effectually protects the interior of the mass from the action of heat. This fact prevented for a time the utilization of such materials, but the difficulty was overcome by exposing only thin layers of material to the heating surface. The retort for this operation consists of a horizontal cylinder of iron, containing for its entire length a screw, which, while moving the materials steadily on by its revolutions, keeps it evenly distributed over the bottom of the retort. The cylindrical retort is so built as to expose the greater part of its length to the heat of a furnace, while at one end is a provision for feeding the material regularly. The other extremity has two branches: one running directly downwards terminates in a tank of water, into which the carbonised substance falls; the other leads to the condenser. Where wood is operated in billets, simple cast or

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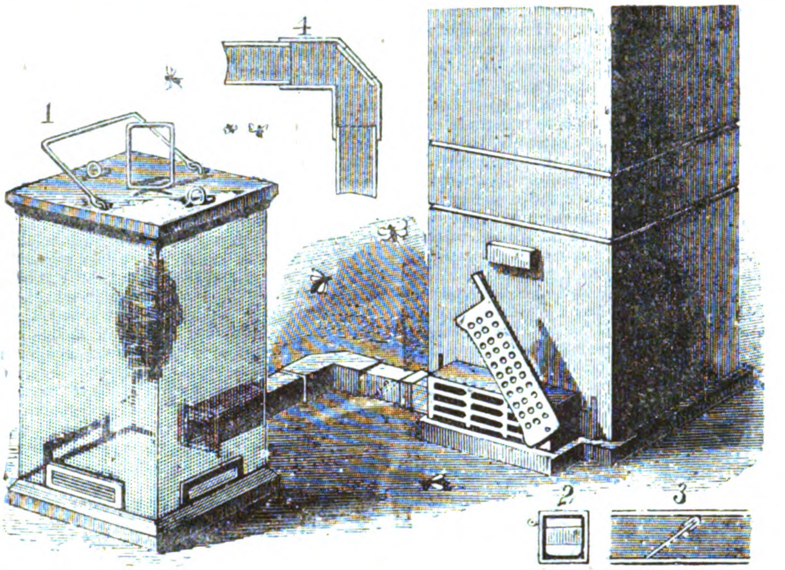
* From *The Engineer*.



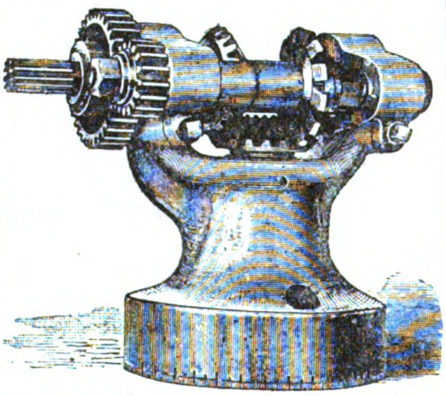
wrought iron ovens capable usually of holding about one-half a cord are used, and the vapours conducted to a suitable condenser. The amount of acid and charcoal obtainable from a given weight of wood varies with the kind of wood employed, but in general may be stated as something under 50 per cent. of charcoal. This acid is the crude product containing tarry and other empyreumatic products known in commerce as pyroligneous acid. It is purified by subjecting to a slight heat, to separate benzole, and saturating the acetic acid with lime or soda. The salt is calcined in order to decompose the tarry matter present, and afterwards distilled with sulphuric or hydrochloric acid, which combines with the base and sets acetic acid free. This part of the manufacture is not always carried on by the distiller of wood, who must, from the nature of his crude material, operate near the source of his supply. Therefore, the acetate of lime is a commercial article from which the manufacturing chemist may produce the acid in question. One advantage of this is that the solid acetate is more cheaply transported than the liquid acid.

## FERGUSON'S COMBINED BEE SWARMER AND HIVER.

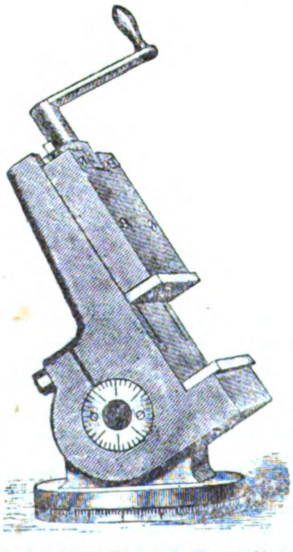
THE object of the contrivance represented in the engravings is to conveniently control the swarming and hiving of bees. It has been invented and patented (in the United States) by Mr. S. E. Ferguson, of Eureka Springs, Arkansas. At the hive entrance is placed a trap, in the rear side of which is an entrance, the size of which can be regulated by sliding gates. By adjusting the slides so that only one bee can pass at a time, the bees can easily guard the hive against robber bees. The front of the trap is provided with a bar door, the spaces of which are large enough to permit the passage of the working bees but not the queen, and also with a perforated door, through which only the workers can pass. These doors are hinged so as to swing open and shut through vertical planes. In one or both ends of the trap is an opening to receive the end of a conductor, the first length of which is made of wire gauze to admit light, so that the queen can readily find her way into the conductor. The second length, Figs. 2 and 3, has a drop door made of mica or other transparent material to transmit light, so that the queen, in seeking to escape, will raise and pass the door, thereby being prevented from returning. When the conductor turns as in Figs. 1 and 4, the elbow is provided with a transparent plate. The other end of the conductor enters the wall of the cluster cage, which is formed with a number of entrances to admit the bees. The wall of the cage is of wire gauze. The lower frame of the cage is permanently attached to a bottom, while the top is formed with slots to receive set screws screwed into the top frame; the top can be secured in place by turning the set screws at right angles with the slots. The handle of the cluster block placed within the cage passes through a slot in the middle of the top, and has a loop at its upper end. The lower part of the loop is at right angles with the cluster block, so that the latter can be supported by turning the loop one-quarter around. The loop also serves as a handle for carrying the block. A bail is hinged to the top of the cage. In using the apparatus the trap is placed in front of the hive entrance, and the perforated door raised to allow the workers and drones to pass. The only passage for the queen to escape by is through the conductor into the cage. The bees then enter the cage through the openings, and cluster upon the block; the swarm can then be readily transported to a hive. If desired, the outer end of the conductor can he connected by another trap with a second hive.

## NEW ATTACHMENTS FOR MILLING MACHINES.

THE vertical angular attachment for milling machines shown in the illustration is especially adapted for heavy milling machines. It is



cast hollow and secured to the head of the milling machine by four bolts. The base has an annular T-slot, and a hole to insert the bolts. It is driven by a socket fixed in the spindle of the milling machine, which is key-seated to fit the keyed stud



in the attachment. Through the medium of a pair of mitre wheels, this stud drives a spindle at right angles to the attachment, and it is geared to a shaft in line with it, which is utilised as a cutter or saw arbor, for cutting racks, sawing-up stock, &c. This shaft runs in gun-metal bearings, and can be removed by means of the two clamp screws in the clamp bearings. This attachment can be used either vertically, horizontally, or at any angle around the centre, the base being graduated to register its position. Cutter arbors or boring bars can be used in either end of the main spindle. For rack cutting there is no limit as to length, while for milling or boring castings of irregular shape or troublesome to hold in ordinary tools, this attachment will be found very useful. In cutting large gears the cutter spindle is placed vertically, and the index head at right angles to the platen; the gear blank is then fed in line with the main spindle of the milling machine. By setting the platen at an angle bevel gears may be cut. Spur gears up to 6ft. in diameter may be cut with this attachment in connection with the heavy milling machine referred to above. This attachment can be utilised for and is adapted to the cutting of racks, spur and bevel gears, profiling or angular milling: boring or drilling at right angles to the main spindle of the milling machine, sawing up stock, milling of slots, links of locomotives, arcs of circles, dies for sheet metal, square pieces on edge, etc.

This vice, represented in the illustration, is adapted to swing from a horizontal to a vertical plane or at any angle therein. A graduated plate with a central stud fills a hole in the base of the vice, enabling it to be set at any angle. It can be held in position on the trunnion by clamping the body of the vice with the two nuts shown in the cut. A graduated dial on the trunnion, marked by degrees, gives the angle to which the vice can be thrown, facilitating the milling or planing of work at an angle. The jaws, of hardened steel, open 8in. with a depth of 2in. In addition to the numerous uses to which this vice can be put on a milling machine, it can be applied to advantage on a planer, shaper, drill press, etc. These milling machine attachments are made by Detrick and Harvey, Baltimore, Md.—*American Machinist.*

## RE-DYEING FADED GARMENTS.*

ALL light-coloured woollen and silk garments especially the former, should be cleaned not hotter than hand heat, and with very little soda in the soap-liquor. When the goods are cleaned and rinsed ready for dyeing, sort them out according to their colours, and pass through an acid bath at boiling heat. For a sixty-gallon copper or bath use ½ pint vitriol, 8oz. oxalic acid, and handle the goods in this for ten minutes; then lift and rinse in two lots of hot water. Observe what garments are the most faded, and after passing through the acid bath, sort them out and keep separate until the scouring is finished. Then add to the acid bath half a gallon nitrous acid, and re-enter the goods which still show the fades, and keep handling them until they are all of a uniform colour. This would not, of course, apply to garments for blue, pink, or grey. In the case of faded white goods for light blue, after cleaning, pass through a bath at boiling heat to which has been added one pint spirits of salts. Work in this for ten minutes, then lift and rinse in two lots warm water; should the goods be required dyed soft, before dyeing pass through a bath at hand heat containing one gill ammonia. Should a greenish shade be required it can be got with indigo, and you can dye direct from the acid bath, adding 12oz. Glauber salts or 1lb. common salt. Dye at boiling heat.

Faded Garments for Grey, Drab, Fawn, and Slate.—If the fades show after cleaning, pass through a bath at boiling heat containing nitrous acid in the proportion of one pint to 40 gallons of liquor. This will cut the fades, and will not give too much yellow body to prevent dyeing a good grey. Some dyers may object to this on the ground that a good grey cannot be dyed on a garment after it is treated with nitrous acid. To this objection my answer is emphatic. I positively affirm that never does an article come into my hands for grey, which is faded, but I treat it with a little nitrous acid as explained above, and with invariably satisfactory results. It matters little what shade of grey is required, as it can be regulated by the proportions of blue and red employed in the dye bath. The principal thing to be studied in dyeing faded garments is the use of the proper drugs. Take for instance an article for marone. If dyed with cudbear, and boiled all the time of dyeing, the faded parts of the garment will turn out much darker than the other parts. If the goods are all wool, dye at boiling heat with acid roseine, acid yellow, indigo, and Glauber salts. There are some classes of goods that cannot be dyed by this method, such as woollen garments trimmed with silk. This class looks much better dyed with cudbear, as the silk and wool will match in the same bath, provided the goods are not boiled.

Faded Damasks for Crimson, Marone, and Claret.—These should, after being thoroughly cleaned and rinsed, be stripped in a bath at boiling heat with spirits of salts and oxalic acid, which will help materially to cut the fades. Rinse in two warm waters, and dye the crimsons with cochineal and cochineal paste (or acid magenta and cochineal), grain spirits, and Glauber salts. The marones can be dyed in the same copper, using acid roseine, acid yellow, and indigo, with a little sulphuric acid. On no account boil the damasks until after they have been in the copper for fifteen minutes. Even after this it is not advisable to boil the goods for long, merely keeping the copper at boiling heat.

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* From *The Dyer.*

FADED DAMASKS FOR GREENS. — These trouble dyers more than any other colours. The great mistake is boiling them too much. Many dyers labour under the impression that the only way to cover fades in green damasks is to boil them well. I have seen a master dyer, who ranked himself second to none as a thoroughly practical man, boil a lot of damasks over four and a half hours, and then, finding the fades still showing themselves, he declared that they had not been boiled sufficiently. Instead of a lengthy boiling covering the fades, it made them still darker. The best method for greens is to dye them with indigo, acid green, and either common or Glauber salts, together with sulphuric and picric acid. But be sure not to err on the side of too much boiling.

# SCIENTIFIC SOCIETIES.

## ROYAL METEOROLOGICAL SOCIETY.

THE concluding meeting of this society for the present session was held on Wednesday, the 17th inst., at the Institution of Civil Engineers, 25, Great George-street, Mr. R. H. Scott, F.R.S., president, in the chair.

Lieut. A. Leeper, R.N., was elected a Fellow of the Society.

The following papers were read:—

(1) "A Few Meteorological Observations made on a Voyage up the Nile in February and March, 1885," by Dr. W. Marcet, F.R.S. The author on a voyaye up the Nile from Cairo to Assouan made a series of meteorological observations, and in the present paper gives the results of those relating mainly to nocturnal radiation, and the temperature of the water of the Nile.

(2) "The Mean Direction of Cirrus Clouds over Europe," by Dr. H. H. Hildebrandsson, Hon. Mem. R. Met. Soc. The author has collected a number of observations on the movements of cirrus clouds over various parts of Europe, and after discussing them has arrived at the following results:— (1) the mean direction at all stations lies between south-west and north-west; (2) in winter the cirri come from a more northerly direction, and in summer from a more southerly; (3) in winter the northerly component is greater on the Baltic and the North Coast of the Mediterranean; (4) the mean directions of the upper currents nearly coincide with the mean tracks of storm-centres; (5) the upper currents of the atmosphere tend in general to flow away from those areas in which a barometrical depression exists at the earth's surface, towards those in which there is an elevation of pressure.

(3) "On the Influence of Accumulations of Snow on Climate," by Dr. A. Woeikoff, Hon. Mem. R. Met. Soc.

(4) "Note on the Weather of January, 1881," by Mr. E. Harding, F. R. Met. Soc. It will be remembered that the weather of January, 1881, was remarkable for the prolonged and exceptionally severe frost, the heavy gale of the 18th and 19th, and the snowstorms. The author has prepared isobaric charts for the North Atlantic and adjacent continents for January, 1881, and compared it with similar charts for January in other years. He shows that the severe weather in 1881 was due to a reversal of the normal conditions, the atmospheric pressure being high in the north and low in the south.

(5) "Results of Meteorological Observations made in the Solomon Group, 1882-84," by Lieut. A. Leeper, R.N.

(6) "Graphic Hygrometrical Table," by Mr. D. Cunningham, M.Inst. C.E., F.R Met.Soc.

**A New Hair Dye.**—A very recent hair dye, and one which is said to be good, is made by dissolving freshly-prepared ammonia-tartrate of bismuth, or the ordinary scale citrate of bismuth and ammonia, in weak glycerine, and mixing this with a solution of hyposulphite of sodium in glycerine and water, and finally diluting with more water.

THE New York *Industrial America*, in commenting on English and American made axes, says the real reason that the latter is preferred by colonists and others is on account of the superior shape. "Its refinements of form are not easily copied. The handle is one of the most perfect pieces of work human ingenuity has produced, and it seems strange that it has not been carefully copied by means of the ordinary copying lathe."

# SCIENTIFIC NEWS.

THE jubilee meeting of the Statistical Society was held this week, and was attended by a number of representatives from foreign countries. Sir R. Rawson, the president, claimed that "statistics might be defined as the science which treats of the structure of human society," and undoubtedly they do form a very valuable branch of knowledge. As M. A. De Foville pointed out, however, "ignorance, passion, and unscrupulousness render an instrument of truth the vehicle for the dissemination of error." Dishonest and unscrupulous statisticians are the worst enemies of statistics; and it is well, therefore, that there is a society in which statistics, which form the bases of arguments, can be calmly examined by a dispassionate body of experts.

At the recent annual general meeting of the Marine Biological Association, the report which was read stated that nearly 300 persons had already joined, and that a sum of over £8,000 had been collected or had been promised. The expenses for the year amounted to only £263. Prof. Moseley and Mr. Crisp spoke warmly of the services rendered by Prof. Ray Lankester, especially in pushing on the work of establishing the laboratory at Plymouth. The scheme has now been taken up at Oxford, and we may hope that it will in a short time become a flourishing institution.

The Astronomische Gesellschaft will be held at Geneva on August 19—22, Prof. Auwers, president, and Profs. Schönfield and Seeliger, secretaries.

Part VIII., Vol. III. of the *Journal* of the Liverpool Astronomical Society contains a variety of interesting papers, several illustrations, and the index to the volume. The annual meeting for the election of officers and council will be held on July 25.

The eighth annual report of the Hackney Microscopical Society shows that, although the finances are in a not altogether satisfactory condition, owing to a non-observance of Rule I. by a considerable number of members, the society is progressing with its work, and attracting notes and papers of considerable interest. The report contains, amongst others, a valuable paper on the Hackney Brook, by Mr. J. Greenhill.

The Cutlers' Company of Sheffield will hold in July, in the Cutlers' Hall, an exhibition of handicraft work carried on within the jurisdiction of the company during the present year. The exhibition will show samples of all stages of manufacture of hardware and metal goods, cutlery taking a very prominent part, and will contain also a loan exhibition of the finest specimens of old metalwork that can be got together for the purpose, and a loan collection of old silver of great value. The applications by exhibitors already exceed 1,400.

The International Industrial and Commercial Congress will be opened on the 16th of August at Brussels, where technical questions and those relating to work and to Industrial property will be discussed. The Congress will then be transferred to Antwerp for the consideration of economical, commercial, and geographical subjects.

The most remarkable ride ever accomplished on a bicycle was completed on June 19, when Mr. H. R. Goodwin, of the North Manchester B.C., reached London from Land's End, and made a record of 2,050 miles in 19 days. Leaving Land's End on June 1, he reached John o' Groats in 7½ days, and arrived at the starting point again in less than 16 days. Thence he rode up to London, and arrived as stated on the 19th, feeling fresh and well. Mr. Goodwin rode a 40in. "Facile," a machine which long ago established its claim to be a first-class and safe roadster.

The *Engineer* says:—Complaints are constantly being made by passengers using the Great Northern trains running on the Metropolitan Extension of the London, Chatham, and Dover Railway. They complain of being forcibly thrown from the carriages as they are stepping to the platform by the sudden recoil of the brakes. A considerable period elapses between the stoppage of the train and this recoil, and hence even the most careful passengers are liable to be thrown as they step from the footboard. Several passengers have been thrown in this way, and insult is then added to injury by their being told to be more careful.

At a public meeting convened last Saturday by the Royal Academy of Music, and presided over by Sir G. Macfarren, it was resolved "that it is desirable to fix a standard for musical pitch throughout the United Kingdom which may accord with that of other countries"; and "that steps be at once taken for securing the adoption of the standard pitch in the principal orchestras; and also, if practicable, by the regimental and other bands of the British Army. Another resolution appointed a committee to carry out the previous resolutions, the following being requested to serve:—Mr. R. H. M. Bosanquet, Mr. A. J. Ellis, Mr. Hipkins, Dr. Pole, Dr. W. H. Stone. Mr. Walter Bache, Mr. Otto Goldschmidt, Mr. Henry Holmes, Dr. Hopkins, Sir G. A. Macfarren, Mr. Walter Macfarren, Mr. Patey, Mr. Sims Reeves, Mr. Sainton, Mr. Santley, Dr. Stainer, Mr. Van Biene, Mr. A. C. White, Mr. Bruzaud, Mr. Blakeley, Mr. Willis, and Mr. Brinsmead. If organs are to be brought to the new standard pitch there will be plenty of work for builders, even if it is only in shifting the pipes to lower the pitch. As to bands, the cost of new instruments will be a great obstacle.

News has been received that the German expedition in Eastern Africa has failed completely, Dr. Böhm having died at Mua in the end of March, last year. His companion, Herr Reichard, is safe at Karema, but all the collections have been lost.

The Mexican Government have resolved on undertaking a geological survey of the whole country, as far as practicable, and they have assigned 10,000 dollars for the preliminary expenses. Such a survey will be of the greatest importance to all the mining districts of Mexico.

Writing in the *Bulletin Société Chimique* on the action of bacteria on albuminoids, M. A. Gautier says that the poisonous alkaloids produced seem to be identical with those generally known as ptomaines. He proposes that, as they are constant and necessary principles in the normal excretions of living organisms, and have been detected in the saliva, urine, muscular juices, sweat, and also in numerous glands, they should be called "leucomaines." They are mostly poisonous, crystalline, and give crystalline platino-chlorides.

It is stated that Dr. Riebeck will next autumn commence a second voyage round the world. He will visit North America, the West Indies, South America as far as Magellan's Straits, the West Coast of America, the Sandwich Islands, Australia, the islands of the Pacific, and Eastern Africa. Dr. Von den Steinen, who has only recently returned from an important exploration in South America, will accompany him.

According to M. Witz, the proportion of ozone in the atmosphere of Paris last year was in inverse ratio to the mortality from cholera.

**Selenium Sunlight Measurer.**—M. Morize, of Rio de Janeiro, has invented an ingenious selenium apparatus for measuring the relative intensities of the rays of the sun at different altitudes above the horizon. It consists of a selenium cylinder prepared according to the plan of Professor Graham Bell, 38 discs of copper being insulated from each other by smaller mica discs, and the edges filled in with selenium. It is insulated by glass supports inside a glass envelope, from which the air has been exhausted. The vessel is elevated in a place where surface reflection does not reach it, and the axis is placed parallel to the axis of the earth, so that the rays of the sun fall normally on the selenium cell, and illuminate the same surface. Its position can be altered to keep up this condition from day to day. A constant current traverses the selenium and a galvanometer in circuit with it.

**Koumiss.**—The following is said to be a good recipe for the preparation of koumiss: Powdered sugar of milk, 100 parts; glucose (prepared from starch), 100; cane sugar, 300; bicarbonate of potassium, 36; common salt, 33. Dissolve these ingredients into 600 parts of boiling fresh whey of milk, allow the solution to cool, then add 100 parts of rectified spirits, and afterwards 100 parts of strained fresh beer yeast. Stir the mixture well, and put into half pint bottles. The bottles must be well corked and kept in a cool place. For the preparation of koumiss add five to six tablespoonfuls of this extract to a quart of skimmed, lukewarm milk, contained in a bottle of thick glass, cork well, keep the bottle for half a day in a moderately warm room, and afterwards in a cool cellar, shaking occasionally.

# LETTERS TO THE EDITOR.

*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

*All Cheques and Post-office Orders to be made payable to* J. Passmore Edwards.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

> **"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original."**
> —*Montaigne's Essays.*

## 16 CYGNI AND PAIR IN FIELD—$\alpha^1$ CANCRI—$\alpha$ DRACONIS—53 OPHIUCHI AND STARS IN FIELD—M 53 COMÆ—THE LATE PREBENDARY WEBB—16 COMÆ—OPTICAL.

[24390.]—In mentioning the fact that in the immediate neighbourhood of the wide pair formed by 48 Cygni and P XX. 243, there are "two similar but smaller pairs," Prebendary Webb says: "The student will meet with many inexplicable arrangements of this character in crowded fields." In speaking of 16 Cygni, Mr. Webb makes no mention of the circumstance that there is a pair in the field which to a considerable extent illustrates the truth of the remark quoted. 16 Cygni is itself a beautiful object. I observed it for the first time on the 17th September last, with 45 in my 3¼in. (o.g. by Wray). Both stars were yellowish, but B was noticed to be dusky. A was found to be 0·2 mag. above B. The pair in field referred to above was observed, and noted in these words: "An exactly similar, but fainter, pair in field, *following*." On the 21st I saw 16 Cygni again, and confirmed these observations. On November 27th I made another observation. Both seemed pale gold, but B somewhat dusky in comparison with A. A was a little brighter than B. The pair in field was again observed, and the *f.* star was found to be the brighter. From "Celestial Objects" we find that the difference between the components of 16 Cygni was found by Struve to be 0·2 mag.; but that the difference between them, according to Smyth, is half a magnitude. A suspicion might therefore arise that one of the stars, probably the smaller, is variable; but from the observations given in "Celestial Objects" by Mr. Webb himself and by Mr. Franks, it is evident that the relative brightness of the components has been for a long time the same as it was found to be by Struve, and it will be noticed that the observations given above show that the difference between the stars last year was just the same as what Struve found. Perhaps Mr. Sadler will say whether or not *both* the magnitudes given by Smyth are taken from Piazzi, or whether the magnitude of B was estimated by Smyth himself.

*$\alpha^1$ and $\alpha^2$ Cancri.*—I think I can clear up Mr. Holmes's difficulty. The star called "α Cancri" in the appendix to "Celestial Objects" *is* $\alpha^2$; but Mr. Webb seems to have omitted the small "²." I presume the small "²" has been omitted because the star is simply called "α" in Proctor's "Atlas." $\alpha^1$ is commonly known as "60 Cancri," and is so marked in Proctor. 60 Cancri is β 212; and it is 275 in Mr. Gore's recently issued and most valuable "Catalogue of Suspected Variable Stars." There seems some reason for believing it variable; for while the *D.M.* mag. is 5·8, Webb and Birmingham both found it 8 mag. In 1877 and 1878 Mr. Gore found it equal to 45 Cancri (which was the same brightness as that which Sir Wm. Herschel had found it to have); but in 1883 he found it to be "two steps less than 45." The colour given by Birmingham was "pale orange red." I observed it twice within the last few months for colour; but although I did not estimate or record its mag., I may say safely, I think, that it was not fainter than 6 mag. On Jan. 11, I called it "light orange," and on February 9th "orange."

*α Draconis.*—Under this star, Mr. Gore, in his work referred to above, quotes this from Smyth: "I have had this in view many times, and always looking like a small third, though Baron de Zach but shortly before classed it 2·3." Could Mr. Gore or Mr. Sadler give me Smyth's authority for this statement, and any additional information concerning Baron de Zach's observation referred to? If de Zach was right, the star must have brightened very appreciably after the epoch of Pigott's observation.

In describing M. 53 Comæ, Prebendary Webb says, "Not very bright, $3\frac{7}{10}$in." I was much surprised in examining this object, for the first time, recently, to find that this description could not be considered applicable, but that the cluster was both bright and beautiful, even although the aperture (3¼in.) I employ is less than the aperture of Mr. Webb's telescope. My first observation of it was obtained on the 10th May. I used powers of 45 and 145. I entered, "Large and splendid; like a comet; and with blazing centre. It is difficult to understand how Mr. Webb could say, 'Not very bright $3\frac{7}{10}$in.' Brighter and larger than M 94, Can. Ven., with which it was compared. It forms an isosceles triangle with two small stars." Conditions on this occasion were not at all good. On the 14th it was "quite plain; bright," despite the fact that dawn was commencing, and the sky hazy. On the 17th I wrote, "Bright; though it did not seem quite so bright as before." The sky was beginning to brighten, and definition was poor.

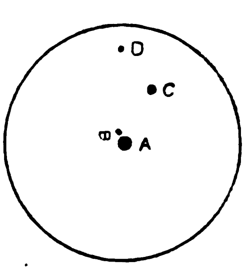
Since writing the preceding, I have learnt the heavy loss astronomy has sustained in the death of Prebendary Webb. I am sure all will heartily agree with what "F.R.A.S." says on p. 300. No one, probably, has done so much for amateur astronomers, even in England—where astronomical research has been so much and so successfully prosecuted by amateurs. He was, too, an astronomer in the truest sense of the word. Everything he wrote showed how unaffected was his pleasure in his favourite pursuit, and showed also how fully he realised the true nature and object of that pursuit. The most apparently trivial detail and circumstance has its beauty and its value for him; he rejects nothing as insignificant; yet he never subordinates the end, the attainment of a realisation of the constitution and mechanism of the universe, to the means, the registration and discussion of the detailed facts. I think that herein, and in the feeling of the vastness, the unity, the mystery, and the beauty of the heavens, which pervades his work, lay the secret of much of its influence. Of course, the detailed facts of the science, and its technicalities of detail and expression, are essential, are the indispensable material out of which it is to be built up; but they are not the science itself, and it was Mr. Webb's good fortune so clearly to recognise their true importance as to accord them their full value and their proper place, neither depreciated nor exaggerated, in the vast and matchless structure of the science.

On p. 280 of "Celestial Objects" it is said, concerning 12 Comæ, that it is "1½° *s.p.* 16, the 'lucida' of the constellation." Upon what authority does this statement that 16 Comæ is the "lucida" of Coma Berenices stand? For whether we include in the name "Coma Berenices," the whole constellation, or restrict it to the lovely asterism from which the group derives its name, 16 Comæ certainly cannot be called the "lucida" now. Argelander makes β Comæ mag. 4, and the brightest star in the constellation. Heis makes β and γ the brightest stars, making them equal, and the mag. 4 – 5. Argelander and Heis agree in their estimates of 16 Comæ, making it mag. 5. So far as the results of my own observations go, γ is the "lucida" of the group itself. On May 18, 1884, I made it, with opera-glass, 4·5, and called it, with 45 on 3¼in., "ruddy orange." The next evening I estimated it again, and made it 4·6. On June 18 I made the following sequence and estimates of colour. I used γ Comæ as the standard at 4·5. The mags. in the last two columns of the following table are Mr. Espin's, and are taken from the L. A. S. *Proceedings* II. page 65.

| Star. | Mag. | Colour. | Arg. | Heis. | Acti-nic. | Opera glass. |
|---|---|---|---|---|---|---|
| Comæ | | | | | | |
| 14 | 5–1 | Reddish cast | 5–4 | 5 | 5·05 | — |
| 16 | 4·9 | — | 5 | 5 | 4·95 | 4·90 |
| 13 | 5·1 | Yellowish | 5 | 5–6 | 5·00 | 5·30 |
| 12 | 5·0 | Pale yel. or pale orange | 5 | 5 | 5·00 | 4·90 |
| 17 | 4·9 | Yelsh. white | 5 | 5–6 | 4·80 | 4·80 |
| 21 | 5·2 | — | — | — | 5·20 | 5·50 |
| 18 | 5·5 | — | — | — | 5·52 | 5·60 |

The magnitudes of 21 and 18, according to Arg. and Heis, are not given in Bazley's "Stars in their Courses," from the table in which I have taken these comparative estimates. Just now I have not access to any other authority. If, therefore, 16 Comæ was ever the brightest member of this beautiful group, it must surely be variable, unless, indeed, γ Comæ has increased in brightness. γ is 15 Comæ, and is β 279. It is called by Schmidt "deep golden yellow." Its mag. in "D. M." is 4·7.

*53 Ophiuchi and Stars in Field.*—53 Ophiuchi is an exceedingly pretty object. There seems to be some difference about the colour of A. Smyth's colours are "greyish; pale blue"; but Webb adds —"Dawes, 6, light yellow, so Franks 1876." In a valuable letter in "Ours," for Nov. 18, 1881, entitled "Star Gazing," Messrs. Read and Sadler, say: "A, pale yellow; B, pale blue." They add: "According to Smyth there are two 8 mag. stars following, the south one of which seemed very much fainter than the other, which was almost equal to the *comes* to 53." They used a 6½in. Calver. In a letter in the succeeding number, Mr. A. Stanley Williams gives the colour as "pale yellow, bluish," in 1880, with 5¼in. Calver. I have obtained several observations of this star, which are given below. I suppose that Smyth's 8 mag. stars are the two stars lying *s.f.* in field, and marked C and D in the following diagram. It will be noticed that while my observations of the colour of A agree with the majority of those given above, I have always observed B to be either "lilac" or "purple."



| Date | A | B | Power |
|---|---|---|---|
| 1883, July 17 | Light Yellow | Lilac. Assuming A at 5·6 (Σ.'s mag.), estimated B at 7·4. | 145 |
| „ „ 27 | Light Yellow | Purple | 145 |
| „ Aug. 3 | Yellow | Purple 8·0 ± | 145 |
| 1884, Aug. 29 | Pale Yellow | Lilac | 45 |
| | Of the two stars *s.f.* the northern one is much the brighter. | | |
| „ Sept. 13 | The two stars *s f.* are certainly not *both* 8 mag. The N. one is distinctly brighter than the *comes* to 53, and the *south* one is distinctly fainter than the *comes*. | | 145 |
| „ Oct. 15 | Many stars in field. The two nearest *s f.* are very unequal in mag.—the N. one 7 mag., or so; the S. one, not more than 9. | | 45 |
| 1885, June 8 | C is certainly above the *comes* to 53, and D as certainly below it. There is at least 1½ mag. between C and D. | | 45 |
| „ „ 9 | Light yellow. | Lilac. | 145 |
| | Confirmed last night's observations of C and D. | | |

Perhaps Mr. Sadler, "F.R.A.S.," or some other astronomical correspondent, can give further information about these stars.

With reference to what Mr. Sadler says on p. 276, concerning the dividing by Dawes of η Coronæ with a 3⅜in. when the distance was only 0·88, I would like to ask if Dawe's formula was not intended to apply to *six-magnitude pairs*, and whether the circumstance that both the components of η Coronæ are brighter than the sixth magnitude may not have a bearing upon the matter? I would also like to ask whether the distance Mr. Sadler names (0·88″) is an actual measure, or was obtained by calculation—and if the latter, whether the theory of η Coronæ is so thoroughly understood that calculation based upon it may be relied upon implicitly?

Upon p. 277, "Beta" says, speaking of the telescope employed by "F.R.A.S.," "His o.g., however, is probably no larger than mine; for although I called my telescope a 4in. for brevity, it has a *clear aperture* of that diameter, and the o.g. must, therefore, be about 4⅛in." I would like to inquire concerning this remark, whether it is not founded on a misconception. Is it not the case that the "aperture" assigned to a telescope is almost invariably the "clear aperture"? I presume, for instance, that when "F.R.A.S." says that his telescope is "a 4⅛in. Dallmeyer," he means that its clear working aperture is 4⅛in., not that its total aperture is 4⅛in., and that, therefore, its clear aperture is something less. If this be so, "Beta's" criticism must be founded on a mistake.

Glasgow. **S. Maitland Baird Gemmill.**

## B. 607.

[24391.]—This red star, which is No. 683 of my catalogue of suspected variables, seems worthy of further attention. It was rated 5m. by Heis, and was measured 4·67 at Harvard (H P. 3935), but was estimated only 7·5 by Burton in 1876. A remark of Sir W. Herschel's in the *Philosophical Transactions* for 1873, evidently refers to this star. He says: "Near Lacerta's tail-end is a star of between the 4th and 5th magnitudes, not mentioned in Flamsteed's catalogue, though the 1st Lacertæ, not far from that place, is recorded. It is so easy to be seen with the naked eye, and in a spot where but few of that magnitude are near, that we can hardly account for its being omitted if it had been visible to Fl. Its colour is pale red." This remark of Herschel's seems strongly in favour of variability, as it shows that the star was probably faint at the date of Flamsteed's observations. The star is identical with 7765 B. A. C., and lies about 2° north of 1 Lacertæ. **J. E. Gore.**

Ballysodare, co. Sligo, June 20.

### THE CASSEGRAIN.

[24392.]—It seems fruitless to appeal to the mathematicians. Neither Mr. Wassell's letter nor my own has elicited the slightest response, or, I presume, the problem is too hard a one even for Cambridge wranglers.

I think Mr. Edmunds's letter comes very apropos, for, speaking of such mathematicians as I have met, I have found that, though familiar with all the intricacies of the higher branches of the subject, they seemed quite unable to apply their formulæ and deductions to any practical use.

Thus I do not doubt that amongst the readers of the "E. M." are many who have given much attention to optics as a theoretical subject, yet are quite unable to work out this question of the curves for a Cassegrain or a Gregorian. Even our talented correspondent "Orderic Vital," though thoroughly at home in every point of the theory of the achromatic object-glass, has shown himself unwilling to tackle that of the compound reflector. Dr. Royston Pigott, too, having made a beginning, seems to have broken down halfway. Will *no* one come to the rescue? **A. S. L.**

### HIGH-POWER OPERA AND FIELD-GLASSES (AND BINOCULAR TELESCOPES).

[24393.]—On return from a visit to Paris, I availed of the invitation contained in the trade advertisements inserted in the "E M 's" of 5th and 12th June, to compare the so-called English instruments—the result of 30 years' experience—with the new French-made high-power glasses.

I found an excellent, clear, large field glass, power 6, price, in aluminium, 11 guineas, which compares with the small field rather lighter French glass, power 7, price, in aluminium, £4 2s. I also found a very good smaller glass, power 5, price £5 in brass, which compares with the rather smaller French instrument, power 4, price £2 10s. in aluminium. There was, of course, nothing to approach the 10 power at any price.

I should warn your readers against the remarks of "Experience" (letter 24285, p. 279), and G. R. Baker (letter 24318, p. 302), in so far as they suggest that high power means necessarily loss of light, and that the binocular telescope may compete with the 10-power French Galilean glass.

I saw in Paris a beautiful specimen of the 15in. binocular telescope, power 22, price £12 in aluminium; but the French makers admitted that it was useless after dark. To make perfectly sure, however, three days ago I took to the Albert Hall a 10-power French glass and a new 14½in. binocular telescope which a friend had just purchased of the house now trading in the name of Ross for £18, in aluminium. At 5 p.m., by daylight, the 22-power telescope could not distinguish a person's features at the opposite end of the hall, for want of light. By night it could show nothing at all; whilst the 10-power showed everything perfectly by day and night equally well.

Excellent as the binocular telescopes now are, and delightful as they are for telescopic use in the open with plenty of light, they are not to be mentioned in the same day with the high-power Galilean glass for general use. The four-lens eyepiece is fatal to them on the ground of absorption of the light.

There appears to be some desire to attempt to persuade the public—as an apology for low powers—that (as G. R. Baker expresses it) "glasses are required primarily to give *extensive* views of landscapes or groups on a stage," forgetting that whilst there is no possible excuse for such a statement when it comes to be examined, there is, on the contrary, every reason why, with very rare exceptions, a magnifying glass should magnify as much as it can be made to do without losing light. When once the public learns that high powers can be had, the determination to possess them is universal. One of our readers wrote from San Francisco for them: he was in the trade, and understood it well. Another was a Royal Engineer in the Afghan Boundary Camp at Quetta, who wrote he would gladly sacrifice some field for more power, as they had no glass over four power in all the camp!

On inquiring how a glass might be forwarded to Quetta, I learnt that 16 glasses were going out that week, and that the benighted War Office authorities had ordered them of four-power only, again. The Paris maker told me last week that the Russians had taken all the high-power glasses he had offered them, including the ten-power models.

It still remains to arrange for the supply in London. Necessarily disgusted at the treatment which G. Dickson and others received (24284, page 279), I would gladly act on the Editor's very natural suggestion following that paragraph.

**Montmartre.**

### AUTOMATIC MUSICAL INSTRUMENTS.

[24394.]—Replying to the letter of Thomas Pugh (page 348), I should say his valour has outrun his discretion in attempting so large an instrument, more especially as he has constructed it on the principle of using the paper itself as the valve, which requires a much wider band than when the paper serves only as a stencil.

On the latter system the width of the perforations would not exceed ⅜in., and the spaces between might be the same, thus making the "gauge" ¾in. centre to centre of holes. Allowing for margins, this would bring the five octaves within a width of 23in. instead of 41in. as at present.

In order to get the levers this distance apart, it will be necessary to rearrange the windchest, and put the lower reeds alternately in two rows, so as to get the channels and pallets of sufficient width; the higher notes can be got into the ¾in. space. Mr. G. Fryer has again and again promised, and equally often broken his promise, to send a sketch of the mechanism of the "Organette," which I think is somewhat simpler than that of the "Organina" described by myself; but either of them would serve as a model for Mr. Pugh to work from in altering his instrument to the stencil-plate principle.

Mr. Wenham's tune-bands are only 9in. wide; but all such instruments as the "Pianista" are very complex and delicate, and require greater accuracy of workmanship than such as the "Organette" or "Organina." If, however, Mr. Pugh likes to try his hand at one, there is a drawing of it in one of the "E. M.'s" of a year or two back.

The "Cabinetto," notwithstanding its high price, only contains, I think, 16 or 17 reeds, and an imperfect scale to which all the tunes have to be adapted.

Mr. Pugh's roll of 600ft. rather takes one's breath away. Has he estimated the labour of punching the holes, and the length of time it will take to "grind" such a length through the instrument? **A. S. L.**

### NITROBENZOLE FOR ENTOMOLOGISTS.

[24395.]—Most insect collectors have some pet poison wherewith to shorten the lives of those insects which, like the Lepidoptera, are given to knocking off their delicate scales if allowed to live.

Prussic acid, or to speak more exactly, potassium cyanide, under a stratum of plaster of Paris is very efficacious and cleanly, and in careful hands is all that can be desired; still, the cyanide is a fearful poison, and young people (and many of our insect collectors are very young people) are apt to be careless.

I have found that a plug of plaster of Paris at the bottom of the "killing bottle," if saturated with nitrobenzole, is quite as efficacious as when prepared with potassium cyanide, while the nitrobenzole is not a dangerous poison.

**S. Bottone.**

### THE CALORIE OR FRENCH THERMAL UNIT.

[24396.]—"Tubal Kain" (letter 24191) was certainly moved by a good intention when he wrote his lines on this subject, but although there is truth in them—to use his own expressions—"unless corrected, they will lead to serious errors." True, what he calls the *British* thermal unit, which ought to be called German, as Fahrenheit was a German, is one pound of water elevated in temperature 1° Fahr. True, also, the Centigrade thermal unit, which might be called Swedish, as Celsius, its creator, was a Swede—not a Frenchman—is one kilogramme of water elevated in temperature 1° Centigrade. True, again, that the division in 100 parts of the temperature, from melting ice to boiling water, represents 180° Fahr. Thus far, "Tubal Kain" is right; but he is wrong when he says that the degree Centigrade equals 1·80° Fahr. He certainly forgets that the two thermometers have not the same starting point. The zero Centigrade is at 32° Fahr. How, then, will he calculate the temperature in Centigrade degrees of, say, 16° Fahr., with the proportions of 1·80? Boiling point being 212° Fahr. is 100° Centigrade; 212, divided by 1·80, will give 117·7 instead of 100. 64° Fahr. = 17·7 Centigrade. If you multiply 17.7 by 1·80, you will find only 32·4. Blood-heat is 37° Centigrade, which × 1·80 = 66·60, instead of 99 Fahr. Text-books give several means of converting these degrees into one another.

**Ch. Rabache.**

### GLASS DISCS FOR SPECULA.

[24397.]—Mr. Wigmore, of Melbourne, appears to have overlooked the fact that I gave in these columns, a few volumes back, two or three addresses where the above might be obtained. I am quite sure he might safely intrust his order and cash to Messrs. Chance, of Birmingham. They supply properly annealed discs at a somewhat lower price than the Northern Plate Glass Company, of Newcastle-on-Tyne; but the cheapest source of any I know was a Mr. Scott, of Sunderland, a contributor to this paper. Unfortunately he has lately died, and I do not know whether they can now be obtained. These were cast with a concave curve, not perfectly regular, but it would save some labour in the rough grinding.

Messrs. Chance could supply you with an 18in. disc, 2½in. thick, cost £5 to £6; a 12in. disc, 2in. thick, would cost about 25s.; and a 9in. disc, 1½in. thick, about 10s. A 2½in. cube of glass (ordinary cast plate or crown quality) weighs 1lb. 7oz.; and from this you can easily calculate the weight of any size disc if you know the thickness. With a view to render you the most material assistance, I have written to Messrs. Chance, giving your name, address, and requirements, and asking them to write to you direct.

If I can obtain any further information, in a week or two I will write again to the "E.M.; but if you are desirous of losing no time, you might quite safely, I am sure, send Messrs. Chance a P.O O. for 30s. or £2, with the order for a 12in., and asking them to pay freight and insurance at their discretion, and send you the balance by letter. Let me advise not less than 2in. in thickness, and 2¼in. or 2½in. would be better. I am sure that we, on this side, will be glad to hear from you again.

Ramsgate. **J. C. L.**

### A NEW TELESCOPE FOR GREENWICH OBSERVATORY.

[24398.]—With reference to the letter of Mr. W. S. Franks, p. 347, and the remarks of "F. R. A. S." on p. 346, I presume those gentlemen are by this time aware that it has been decided to make a 28in. equatoreal for Greenwich, in accordance with the suggestions of the Astronomer Royal, which I append as taken from his report:—"The aperture of our largest refractor (12¾in.) is too small to allow of our observing successfully with the spectroscope any but the brightest stars, and though the Lassell reflector is somewhat more powerful, its mounting and clock-work are not adapted to carry a heavy spectroscope with the necessary steadiness and accuracy of motion. The firmness of the mounting of the South-east equatoreal and the perfection of its clock-work would make it peculiarly suitable for this class of work if it carried a much larger object-glass. After careful consideration of the conditions, I have satisfied myself that an object-glass of 28in. aperture and of 28ft. focal length could be mounted on the South-east equatoreal, in place of the present object-glass of less than half that aperture; and I have ascertained that Mr. Grubb would be prepared to undertake the construction of such an object-glass with a tube suited to the special requirements of the case, so that the telescope would be equally available for eye-observation or for use with the spectroscope. With Mr. Grubb's assistance, I have prepared a model showing how this may be arranged. While a large refractor is required specially for spectroscopic observations, it seems desirable also on other grounds that this Observatory should possess an equatorially mounted telescope comparable with those of other first-class observatories, so that we may no longer be prevented by deficient optical means from obtaining complete series of observations of comets and faint satellites."

I understand that it has been decided to carry out the suggestions above named, and that Mr. Grubb will at once set about the work. **S. B.**

### SAVAGES, WILD GRAIN, &c.

[24399.]—Having had exceptionally good opportunities of learning something about these degraded remnants—as some call them—I cannot help advising all who really desire to learn something about the past to study carefully E. B. Tylor's "Anthropology." It is wonderfully reliable on all matters hereto relating.

I have been now over 20 years alongside the Nogas, Singphus, Miris, Mishmis, Abors, Akas, and the first-class savage tribes that surround Asam, and among whom there are neither *coins, architecture*, nor *literary remains*, the usual sources of history; nevertheless, there are many clear proofs that the history of these races must extend back for an immense period, and that they have always been savages.

They are the remains of the races that once covered the *whole of India* ere the Aryan invasion, somewhere about 3,000 B C., drove them right and left to the hills, and amalgamated with some to form the Sudra out-caste staple of the people. The names given by these "Pre-Aryans" to the rivers are thick all over the maps, and customs that show a common origin, in the far past, are seen among races whose languages are now quite differentiated, except in numerals and such, which seldom change.

One singular custom common to all these Hill races, illustrates the original sexual liberty that existed ere marriage by capture gave a man right of private property in a woman.

The boys and big lads and single men have to sleep in large houses away from their parents, and also the girls in other houses, and I may say that *morality begins with marriage*. They see no harm in it, and when married are far more faithful than so-called "civilised nations."

I have got the history in outline of one group of tribes back to about the year A.D. 1400. The languages of all are monosyllabic and limited; we know as little about *them* as they know about us; they read nature like a book, where *we* are blind, and fatten where we should starve. Comparative philology and anthropology will eventually show who they are, and where from. They seem a mixture of the yellow Chinese, on one hand, and the Dyak (Malayan) on the other; developed slowly all over Southern Asia.

The vast amount of valuable information that lies buried here as to the past, people have no *conception* of, nor have anthropologists even, and few men here bother their heads about it.

As to wild grain, and its survival in a state of nature, we have here some five or six allies of rice alone, as common grasses. Surely those who consider the grains, vegetables, and animals we now use as specially created for us, forget that hundreds that are now useless may yet be indispensable. All nature is before us, if we only knew how to use it—animals, vegetables, and minerals.

The day may not be far distant when posterity will pity our practice of getting food from the present *natural* sources: it may be made synthetically. As it is, our loaves do not grow on trees, nor is sugar found like sand; compared to savages, our food is already highly artificial, and proof of *progress*.

**S. E. Peal.**

## TEST FOR PLATINUM.

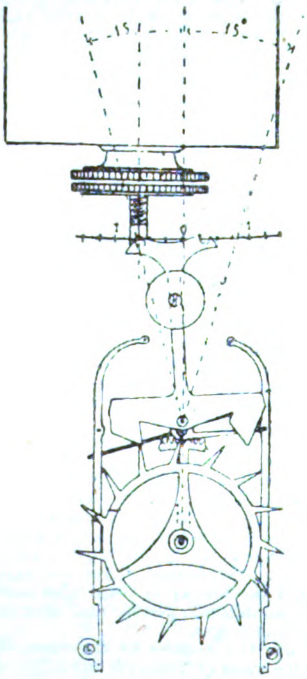
[24400.]—While analysing a mixture of salts a few days ago, I came across a very delicate test for platinum, which may be of interest to your readers. If to a very dilute solution of platinic chloride, a little potassium iodide solution is added, a rose-red colour is observed, which deepens in shade on standing. In stronger solutions the KI gives a deep red, almost black colour. If hydric sulphide be now added, the red is bleached, turned brown, or changed into a brown precipitate, according to the strength of the solution.

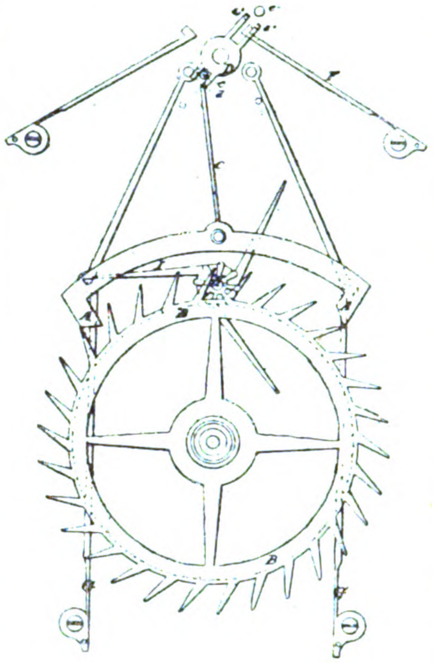
The red colour appears to be due to the formation of potassium iodo-platinate.

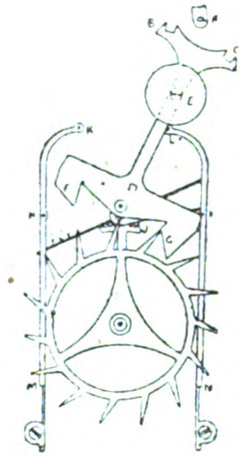
**C. Dampier Whetham.**

## HART'S PENDULUM ESCAPEMENT.

[24401.]—What does Mr. Hart, whose escapement you illustrate on p. 320, No. 1055, claim as the distinguishing novelty of his invention? As far as giving impulse at the bottom of the pendulum goes, Breguet did this in 1796 or 1798 (see *La Revue Chronometrique*, Vol. VI. p. 92, or the *Horological Journal*, Vol. XX. p. 4). And there are many other arrangements for giving effect to the same idea. As regards using a lever escapement for maintaining the vibrations, I have shown that method in conjunction with a remontoir (Fig. 11, *e* is the pin on pendulum rod), in my specification 191, A.D. 1877, of which I inclose a copy. I also send another arrangement of the same invention, which I designed some years ago. The nine figures trace the escapement through a whole vibration of the pendulum and back; but perhaps 1 and 5 will be sufficient to show the idea.







A is a pin in the bottom of the pendulum rod. There are dangers and difficulties attending this method of giving impulse to a pendulum.

84, Strand, June 17. **H. M. Frodsham.**

## CRANK AXLES.

[24402.]—I see (p. 345) that the Leicester railway servants are still for *iron* axles. The resolution of a meeting of drivers and servants is one that must be important, as they are the men who know the working part.

Messrs. Linney and Lawson's way of making cranks with all the fibres in the proper direction seems very good indeed. Might I ask them if they find trouble in making sound welds?

Perhaps Mr. Casebourne (p. 349) would give some more figures from his diary to show if the fractures were in the inside or the outside webs? Is it found that the axles last longer with two or four bearings? How many square inches of section are there in a web, and in a crank-pin? And if the strength is, say, 27 tons per inch, what ought the total breaking strain to be? Do your readers think the size of piston, stroke, and diameter of wheels has very much to do with the matter? Also, with regard to keys, do keys outside give any assistance to the crank and other axles? These are some of the matters that suggest themselves to an

**Engine-Driver.**

[24403.]—In reply to "Original Lockstitch," in your impression of the 5th inst. (let. 24321), I would remark that he seems to be surprised at the statement made by a correspondent that "Crank axles mostly break across the webs"; but I contend that statistics fully bear out the truth of this statement. Then, with regard to the question of twisting the iron, in order to bring the throws at right angles, I may say that at all the several railway companies' works in the district I belong to, crank axles are made in that manner, and I do not know the railway company who dispense with twisting, although I have worked at the forge for the last 26 years.

I am much surprised at his statement that "In a properly-made crank there is no grain." Now, I argue that the process of welding-up and drawing-out the iron naturally brings the fibre to run in the direction of the length of the axle, and when the throw is cut out the metal is cut against the grain, and the fibre of the iron forming the webs runs crosswise, hence their frequent breakages.

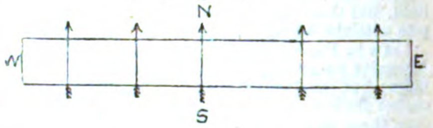
In the method of forging, illustrated in your last issue, the faults (in ordinary crank axles) caused by the direction of the fibre, and of being twisted, would appear to be overcome, if we may believe the patentees; but this remains to be practically tested. Perhaps other practical men would give their opinions upon this matter. **Wilfred.**

[24404.]—I have read with much interest the letters that have been written on this subject, and have been expecting every week to find some mention of "Saxby's method of testing for flaws in iron and steel." I would have sent this description before, but thought it might be "ancient history" to many. I do not know if this is the test referred to by "Iron Crank"; but anyhow I think it should not be overlooked. The following is extracted from Pepper's "Cyclopædic Science":—

"It is well known to engineers that it is a most difficult and often impossible thing to find out the existence of a false weld in a forging, or of a blow-hole or honeycomb in an iron or steel casting. Everyone knows that a simple method by which internal flaws and solutions of continuity in constructive details could be easily detected would be of enormous value to the world. Such a method has undoubtedly been discovered by Mr. S. M. Saxby, R.N., who has very judiciously been allowed by the Admiralty, during the course of this year, to experiment with it in the royal dockyards.

"It has been known for nearly a century and a half that when a bar or any mass of soft iron is placed in the position of the dipping needle, it is at once sensibly magnetic, the lower extremity being a north pole in our latitudes, and the upper extremity a south pole. The same action, only weakened, takes place in a bar hanging in a vertical or any other position; only the effect is weaker the more the position of the longitudinal axis of, for instance, a long bar departs from that of the magnetic dipping needle.

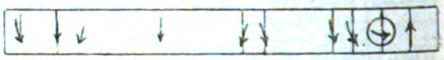
FIG 1



"When, therefore, as in Fig. 1, a small compass needle is slowly passed in front of a bar of very good iron, placed in an east and west direction, the needle will not be disturbed from its proper direction, which is of course at right angles to this, or north and south.

"All this refers to regularly homogeneous bars of best quality—to bars without any mechanical solutions of continuity. With internal flaws, or interruptions of continuity, the bar is no longer regularly magnetic. It has long been known that a good compass needle, or a good permanent magnet, must be homogeneous and without flaws, in order to take and retain its maximum amount of magnetism. In a word, *any mechanical solution of continuity is accompanied with a polar solution of continuity*, and the given bar or mass with flaws, whether permanently magnetised or temporarily so by the inductive action of the earth, is no longer one regular magnet, but several different magnets, with the different magnetisms separated from each other. The delicately-poised magnet of a compass can thus be made to tell the presence of such solutions of continuity.

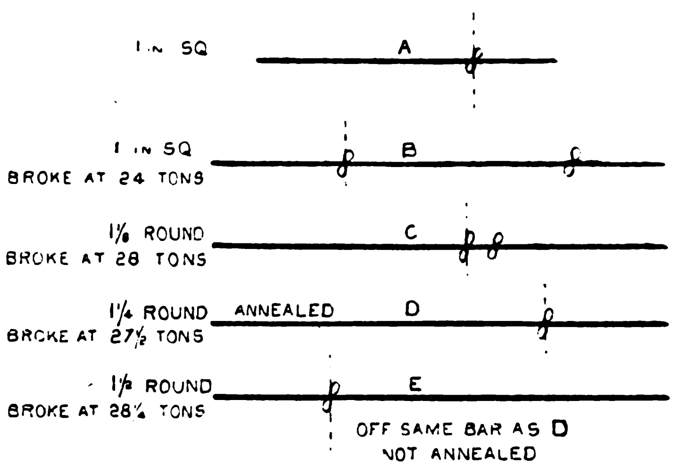
FIG 2



⅝ ROUND 12" LONG

"Fig. 2 shows the actual results of the test with a ⅝in. bar 12in. long, and will illustrate the manner in which the compass magnet is affected by the pre-

FIG 3



sence of cracks, of solutions of continuity, in the bar, which is supposed to be lying in the equatorial magnetic plane, or east and west.

"Among the experiments which took place in the dockyards of Sheerness and Chatham were the following trials, conducted in the presence of the master smiths, the foremen of the testing houses, and several of the chief engineers of the Royal Navy.

"Mr. Saxby, for instance, was requested to find out the weakest spots in a number of bars, and to tie a string, or make a chalk mark, on each spot. Immediately afterwards all these bars were put into the testing machine and broken. Their history is given in Fig. 3. A scroll is placed where the weakest spot was found out by the needle. The vertical lines indicate the spots where the several bars broke.

"The smiths of the dockyards seem to have properly tested Mr. Saxby's powers in almost every possible way, and most ingenious devices were sometimes resorted to for the purpose. For example: In the centre of a bar of 1in. square forged iron was welded a piece of unmagnetised steel, about 5in. long. The needle detected a fault at about the centre of the piece of steel.

"Now, Mr. Saxby's method can detect the presence, and negatively, of course, the absence, of small or large solutions of continuity.

"It can detect false welds, smaller flaws caused by bad workmanship or wear, and, we believe, what is commonly termed 'crystallisation,' which will, probably, at once be generally acknowledged to consist in a disruption or parting of the facets of the amorphously arranged crystals of which iron is built up."

Such is "Saxby's test," as reported by Mr. Paget, C.E. As the space I have already occupied is so much, I will not offer any remarks of my own on the subject just now; but leave experts to say whether or not it can be applied to testiing railway crank axles. I believe it can.

**W. Rowland Hart.**

## SCREW THREADS.

[24405.]—The accompanying tracing is from a block of wood in which I have made seven cuts, all with the same cutter, but applied to the work in different ways. No. 1, 2, and 3 are horizontal cuts taken on the level or line of centres, No. 2 being an exact reproduction or counterpart of the cutter, which was itself placed in the axial plane of the work with its spindle vertical. In No. 1 the cutter spindle was inclined 10deg., and in No. 3 5deg. to the vertical. The other four cuts are all screws of 8in. rise in one turn.

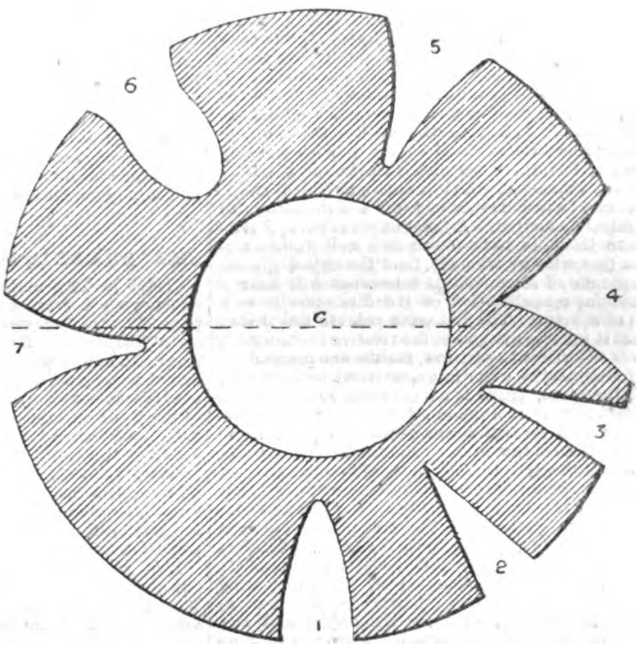
In No. 4 the cutter spindle is inclined 54° 46′, that being the angle of rise of the bottom of the thread, which is 5·65in. diameter, with a rise, as before stated, of 8in. per turn. In this case it will be observed that the acute angle of the tool leaves a sharply defined bottom to the groove, and that all the distortion occurs towards the top.

In No. 5 the spindle is inclined 45°, the mean diameter of the screw being 2·55in. with a circumference of 8in., and rise as before of 8in. Here the distortion is divided between the top and the bottom of the groove.

In No. 6 the inclination of the spindle is reduced to 37° 42′, that being the angle for a circumference of 10·35in. with rise as before of 8in. Here the great distortion occurs at the bottom of the groove.

No. 7 is a repetition of No. 5, as to angle of inclination of spindle; but with the plane of the cutter lowered so as to pass ⅛in. below the line or level of centres, which is indicated by the broken line L C. As the figure is a tracing from the flat end of the cylinder out of which the grooves are cut, Nos. 1, 2, and 3 alone show actual cross-sections of the respective grooves. The remaining four show greater widths with the same depth, as real cross-sections would do. I may remind the readers hereof that a real cross-section of such grooves is as impossible to represent in a drawing as it is to cover a globe with flat paper. I have been unable to send the specimen screw that I promised to the Editor's office, so I forward instead this tracing of another which will probably answer the purpose even better.

**J. K. P.**



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[24406.]—I resuscitate my pen without much pleasure as regards the above subject, as it is once more its purpose to point out Dr. Edmunds's departures.

If Dr. E. would reflect upon or look up the history of deduction in Mechanics, he would be more chary of geometrical deduction even in statical questions. (24358), page 327, "The normal section is, as I have already shown, always a screw surface and never a plane. The base of the normal section is also always a screw line, and never an ellipse."

This is geometry pure and simple, and such normal section to a "bundle of spiral lines" has no theoretical or other use in any screw calculations.

Mechanical forces resolve themselves into straight lines, and with these straight lines and their vertical planes or "normal sections" have we alone to deal. The normal cross section of a screw thread for mechanical purposes is always cut by a plane and has always an elliptic base, and is never a screw-surface nor has ever a screw-line base.

The use of any normal section for calculation is remote. The "normal section" that assists a leading screw to resist torsion is the axial section, that being the one "normal" to the transverse stress from gear.

The value of its resistance is its area at one-third its height from base. A pure spiral, say of equilateral triangular section, would resist tension, compression, and shear in a plane normal or vertical to the tangent at about one-third the height from the base; for torsion, a tangent at about one half its height.

The only section needing regard in ordinary screws is the attachment surface to the shank; the stress on this section is on lines vertical to the tangent that bisects the vertical surface of the thread: only approximations can be got, but in fine-threaded screws the stress and breaking is practically simply longitudinal.

In an ideal screw and nut, the shear will take place on the attachment surface to the screw shank, the weakest place. That surface is about 6⅛ times the thread's height less in width than that of the nut, and at any point between the two attachment surfaces, both threads would have to be sheared, and they have a greater area than the shank surface.

**Vulcan.**

## LOOPED FIGURES BY GEARING.

[24407.]—I cannot but be pleased at the satisfactory results of "F. A. M.'s" experiments, and I think few will deny the beauty and symmetry of the designs transmitted to the English Mechanic. Very little credit is, however, due to me, as I did not myself invent this method of executing such work. All who were subscribers to the English Mechanic at the time will remember that I merely advocated the system originated by the late Mr. Gilray, whose lathe I described and illustrated; stating at the time, however, that in construction it was clumsy and ill made, owing chiefly to the fact that Mr. Gilray was not a very skilful mechanic, although a man of unusual ingenuity. I need not state that I was "written down," and the whole thing ignored or abused. "F. A. M.," however, took the matter into his hands, and has proved that I was perfectly correct in my estimation of this mode of originating looped and rose-engine patterns. The system is perfectly sound, and all that is needed to carry it out is accurate fitting of the apparatus, which Gilray was not capable of. It does away with the necessity of costly chucks, and the variety of figures obtainable is simply endless.

**O. J. L.**

## WHAT IS CREATION?

[24408.]—In letter (24365, p. 345), "F.R.A.S." propounds the above question, and asks me further "whether an Albino, born of normally constituted parents, is 'created,' and whether the same may be predicated of the descendants of salt-water mollusca, when their habitat becomes merely brackish, or vice versâ?"

I had thought that I had made my contention sufficiently clear in previous letters; but I will now try to make it more explicit!

In letter (24256, p. 257), I defined "creation" as the coming into existence of qualities, either physical or mental, which previously did not exist.

Does "F. R. A. S." take exception to this definition, or has he simply overlooked it?

Now, Darwin asserts that natural selection is daily and hourly at work, scanning animated or organic nature, to see where it can step in, rejecting some forms, selecting others! At the same time, he assures us that, unless new forms, which natural selection cannot account for, do appear, natural selection must remain inoperative.

It takes advantage of new and previously non-existent forms, only when they do appear; but it does not explain their appearance.

I hold that the appearance of such new and previously non-existent forms is due to "creation," which, necessarily, is at work as long as we have evidence of it, and I ask "F. R. A. S.," as I have asked evolutionists generally, how otherwise can the abrupt appearance of some new variety be explained?

I do not doubt that many qualities, physical as well as mental, morphological as well as physiological, may remain, through very many generations, latent and unexhibited; and that with a change of environment, these may appear to a greater or less degree, assisted sometimes by creation, in introducing a really new variety; but, in so far as the altered species is not absolutely non-pre-existent, it is attributable to heredity by reversion.

Albinos, and brackish-water varieties of mollusca descended from definite marine species, may be so explained.

In a recent letter, which the Editor had no room for, I illustrated the position by comparing natural selection to a steam-engine, the boiler of which was creation, without which it could not work; and tentatively, to elicit a definition of "evolution," I asked—"Is evolution a steam-engine which works without steam?" **H. B. F.**

## 100 TO THE INCH OF APERTURE.

[24409.]—It is surprising how tenaciously people will cling to a mere supposition if it is only bolstered up by the name of science. No doubt working hypotheses are useful—nay, almost indispensable—in grouping together isolated facts in the endeavour to formulate a coherent and intelligible whole which shall satisfy all the known phenomena. And, more than this, a sound theory ought to be able to indicate the regions where new facts are likely to be discovered. Used in this legitimate manner, there can be no possible objection to such working theories; but there are also theories of a totally different character, which do not explain a single fact, and which rest solely on a substratum of empirical deduction. A fair sample of such, I venture to think, is to be found in a well-known formula (invented by whom?) that the object-glasses or specula of astronomical telescopes will bear a maximum magnification of 100 diameters to each inch of aperture. The first weak point in this theory is that it ignores altogether the relative illuminating power of different apertures, for the one proceeds in arithmetical, the other in geometrical, progression, and, therefore, there is no constant ratio between the two factors. Suppose, for the sake of argument, that a 4in. will bear a power of 400 diameters under the most favourable conditions. Then a 2in. with half the power (200) has only one quarter of the light, and an 8in. with double power (800), has four times the light relatively. For the best conditions of vision there must be some balance between the two factors of illumination and amplification. Sir W. Herschel said, "Objects are viewed in their greatest perfection when, in penetrating space, the magnifying power is so low as only to be sufficient to show the object well, and when, in magnifying objects by way of examining them minutely, the space-penetrating, or illuminating power is no higher than what will suffice for the purpose, for in the use of either power the injudicious overcharge of the other will prove hurtful to perfect vision." ("Phil. Trans." Vol. XC. p. 81.)

It is well known that very small telescopes, say, of 2in. aperture and under, will not bear a power of 100 to the inch under any circumstances whatever; theoretically they should do, but practically they break down from want of light. On the other hand, some larger glasses will bear more than 100 to the inch. On several peculiarly favourable occasions I have used a power of about 700 diameters on a 5in. aperture without definition breaking down; but this limit has never been exceeded with the 11¼in., although the latter instrument is infinitely superior in penetrating and defining power.

According to the "Mensuræ Micrometricæ" the highest power employed by Struve in his great work appears to be about 800. Nor do I believe that on very large apertures much higher powers can be used to any advantage, the real limit to magnifying being, as most practical observers are painfully aware, the atmosphere. Local conditions do, undoubtedly, somewhat affect the ultimate result; but, go where we may, we cannot escape the disturbing effects of that great aërial sea through which we must necessarily view all celestial objects. Even the Italian and American skies, though eminently translucent, are not, so far as I can learn, much superior to our own in point of steadiness. Yet again, more can be seen with a low power on a large aperture than with a higher one on a smaller glass. Browning says, in his "Plea for Reflectors" (p. 34), that "when working with an 8½in. mirror, I generally used a power of 210; while latterly, using a 12¼ mirror of equally fine figure, I have nearly always had to observe with a power of 146. Yet with this I see much more than with the 8½, and power 210." Large apertures are certainly more sensitive to atmospheric disturbances; but a reducing stop can easily be applied when necessary, and the telescope will even then be more effective than a smaller instrument of the equivalent full aperture. But the value of large instruments does not depend upon any enormous magnification according to their inches of aperture. For instance, does any sane person believe that a power of 2,600 could be effectively used on the 26in. telescope at Washington? The experience of those astronomers who are in the habit of using great apertures would be, if published, an instructive commentary on the fallacy of the 100-to-the-inch hypothesis. Let it be distinctly understood, however, that I intend no disparagement of large apertures generally. On the contrary, I recognise fully their value and superiority for such objects as are beyond the reach of a moderate instrument. All I wish to point out is, that mere magnifying is a purely secondary question when compared with the increased penetrating and defining qualities possessed by a large aperture. Of course, it is the atmosphere which really is to blame for these discrepancies; but the atmosphere we have with us always, and any respectably consistent theory that deals with magnifying it (to an equal extent with a celestial object) ought surely to take cognisance of it as a modifying factor in the final result. Whether the lunar surface might afford such conditions as would irrefragably demonstrate the truth of this grand modern theory of magnification, I am not prepared to say; nor would I care to undertake a personal investigation, even with the assistance of the famous Jules Verne! All I can say is that my own limited experience on this planet leads me to think that the theory of 100 to the inch (except within exceedingly narrow bounds) is scarcely deserving of more respect than another well-known and much-abused formula which, from the log. of the aperture of any given telescope, deduces the minimum star magitude, to two places of decimals, that any given observer shall see with it?

**W. S. Franks.**

## THE BREAKING OF CRANK AXLES.

[24410.]—The method of testing iron bars to which your correspondent "Iron Crank" refers, page 349, was discovered by Mr. S. M. Saxby about eight years ago. He found that when a small magnetic needle was passed slowly in front of a bar of homogeneous iron placed east and west, the needle was not disturbed; but if the iron were not uniform, or contained flaws, its effect on the magnetic needle varied, and the deflection indicated a defect in the iron. Mr. Saxby was thus able to indicate the weak points in a number of bars, and when broken the defects were found to exist. I saw some experiments, and in every instance the needle indicated a flaw; but I am not aware that the plan was tried for the detection of flaws in axles.

Last week I gave the mileage of some crank axles which had broken upon the Midland Railway. The following list shows the highest mileage attained by steel crank axles made by Vickers and Co.:—

| Name or No. of Engine. | Railway Co. | Mileage. |
|---|---|---|
| "Munster" | G. N. of Ireland | 547,965 |
| 17 | South Eastern | 521,246 |
| 251 | L. C. and D. | 479,515 |
| 1,003 | G. S. and W. Ireland | 477,388 |
| 36 | Glasgow and S. W. | 420,517 |
| 152 | M. S. and L. | 415,097 |
| — | North London | 412,536 |
| Old 10. R. 2 | Maryport and Carlisle | 396,753 |
| 204 | L. B. and S. C. | 391,115 |
| 5 | Great Eastern | 376,186 |
| 7 | Waterford and L. | 360,959 |
| 23 | Belfast and N. C. | 348,213 |
| 266 | Midland | 326,102 |
| 14 | G. N. of Ireland | 319,115 |
| 55 | Taff Vale* | 252,938 |

* With the exception of the Taff Vale axle, all the others were at work when the details were compiled.

The above figures are very useful, showing what steel axles can do; but at present there is no similar comparative table giving the performance of iron axles.

Through the courtesy of several companies, I have lately been supplied with a very considerable amount of information which, now tabulated, adds to the data upon this important subject. So far as these inquiries have at present extended, they appear to point to a conclusion that if a "steel" crank axle is destined to break, the failure takes place at an early period in its life, and that if it exist for 150,000 or 200,000 miles there is a great probability that it may run a very great distance. It will be understood that I do not mention this in a spirit of assertiveness, but simply place the suggestion before your readers in order that the circumstance may be considered and further investigated by them. If the conclusion proves to be founded on sound data it will be important, as in such case we shall practically have to wait until some of the cranks which have run an unusual mileage ultimately break, which may be a matter of several years.

The question of crank-axles breaking has sometimes been considered as one of mere "strength," and as steel is stronger than iron, it has been assumed (by "Beginner," p. 284, for instance) that steel must be the best for axles. Now, I contend that very many other matters have to be considered besides tensile strength. An axle may be too stiff and too strong, and this great strength amounting to rigidity, is the principal cause of its own weakness. Extra strain and shock are thrown upon it by its extra strength, and as it will not give way in the least to circumstances, it is absolutely obliged to break. It, therefore, follows that an axle must be strong, but at the same time contain a certain amount of elasticity, and it is not so much a question of simply strength and brute force as of capability to resist strains.

The Board of Trade returns show that during the past four and a quarter years the average mileage of iron axles has been greater than of steel; but, on the other hand, the steel axles had fewer failures. This fact requires attention to be directed to the total axles of each material in use. From a list before me I find that on the 31st December, 1883, there were—

| | |
|---|---|
| Iron crank axles | 6,988 |
| Steel crank axles | 5,955 |
| Straight driving axles | 1,905 |
| Total | 14,848 |

Therefore, when considering the average mileage of iron and steel cranks, it must be always remembered that there are over one thousand more of the former than of the latter in use. I do not advocate any one material or system; but, on the contrary, my object is to fully and impartially investigate this important matter with a view to draw out practical data and conclusions upon a subject that all must admit is not so well understood as it should be.

**Clement E. Stretton, C.E.**

Leicester, June 20th.

## UNITED ASBESTOS CO.'S EXHIBIT AT THE INTERNATIONAL INVENTIONS EXHIBITION.

[24411.]—My attention has just been drawn to the remarks in your issue of 12th inst. *re* this company's exhibit in West Gallery. [See p. 315.]

You state that our machine, albeit ingenious, might have been omitted with advantage, especially as it is shown at several stands—at Treloar and Son's, for instance.

You do not state for what reason you would admit the others and omit ours, and to me it seems that if this rule had been applied to all classes of exhibits, a very small space would have sufficed for this year's exhibition, and we should not have the large numbers of engines, looms, pianofortes, &c., all of which have a much greater resemblance to each other than has our machine to the one cited by your reporter.

If he will, however, take the trouble to examine our machine a little more closely, he will find a considerable difference between the two machines.

Possibly their greatest resemblance is in the noise they make; but in this they are not singular.

Those who are practically acquainted with the history of the asbestos trade, and who have not been dependent on a manufacturer's catalogue for their knowledge of it, will be able to form an opinion of the value of your *résumé*.

Harefield Mills, June 20th. **James Boyd.**

## GAS ENGINES.

[24412.]—"J. K. P." certainly deserves the cordial thanks of the readers of this journal for his valuable letter on page 348. He would certainly greatly oblige me if he would send for publication a sketch of this little motor. Or if that would be encroaching on his kindness, would he communicate with me through the address column? By either of the above he would greatly oblige.

**Invicta.**

## COMPARISONS OF TIDES MADE AT LIVERPOOL AND FLEETWOOD, IN MAY, 1885.

[24413.]—The accompanying comparisons have been made as usual, by collating the observations made at George's Pier, Liverpool, with those at Fleetwood, so as to insure accuracy. It will be seen that the barometric conditions have been not unsteady, and the accordance, therefore, has been sufficiently precise. The Meteorological Office reports that from the 3rd of May to the 9th of May

COMPARISON OF TIDES FOR MAY, 1885, AT LIVERPOOL AND FLEETWOOD.

| Date. | Calculation. | | Observation. | | Error. | Barometer | Wind. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | ft. | in. | ft. | in. | | | | |
| May 1 | 26 | 10 | 26 | 10 | 0 | 29·7 | W. and N.W. | Light. |
| | 26 | 3 | 26 | 4 | + 1 | 29·6 | Calm. | — |
| 2 | 26 | 4 | 26 | 5 | + 1 | 29·5 | S.W. | Slight. |
| | 25 | 4 | 25 | 6 | + 2 | 29·5 | S.W. | ,, |
| 3 | 25 | 2 | 25 | 5 | + 3 | 29·6 | N.E. | Slight. |
| | 23 | 10 | 24 | 3 | + 5 | 29·6 | N.E. | ,, |
| 4 | 24 | 0 | 24 | 2 | + 2 | 29·6 | N.E. | Fresh. |
| | 22 | 8 | 23 | 0 | + 4 | 29·5 | N.E. | ,, |
| 5 | 23 | 0 | 23 | 1 | + 1 | 29·5 | N.E. | Slight. |
| | 21 | 8 | 22 | 0 | + 4 | 29·4 | Calm. | Bar. falling. |
| 6 | 21 | 11 | 22 | 1 | + 2 | 29·4 | N.N.E. | Slight. |
| | 20 | 5 | 20 | 10 | + 5 | 29·5 | N.W. | Fresh; low bar. |
| 7 | 20 | 10 | 21 | 5 | + 7 | 29·5 | N.W. | Fresh to strong. |
| | 19 | 7 | 20 | 1 | + 6 | 29·6 | N.W. | Fresh. |
| 8 | 20 | 5 | 20 | 7 | + 2 | 29·8 | N.W. | Fresh. |
| | 19 | 8 | 20 | 2 | + 6 | 29·8 | W.S.W. | Fresh to strong. |
| 9 | 21 | 1 | 21 | 0 | − 1 | 29·8 | S.W. | Fresh. |
| | 20 | 7 | 20 | 6 | − 1 | 29·8 | Calm. | — |
| 10 | 22 | 4 | 22 | 0 | − 4 | 29·8 | W.S.W. | Fresh to strong. |
| | 22 | 1 | 22 | 3 | + 2 | 29·8 | W. | Slight. |
| 11 | 23 | 8 | 22 | 10 | −10 | 29·9 | N.N.E. | Strong to gale. |
| | 23 | 8 | 23 | 7 | − 1 | 30·0 | N.E. | Slight. |
| 12 | 25 | 6 | 24 | 9 | − 9 | 30·2 | Variable. | High bar. |
| | 25 | 6 | 25 | 4 | − 2 | 30·1 | S.E. | High bar. |
| 13 | 26 | 7 | 26 | 7 | 0 | 30·0 | S.E. to S. | Slight. |
| | 26 | 6 | 26 | 5 | − 1 | 29·9 | S.E. | Slight. |
| 14 | 27 | 8 | 27 | 8 | 0 | 29·8 | W.N.W. | Slight. |
| | 27 | 5 | 27 | 7 | + 2 | 29·8 | Calm. | — |
| 15 | 28 | 1 | 28 | 4 | + 3 | 29·9 | S.W. | Slight. |
| | 28 | 1 | 28 | 11 | +10 | 29·8 | N.W. | Strong breeze. |
| 16 | — | | — | | — | 29·8 | N.W. | Strong. |
| | 28 | 4 | 28 | 11 | + 7 | 29·8 | N.W. | Strong. |
| 17 | 28 | 1 | 28 | 7 | + 6 | 29·7 | N.W. | Strong. |
| | 27 | 7 | 27 | 9 | + 2 | 29·8 | Slight. | — |
| 18 | 27 | 6 | 27 | 6 | 0 | 29·9 | N. to N.W. | Slight. |
| | 26 | 7 | 26 | 10 | + 3 | 29·9 | Variable. | — |
| 19 | 26 | 3 | 26 | 6 | + 3 | 29·9 | S. to S.W. | Slight. |
| | 25 | 2 | not observed | | | — | — | — |
| 20 | 24 | 8 | ,, | | ,, | — | — | — |
| | 23 | 6 | 23 | 8 | + 2 | 29·5 | S.S.E. | Moderate. |
| 21 | 23 | 5 | 23 | 7 | + 1 | 29·2 | W. to S. | Slight. |
| | 22 | 4 | 22 | 4 | + 0 | 29·3 | Calm. | — |
| 22 | 22 | 5 | 22 | 7 | + 2 | 29·3 | W.N.W. | Moderate. |
| | 21 | 10 | 22 | 1 | + 3 | 29·4 | W.N.W. | Slight. |
| 23 | 22 | 5 | 22 | 5 | + 0 | 29·4 | W. | Fresh. |
| | 22 | 5 | 22 | 6 | + 1 | 29·5 | W. | Slight. |
| 24 | 23 | 1 | 22 | 7 | − 6 | 29·7 | N.W. to N. | Moderate. |
| | 23 | 4 | 23 | 6 | + 2 | 29·8 | W.S.W. | Slight. |
| 25 | 23 | 11 | 24 | 4 | + 5 | 29·9 | W.S.W. | Slight. |
| | 24 | 2 | 24 | 5 | + 3 | 29·9 | W.S.W. | Slight. |
| 26 | 24 | 10 | 24 | 9 | − 1 | 29·8 | S.W. to S.E. | Slight. |
| | 25 | 1 | 25 | 2 | + 1 | 29·9 | S.W. to S. | Slight. |
| 27 | 25 | 4 | 25 | 3 | − 1 | 29·9 | S.W. | Fresh. |
| | 25 | 6 | 26 | 2 | + 8 | 29·7 | S.W. | Strong; bar. falling decidedly. |
| 28 | 25 | 6 | 25 | 10 | + 4 | 29·6 | S.S.W. | Strong. |
| | 25 | 10 | 26 | 9 | +11 | 29·5 | S.W. | Strong to gale. |
| 29 | 25 | 7 | 25 | 10 | + 3 | 29·5 | S.W. | Strong. |
| | 26 | 0 | 26 | 9 | + 9 | 29·7 | S.W. | Very strong. |
| 30 | — | | — | | — | 29·8 | S.W. | Strong. |
| | 25 | 5 | 25 | 4 | − 1 | 29·9 | S.W. | Strong. |
| 31 | 26 | 1 | 25 | 11 | − 2 | 29·9 | W.N.W. | Moderate. |
| | 24 | 11 | 24 | 5 | − 6 | 29·9 | N.W. to N. | Strong. |

the distribution of pressure was chiefly *cyclonic*, but complex, and the gradients were slight. In the following week, the distribution of pressure was constantly changing; but not abnormal. Then followed a *cyclonic* continuance of disturbances, some of which were violent; and, lastly, a succession of gales from the S.W., the effect of which, on the sea-level, was very perceptible. **James Pearson, M.A., F.R.A.S.**

Fleetwood, June 8.

## MATHEMATICS AND PHYSICAL SCIENCE.

[24414.]—THE true student of physical science cannot, I contend, advantageously work by rule of thumb; but there are, no doubt, those whose calling necessitates only a superficial acquaintance with registered scientific facts, and who would, therefore, do little better than waste time and endanger their worldly prospects by any serious attempt to dive deeply into the profundities of advanced mathematics. Nevertheless, in simple cases, such as I had in view when addressing my letter to your valuable journal, I feel convinced that the reason for each particular process should be clearly set forth.

The sailor whose knowledge of logarithms, &c., consists in being aware of some of the uses of certain tables, has this knowledge kept alive by the continual working of problems involving constant reference to these tables.

But with the architect and engineer, who should always possess a good all-round acquaintance with natural philosophy, questions connected with first principles sometimes arise which even an everyday familiarity with text-book formulæ would not enable him to decide. For such a one a little solid mathematical knowledge ought to be considered absolutely indispensable.

It would be indeed well if, in accordance with your correspondent Mr. L. Edmunds' suggestion (24385, June 19th), some one would publish a well-digested and logically-arranged mathematical course suitable for the general student. For geometry we have, it is true, a grand and inimitable textbook; but Euclid's elements; to which I refer, are seldom intelligently expounded, the result being that one proposition is but imperfectly understood when the learner is required to pass on to the next. A teacher should, in my opinion, insist upon each figure being drawn with *scale, compass, and protractor*, and strictly in accordance with the method and order of construction observed by Euclid; and, moreover, all the subordinate propositions employed in working out a problem should be repeated during the lesson, which should include the graphic proof, and some information about the application of algebra to geometry. Instruction imparted in this manner is interesting to the young mind—the true object of the work is perceived, and disagreeable toil becomes pleasant exercise.

**Recte Faciendo Securus.**

[24415.]—MR. LEWIS EDMUNDS (24385, p. 349) scarcely meets the complaint of the writer on "Cramming in Physico-Mathematical Science," 24362, p. 327. So far from the one letter answering the other, they have no sort of relation, and both are perfectly true. It is most mischievous work when teachers permit students to merely charge their memories with formulæ, instead of making them thoroughly grasp principles with their understanding. In this way dishonest teachers may no doubt enable lazy and stupid students to gain marks in an examination over those of intelligent, conscientious learners. But the ultimate result is that pointed out p. 327, the production of addled, stupid brains in the possession of ignorant and conceited people put into positions they are utterly unfit for.

On the other hand, in practical and for known specific purposes, mere formulæ may be amply sufficient without any comprehension of their *rationale*. It is quite true that "our ships are navigated over the whole world on this principle." But why? It is known that certain formulæ applied to angular measurements of the positions of the heavenly bodies will give us the position of the observer on the earth's surface. By the aid of books easily carried, a navigator can do his work accurately, although he has no comprehension whatever of the principles of spherical trigonometry or of the astronomical laws on which the formulæ are based. But then he has only to apply mechanically a single formula to a single known case; his personal part of the matter lies in taking the observations accurately, and in working out the figures. The case is not analogous to that of a student who is learning principles which may have manifold applications in the future, and who needs not only formulæ, but the knowledge how to select and apply the proper formula to any one of many possible cases. But the captain who knew no more of navigation than a few cut and dried formulæ for the application of logarithms would be very untrustworthy and helpless in those very probable conditions where his books were not available. There is another navigation always carried out, though usually disregarded, which comes into serious use when observations are impossible and the formulæ useless.

The subject is summed up in the remark I have often made, that mathematics are a most valuable servant, but a most dangerous master. They are invaluable tools of thought: this is Mr. Edmunds's side of the question. They are most dangerous substitutes for thought: this is the aspect of "Recte Faciendo Securus." The two are describing the two distinct sides of that shield so often referred to.

The student ought never to be permitted to use a formula in his scientific work until he has thoroughly mastered the principles and objects of his work itself. **Sigma.**

# REPLIES TO QUERIES.

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[56031.]—**Reservoirs (U.Q.)**—Your query is too vague. Are your tanks vertical, like a bucket, or horizontal, like a Cornish boiler? Is there not a mistake in the wording, which speaks of the pressure *outside* the tanks?—GLATTON.

[56039.]—**Explanation Wanted (U.Q.)**—"A Constant Reader" will see, if he looks again, that what he calls ·9in. is printed with but one dash, meaning ·9 *feet*. The last part seems to be rather confused by the fact that the figures are printed in one sentence. They should stand thus:—

$$48\text{lb.} : 125\text{lb.} :: 32 : \frac{v^2}{\cdot 9}$$

Having found this value, the rest follows as another sentence. I see W. Morshead has not gone into small fractions.—GLATTON.

[56061.]—**Vapour Density.**—Mr. W. John Grey says: " . . . what would be the volume of vapour under standard conditions . . . a litre will weigh 4·4493grm. . . . Vapour density is 49·167." How can this be demonstrated? Vapour is simply liquid water transformed by heat into steam, thereby acquiring an increase in volume which textbooks estimate to about 1,700 times. (Let me observe *en passant* that in true science there are no "abouts.") Most certainly this expansion of liquid water is not an "about," but is an absolutely precise one, the proportions of which do not vary. As it takes place in every direction—length, width, and height, it is cubical. Well, 1,700 is not the cube of any number, therefore it cannot be correct. It was adopted, in consequence of Gay Lussac's empirical experiments, by which he found the expansion to be 1,698 times; but he gave no scientific base, no physical law in obedience to which the phenomenon was produced, and therefore, could give no mathematical equations of the constituent elements. However, as scientists don't know better, let us take their "about" as correct, until they acquire the conviction that it is 1,728, the cube of 12. One litre of water is 10 × 10 × 10 = 1,000 cubic centimètres in volume and 10 × 10 × 10

= 1000 grammes in weight; when transformed into steam its weight remains unaltered, but its volume is about 1,700 litres, weighing 1,000grm. If we divide 1,000grm. by 1,700cc., we find that the weight of one litre steam is 0·5882grm., and not 4·4493. Should the last number be right, it would give 7·5638k. as the weight of one litre of water, instead of 1k. or 1,000grm. Ganot, whose "Physics" is very often referred to, says: "The density of vapour at 100° C. and 760 pressure is = 0·6235. The weight of one litre of dry air at 100° is $\frac{1\cdot3\text{grm.}}{1366}$ = 0·951grm. Therefore, one litre of saturated vapour at 100°, press. 760, weighs 0·951grm. × 0·6235 = ·592grm. To find at same temperature and pressure the volume occupied by one gramme of vapour, you have only to divide 1grm. by 0·592, the volume = 1 litre 689 = 1689 cubic centimeters. In transforming into water takes a volume nearly 1,700 times greater than in its liquid state (– 11)." But Ganot's numbers are subject to correction. He takes the weight of air as 1·3grm., whereas it is 1·2932. Therefore, the expansion is not 1,689, or nearly 1,700. It is exactly as follows:—1 × 3 × 4 = 12 × 12 × 12 = 1,728. This, being based upon the respective forms, volumes, weights, and numbers of the atoms of the molecules of the gases and steam, and of liquid water. The density of liquid water is $12^3$ that of its steam, and *vice versâ*. Before Foucault, H was considered as being 0·0691, which × 2 = 0·1382 × 8 = 1·1056 + 0·1382 = 1·2438, which, divided by 2, gave 0·6219 as the density of vapour. Foucault having found that H = 0·06926, which × 2 = – 13,852 × 8 = O = 1·10816 + 13,852 = 1·24668 volume of vapour, which, divided by 2 = 0·6234 as its density, proving the great merit of Gay Lussac's experiments in which he found O – 6238. Again, H = 0·06926, O = 55408 – H O vap. 0·6234, or 0 06926 × 9 = 0·6234. All this disagrees with Mr. W. John Grey's numbers. In No. 948, May 28th, 1884, this gentleman wrote that the respective proportions of H and O in one volume of water were 1,240 vol. of H, and 620 vol. of O = 1860 vol. H O. Can this be correct? As the expression volume has no precision, let us use a well-known and precise measure—the foot. If Mr. W. J. G.'s numbers are correct, one cubic foot of water contains 1,240 cubic feet of H and 620ft. of O = 1860 HO. In a gas holder let us introduce first 620 cubic feet of O, and, second, 1,240 cubic feet of H. The first gas, being sixteen times as heavy as the second, in obedience to the law of gravitation will remain at the bottom, and the second will float at the surface: but no. Not so obedient, the gases. In spite of such universal law, the heaviest will rise up and the lightest will fall down, and they will mix and equilibrate. This I should like to see scientifically explained by a physical law, not be a scientist's opinion. The mixed gases are said to have a great affinity (?) for each other. Still, in spite of it, if not otherwise acted upon, they will remain for ever in that state, and their volume will stand = 1860 cubic feet. They are aphone, silent, invisible, gaseous, and cold. If you ignite them they explode, thereby producing a great noise, heat, light, and visible steam; but the 1,860 cubic feet will be reduced to 1,240. What has become of the 620 cubic feet disappeared? By what were the explosion and noise produced? How and what with cold invisible gases have they produced heat, light, and visibleness? Which are the constituent elements of the two fluids, and their respective proportions? How did the invisible become visible but colourless? Now, the product being 1,240 cubic feet of steam, the latter is at a high temperature. If left to cool, the 1,240 cubic feet, according to textbooks, will be reduced to 1,240 divided by 1,700 = 0·729 cubic feet of liquid water. What was there in steam that caused its volume and has disappeared in cooling? So, 1,240 cubic feet of H and 620 cubic feet of O = 1,860 cubic feet HO don't produce one cubic foot of liquid water, but only 0·729 cubic foot, as stated. Now, let as take one cubic foot of liquid water, and by application of heat let us transform it into steam. According to textbooks we will obtain about 1,700 cubic feet of steam (exactly 1,728) composed of 1,700 cubic feet of H and 850 cubic feet of O = 2,550 cubic feet of gas mixture (exactly 1,728 + 864 = 2,592), and not 1,240 H and 620 O = 1,860 cubic feet HO as indicated by Mr. W. John Grey. Analysis and synthesis agree perfectly.—Ch. Rabache.

[56068.]—**Adjusting Telescope for Collimation in Dumpy Level (U.Q.)**—The following is extracted from Rankine's "Civil Engineering":—Make two bench marks about ten chains apart; set up the level exactly midway between them, and read staves set up on them, so as to find by the difference of those readings the true difference of level of the bench marks. Now set up the level beyond one of the bench marks, and read both staves. If the difference of the readings deviate from the true difference of level, alter the inclination of the telescope by means of the plate-screws, until the readings of the staves give the true difference of level, and bring the bubble to the middle of the spirit level by means of the adjusting screws which connect the level with the telescope. —Glatton.

[56090.]—**Lubricating Bearings (U.Q.)**—Do you want bearings for a wooden shaft? There are so-called self-lubricating bearings advertised in the engineering journals, but they would not do for wood, I think. They are made by drilling a number of small holes, say ⅜in. diameter all over the inner surface of a pair of brasses, and then inserting plugs of antifriction metal in them. There is thus more of this metal than of brass on the wearing surface.—Glatton.

[56141.]—**Lobster-back Cowl (U.Q.)**—Why not lap the pieces alternately, one inside, the next out, and so on?—Glatton.

[56154.]—**Working Strain (U.Q.)**—I presume F. Search means stress, not strain. I cannot find the results of any experiments on the transverse strength of shear steel. Rankine gives 118,468 as the tensile stress to break it. Assuming 118,000lb. as the transverse stress, the weight in the centre of your bar will be given by the formula—

$$w = \cdot0982 \times \frac{4fa^3}{l}$$

$$= \cdot0982 \times \frac{4 \times 118000 \times \cdot5 \times \cdot5 \times \cdot5}{3}$$

which gives 1,935lb. as the weight which would break it. As the data are so uncertain, a large factor of safety should be allowed, which will also depend on the kind of load to be applied, whether "dead" or "live."—Glatton.

[56188.]—**Pump (U.Q.)**—A chain pump will probably suit you. Write to any hydraulic engineer.—Glatton.

[56540.]—**Westinghouse Engine for Flour Mill.—(U.Q.)**—As no one else seems to have noticed this query, I will give you an opinion on some of the points. The first is the question of engine and boiler power. The Cochrane boiler, with 160 square feet of heating surface, would drive a 10 horse-power engine all right provided 10 horse-power would be sufficient to drive your mill and machinery. As to the engine, by all means have a compound. The 10 H.P. compound with 6½in. and 10in. cylinders, 12in. stroke at 180 revolutions a minute, would be far superior to the simple 10in. by 20in. cylinder engine, or the high-speed Westinghouse; so that I should most unhesitatingly recommend the compound engine. The economy in a compound engine, be it large or small, depends on its steam pressure. Thus, a small compound, with a good boiler pressure of, say, 80 to 90 to the square inch, would be economical, whilst a 50 horse-power compound, with 20lb. or 30lb. steam only would fail to be better than an ordinary engine. If I wanted as little as three or four horse-power even, I should be inclined to use a compound with perhaps 100lb. pressure or more, rather than a simple high pressure. Your Cochrane boiler would be very ample for a 10 horse-power compound; but I would not expect it to drive a 10in. by 20in. cylinder. I would with pleasure help you with plan of shafting, &c.; but very much depends on the disposition of the machinery. If the well has a constant supply, you might utilise it for feed. But can it be depended on to give a constant supply? I should also sink a catch pit at a convenient spot in the rivulet, and also connect a pump with that, so that all the available water could be got. As with a condensing engine, you will want a good volume of water. But even that can be managed by the use of a cooling pond, so that the same injection water is used over and over again. In fact, inside the realm of mechanics, very few things are impossible to those who understand their business.—Invicta.

[56571.]—**Electrical.**—"Bobadil" says, "In decomposing water, two volumes of H gas are obtained for every volume of O"; but he does not say the respective proportions of Ag, H, and O. "J. H. E. D." says, "Two volumes of hydrogen are given off for one of oxygen; by weight one of hydrogen to eight of oxygen." Again, nothing is precise. S. Bottone says, ". . . . You decompose 9 grammes of water and produce 11 litres of hydrogen and 89 litres of oxygen." Well, one litre of H weighs 0·0896grm. × 11 = 0 9856grm., one litre of O weighs 1·4330grm. × 89 = 127·5370grm. together 128·5226grm., so that in decomposing the 9 grammes become 128½grm. Is it possible? Eugene Brown says, ". . . . decomposed per second, ·0000945grm. = 1,764 cubic centimètres, setting free ·0000105grm., H = 1,176 cubic cent., and ·000084grm. O = ·0588c Well, one gramme of water is 1cc. It produces 1,728cc. of steam containing 1,728cc. of H and 864cc. of O = 2,592cc. HO. If one cubic centimètre of water contains only 2,592cc. of gases, how can ·0000945grm. produce 1,764cc.? ·0000945grm. cc. of water transformed into steam increase about 1,700 times in volume = ·1607500cc. in steam, and ·2411250cc. in gas, not 1·764cc. It is true that 1,176 + 588 (not 0588 as printed) = 1,764. True, also, that ·0000105 + ·0000840 = 0000945; but there remains to be proved that such propositions can be obtained. At all events, there is a great discrepancy with Mr. W. John Grey's numbers and Mr. S. Bottone's proportions. Now "X. Y. Z." says, "One gramme of water when decomposed yields 1·24 litre of hydrogen, and ·62 litre of oxygen, or 1·86 litre of mixed gas. Mr. Bottone says 11 litres of H and 89 litres of O, 1·24lit. of H × ·0896grm. = ·1111, and ·62l. of O × 1·433grm. = ·88846, together ·99956grm. = one gramme of water. This is right: the rest is not.—Ch Rabache.

[56575.]—**Galvanometer.**—To "Nun. Dor."—Yes, sir, this query is asked very seriously indeed; but I should mention that the instrument is not for serving the orthodox purpose of testing currents, but for a totally different object. What I really want is fully stated in query No. 56081; but I have been informed, through the medium of this journal, that what is asked there is next to impossible. My grief at hearing this may be imagined when I say that I have spent three years of labour on the machine in question, and this is the last link in a long chain of difficulties. If "Nun. Dor." could render me any help in the matter, I should be thankful. —J. Budge.

[56583.]—**Chloride of Zinc.**—If "Old Reader" must have pure zinc chloride, there is no help for it but to pay the price. It is sufficiently pure for battery purposes when prepared from bar zinc or spelter and hydrochloric acid.—S. M.

[56584.]—**Silvering Solution.**—This querist should look up the recipes in back volumes, and select those which seem most likely for trial. I presume the solution he refers to was a real silver preparation, and not merely nitrate of mercury.—E. G. M.

[56587.]—**Telephone System.**—The current passes direct to B, when the intermediate offices are not put into circuit, which of course they are not unless the telephone is removed from its hook.—S. M.

[56587.]—**Telephone System.**—In your issue of the 29th ult., will "R. F. S." tell me how many cells and kind of battery is required to work this system? I have tried 20 cells Leclanché, No. 2 size; but only works between first and second office, and no further.—T. J.

[56595.]—**Spectroscope.**—I, too, should like to know how to make a spectroscope for 5s., or even a little more. Will any of your readers help?—Essar.

[56599.]—**Photographic Plates.**—Has this querist consulted the makers? Does he adopt the formula and practice recommended by them?—T. J. P.

[56609.]—**Analysis of Asbestos.**—The following analysis shows the composition of Italian and Canadian asbestos:—

| | Italian. | Canadian. |
|---|---|---|
| Magnesia | 40·18 | 33·21 |
| Protoxide of iron | ·75 | 5·77 |
| Alumina | 2·82 | 6·69 |
| Silica | 40·25 | 40·92 |
| Water of hydration | 14·20 | 12·20 |
| Soda | 1·37 | ·68 |
| Potash | traces | traces |
| Protoxide of manganese | traces | traces |
| Lime | traces | traces |
| Chlorine | ·15 | ·22 |
| Sulphuric acid | ·31 | traces |
| | 100 03 | 99·69 |

—S. M.

[56620.]—**Steam-Carriages.**—To "Invicta." —Will you obligingly allow a French subscriber to avail himself of your kind offer? I intend to procure a vehicle to which I will apply the new boiling-oil system. I wish to know—1st, what room, length, width, and height will occupy an engine of 1-h.p., without boiler, with variable cut-off (détente) fit for the purpose; 2nd, at how many atmospheres pressure it would work; 3rd, the number of piston strokes per minute; 4th, the quantity of steam used at each stroke; 5th, and, if possible, about the cost price? Would the Parkyns engine do? In April last I asked the above question to the Paris establishment, Cail and Co. I received the answer that, as they do not construct engines of so small a power, they could not give the required information. I thoroughly believe that any English engineer can supply such information, and I expect from your kindness that you will please to send it to me either through the "E.M." or direct.—Ch. Rabache, Morchain, Somme, France.

[56620.]—**Steam-Carriages.**—The question of steam-carriages on common roads very often appears, in answer to queries, in your columns of late, and as most of the answers relate to now nearly forgotten attempts, I send you for use the following account of a modern steam-carriage which does its work very satisfactorily. Two friends of mine in Alsace are in the habit of using a powerful steam-carriage for running on common roads; it weighs, when in working order, about $2\frac{1}{4}$ tons and seats four persons; the proprietors have a concession from the Government to run at a rate of $12\frac{1}{2}$ miles an hour, but under favourable circumstances this speed is considerably exceeded, 25 miles an hour being occasionally obtained. The sensation at this speed is very exhilarating—infinitely more pleasant than in a carriage drawn by horses the jerking movement being absent, it has more likeness to sailing. This machine gave considerable trouble at first; but now, thanks to the patience and intelligence of the owners, the carriage is in very satisfactory running order, and seems to demonstrate what can be done with this class of vehicle by a judicious expenditure of money and in a country where the authorities do not needlessly meddle. I hope my friends will get a new carriage built, embodying improvements which practice with the present carriage has suggested. The great difficulty now experienced is with the tires: they are of iron, about 4in. by $\frac{3}{8}$ or $\frac{3}{4}$, and three sets had been completely demolished by the time the carriage had run some 3,200 miles, so that a new set of tires are called for about every 1,000 miles. Now the wheels are of wood and extremely rigid, and I believe the excessive rigidity of the wheels is the cause of this excessive amount of wear, and would point out as a remedy an elastic wheel. The makers of slow-moving traction engines have already found this out, and are endeavouring to produce a good elastic wheel. The steering gear of this carriage is simply perfect. The steersman (who is, at the same time, engineer) has the machine perfectly under control, and can execute manœuvres which would be impossible with a horse-drawn vehicle; the ease with which it is guided, even at the highest speed, gives great confidence. The carriage was built by Mr. Ballée, of Le Mans, France.—C. B., Zurich.

[56620.]—**Steam - Carriages.**—"Nun. Dor.," answering on p. 352, imagines that "Progress," in his letter, p. 328, means a steam tramway, when, in fact, "Progress" does not believe either in steam engines on highway roads, nor in any way trammelling the wheels of vehicles for speeds under ten miles per hour. We will, therefore, drop steam-carriages of the past, and refer to motive power and vehicles for use on highways in the future. A "tug of war" was mentioned on p. 328 as now proceeding between flat tire and flange wheels, or tramcar versus omnibus on the same rails, both being drawn by animal (horse) power, and the opinions of readers of the "E. M." was required as to the relative advantages of the two systems, each having an iron or other such bearing surface as "Nun. Dor.'s" description of the word "rail" on p. 352. An iron rail 8in. wide on the surface can be made and fixed at as little cost as a groove rail, the groove having to be ploughed out after the rail is rolled into shape and the quantity of iron in each would be about the same. My idea of an improved highway road is one that shall present the least possible resistance to the rolling of wheels, thereby requiring the least possible motive power, causing the least wear, and allowing the lightest vehicle to be used. Also, that the road should at all seasons of the year be dry on the surface and free from dust and slush. To arrive at such state, we must give up the system of carting gravel on to the road to be ground, the same as we cart wheat to the mill to be made into dust (flour), then with good surface draining and using mechanical motive power, we shall be rid of the horse-droppings, dust and slush, and have a clean, dry road at all times. "Up and down" tracks or ways should be provided, say, each 6ft. wide, which would accommodate all descriptions of vehicles, including a groove for flange wheels if required, and the traffic regulated as on railways. Now, as to motive power. Steam-engines are of great weight; and, of course, every foot of the road they travel, must be sufficient to carry that weight when the vehicles with their loads only require one-fourth part of that strength, therefore, 4lb. must be expended on first outlay on road for engine when only 1lb. is required for the loaded vehicle. As to steam-engines in the future, Sir F. Bramwell, in an address this year, "prophesied a great future for the gas-engine and the relegation to museums of the steam-engine as an old curiosity." Either gas, oil, or spirit could be sold to travellers at all country inns abutting on the highway roads. The first cost of road would follow almost directly in proportion to the quantity of iron used, and that must be governed by the weight the road has to carry; therefore the great necessity of reducing the weight on any one wheel by adding more wheels to the load. Having for some few years given attention to the question of highway roads, I believe they can be greatly improved, and, in proportion to advantages gained, the expense would not be more than it has been. The "poor man" would be able to travel with his own iron horse (pedal machine) and carry as great a load as farmers have hitherto done with their one-horse market carts. Out of about nine or ten queries and statements in my letter on p. 328 only one has been replied to (that giving definition of word "rail.") If readers of "E. M." will kindly discuss the others we will then proceed with description of vehicles and motive power required for the future.—Progress No. 2.

[56650.] — **Lead - burning.**— It would be interesting to learn from Mr. P. J. Davies and Mr. H. Holmes what they mean by the gas being "dirty," and how they recognise it. The simplest method of procuring hydrogen is to pour a dilute solution of sulphuric acid on granulated zinc, when the zinc becomes sulphate of zinc, and the hydrogen of the acid is evolved. An ounce of zinc should liberate about $2\frac{1}{2}$ gallons of gas; but scraps of iron may be used instead—only in that case the gas will be less pure, being contaminated by the presence of compounds of hydrogen and carbon. Is it this carbon which is objectionable to the plumber? Gas made with zinc and common brown vitriol is often contaminated with compounds of hydrogen with sulphur and arsenicum; but surely these are not of much moment in autogenous soldering. If it were not for the risk of getting some carbonic oxide, one would think the best plan for plumbers would be to pass steam through a tube filled with red-hot iron borings and turnings. I suppose that is why they use acid and zinc.—Essar.

[56650.]—**Lead-burning.**—If Mr. Holmes will look to my reply on page 287, he will find that I never spoke of druggists selling bad sulphuric acid; but simply oilshops, for though I have on many occasions, when short of acid, endeavoured to procure such good enough for the work, I have never on any one occasion been able to obtain a suitable material from these shops: hence the reason for my speaking—to put my readers on their guard; and considering that I have been something like thirty years in the trade as a professional lead burner, I think I am justified in cautioning my readers against an evil which is universally, by experienced lead burners, admitted. And with regard to using a pack of old rubbish, such as ventilators and watering cans, it is simply utter nonsense, for such trash would be far more trouble than the preparing and burning put together, and I trust that my readers, if ever they have attempted to use such worthless rubbish, will at once ignore it, and use the proper material, or melt the old zinc down into bar zinc. Mr. Holmes asks me the question as follows: "How does Mr. D. make out that the gas is dirtier the first half-hour than after?" and says, "This is contrary." I say it is not so, and I herewith give substantial reason for my assertion. For argument sake, suppose yourself to be at work in a soap works, oil refinery, vitriol works, and the like dirty places. When you first charge the machine with pure bar zinc the outsides of the zinc are liable to get fouled with vegetable matter, or, for argument sake, greasy and dirty; even the breaking up of the zinc with the hammer, or it knocking against rusty iron is sufficient to foul it. Now, it is a sure thing if any vegetable or oily matter be present when the zinc is first put in the machine, it will at once colour your acid. For instance, drop a little putty, or a drop of linseed oil, or a bit of cork, or such like, into some best sulphuric acid, and you will at once see a discolouration, which will take place exactly the same in the machine; but after a little time the surface of the zinc becomes clean, and the dirt exhausted; but during this time your gas is impure, and according to the amount of foreign matter so will the dirtiness of your gas last. Mr. Holmes says that I keep harping about my book. I am not quite sure as to the *harping*; but simply gave it to show that his words of last week were published, and that he was using my own instructions; and as to the readers of the "E. M." not being able to purchase all the books that are written and published upon the subject, they could very easily do so, considering that there is only one admitted of any practical worth, and which has been published in the columns of our "World of Science," and which is accessible to all readers of the "E. M." who may wish to purchase the numbers at the present moment, if they would only look through the Sixpenny "Sale" Column, &c. I should like Mr. Holmes to properly reply to my question on page 329, wherein I asked him if there is nothing to be done but to throw the acid away, which I see he has forgotten; by doing so he would be giving instructions to many of the uninitiated, and it looks bad for me to answer my own question when in correspondence with a contributor like Mr. Holmes, who says he is willing to give instruction to the young beginner. Trusting he will do so, for although this appears an insignificant question, nevertheless it is one which is not generally known, and which undoubtedly will be useful to others besides the young beginner, whom Mr. Holmes says he is willing to give instructions to.—P. J. Davies, 78, Earl's Court-road, Kensington, W.

[56651.]—**Explosion of Gas in Boiler Tube.**—The cause of the above has been fully explained. I rather expect the explosion took place on closing the fire-door, not opening it; at least such has been my experience, and after more than forty years' hard firing, I never witnessed it with any other boiler except the tubular class, the last boiler I worked, after being driven backwards many times on to the coal-heap, with whiskers and eyelashes cleaned off. I had to close my fire-door very gradually after every charge. Let "A. T." do this, especially first thing in the morning, and the like will not occur. Narrow flues and small damper-hole have much to do with it. If the gases have plenty of room to expand, and get well away up shaft, they would not come out at fire-door.—Hinckley Man.

[56672.]—**Varnish for Wall Papers.**—Dissolve 8oz. of alum and $3\frac{3}{4}$oz. of Castile soap in four pints of water and 2oz. of gum arabic and 4oz. of blue, separately, in four pints of water; mix the solutions, heat slightly, and dip in the single sheets, which hang up until dry.—A. B. C.

[56722.]—**Flywheel.**—Many thanks to S. Beeching and "Invicta." I want the engine to work a lathe or small planer. I should like if possible to alter my query. Would the flywheel do 18in. dia., as it would suit the bed better? And as "Invicta" thinks speed too high, will reduce it to 300, cut-off being at $\frac{1}{3}$ stroke. The rest of my query to remain the same.—M.

[56733.]—**Problem.**—On p. 353, "J. C." says that my answer to this question is incorrect because I supposed a mistake in the question; but "J. C." assumes in his solution that in the eleventh line of the question "100 gallons" should read "10 gallons"; whilst in the other answer on p. 310 it is assumed that the correct reading is "100 gallons more than B. did." There is evidently some mistake in the question, for, taking it as it stands, we have $800n + 100 = 225n$, whence $n = -\frac{4}{23}$ which is clearly wrong. Can "Trophy" say where the mistake is?—East Anglian.

[56750.]—**Gold Plating.**—Add to a saturated solution of nitro-muriate of gold about a fourth part of sulphuric ether; shake the mixture, and then allow it to settle. The ether will take the gold from the acid, and will separate itself from it also, and form an upper stratum in the vessel. Carefully pour this etherial gold into another glass, and immerse in it any utensil that is highly polished; then take it out, and instantly plunge it into water, when the surface will have acquired a coat of pure gold, which will stand polishing. You may use a pen and draw figures on razors, &c., and the gold will remain on them as just described.—W. E. S.

[56753.]—**Horse-power to Drive a Millstone.**—As T. M. Bury has not yet received any reply, I give him a rough-and-ready one amongst us millers; that is, one horse-power per foot diameter of stone, but with a little extra power you will drive stronger and better everyway, especially as your stuff is very hard, and (of course your stones are French) you will have a little power in store for any additional machinery. I should say put six horse-power behind them.—Hinckley Man.

[56759.]—**Waterproofing Canvas.**—Ingredients: 96 parts of ochre, 16 parts of lampback, boiled oil, two parts of yellow soap, eight parts of water. Mode: Mix to a thick paint the ochre, and lampback, with the boiled oil; then mix the yellow soap and water, and add them to the others, stirring all well. Dress the canvas with two coats of this mixture, leaving time to dry; then give one dressing of lampblack, and boiled oil only, mixed to the consistence of a thick varnish.—W. E. S.

[56770.]—**Putty.**—Ingredients: 10lb. of whiting, 1lb. of white lead, boiled linseed oil, a wineglassful of sweet oil. Mode: Work up these ingredients with sufficient boiled linseed oil to form a paste of the requisite consistence; the sweet oil prevents the white lead from hardening. All putty should be made some time before it is used, and sashes to be puttied should have one coat of paint, which will cause the putty to adhere more firmly. Old putty may be softened by applying rags dipped in a solution of caustic potash for some hours, or by rubbing a hot iron along the putty.—W. E. S.

[56777.]—**Paste Blacking.**—Ivory black, 1lb.; treacle, $\frac{1}{2}$lb.; olive oil and oil of vitriol, of each 2oz.; water, a sufficient quantity.—W. E. S.

[56780.]—**Camp Stoves.**—Perhaps a stove just made for me by the Albion Lamp Company would suit inquirer. It is made of galvanised iron, duplex $4\frac{1}{2}$in. wicks, and is a cube of about 14in. I use it on a small yacht; but as it has wind shutters, I think, if it is not too large, it is worth notice. After repeated trials for small yacht stoves, I am at last satisfied. It burns crystal oil. If only a kettle to boil is required, a 3d. spirit reservoir will answer well, put inside a shallow tin box: that is my kit for river excursions of one day.—R. Hannen.

[56794.]—**Storage Batteries.**—I should not advise the querist to use storage batteries at all for such a number of lamps, unless it is absolutely necessary; they are a great deal of trouble. The lead that comes on teachests is no use whatever; it is much too thin. If an "Old Subscriber" would state the E.M.F. of his lamps, and the current they take, then, perhaps, I could help him. If they took 60 volts and one ampère, he would want 30 cells, in series, each cell containing about 30 plates. Then the size of the plates would partly depend on the time the cells were required to light the lamps. The total force required to light the lamps is about $\frac{60 \times 30}{746}$, or nearly 2½ horse-power. Perhaps some one will be able to give some better advice than myself; but, if not, and the querist will tell me the E.M.F. of his lamps and the current they take, I will try my best.—Bunsen.

[56800.]—**Pianoforte - Tuning Hammer.**—There has been no recent improvement in this article, and the choice still lies between the "T" and the "lever" hammers, as it did 50 years ago. For a beginner, the lever hammer is perhaps more convenient, as he will obtain better command of the pins. Either may be obtained of Hughes, Drury-lane, or at Buck's, Tottenham Court-road. W. H. Davies.

[56813.]—**Fracture of Water-Gauge Tube.**—"Bacchus" must have been very fortunate, or had but a short experience. He omits to notice that iron wire is specified, and it is an indisputable fact that water-gauge tubes, barometer tubes, and the like will often go after they have been cleaned. It is probable that they have been slightly scratched by the iron wire. Besides, that is a method employed for purposely breaking tubes of the kind. I believe the barometer-makers use a piece of whalebone, or else a brass rod carefully covered so that no part of the metal can touch the glass. If the glass tubes were thoroughly annealed, they would probably withstand even scratches from an iron wire.—Nun. Dor.

[56814.]—**Hot Food in Hot Climates.**—The physiological effects of spicy, hot foods is to keep up the internal temperature at times when the heated air becomes oppressive, so that the outer temperature would inevitably rise so nearly to that of the vital organs as to produce faintishness and sunstroke. In days gone by the diseased and disordered state of the liver, &c., which rich old "Nabobs" brought home from India and other tropical regions after some years of residence there, were usually attributed to the curried and other spiced dishes of food; but recent experience shows that the real cause of such loss of health arose from the mistaken practice of trying to live in English fashion—on heavy meats and malt and other intoxicating liquors—instead of adopting the foods of the country—viz., the various grains and fruits used by the natives. Those who find this summer weather oppressive may cool and refresh themselves by lunching on a bowl of wholesome soup nicely cayenned. Just try it, and you will thank H. O'B.

[56819.]—**Pickle for Brass.**—After the brass surface is got by some other means (either by polishing, burnishing, or scratch-brushing) as clean as possible, put the goods into aquafortis and water, and leave them there for some hours according to circumstances. The acid will eat away the outer coat, leaving a bright surface beneath. The brass is now put into hot sawdust, and shaken about to dry and clean them, when they will be ready for lacquering.—A. B. C.

[56822.]—**Small Dynamo.**—To Mr. S. Bottone.—You might use No. 16 on the armature and No. 14 on the field. Fill the spaces on the ring with No. 16, having previously weighed the ring. Weigh the filled ring. One quarter the weight will give the weight of an equivalent resistance in copper wire. (See any table of wire resistances; one was published last year in the English Mechanic by Mr. Sprague.) Now coil the F.M.'s with No. 14, rather more than is required to balance the resistance of the armature as just found. The quantities will be found to be 1½lb. of No. 16 and 4lb. of No. 14, nearly. If you can test the resistance by means of galvanometer and Wheatstone's bridge, you will get much more accurate results.—S. Bottone.

[56823.]—**Steam.**—The number of cubic inches of steam admitted into the cylinder is $32^2 \times 7854 \times 72 \times \frac{2}{10} = 11581{\cdot}05$ cubic inches. The temperature of steam at 35lb. above the atmospheric pressure is 283° Fahr. 1 cubic inch of water will form 554 cubic inches of steam at the above-named pressure. Let the latent heat of steam be taken at 966°. The total heat contained in the steam will be 966° + 283° = 1249°. Let the temperature of the injection water = 50°, and the temperature of the mixture of the steam and water is to be 100°. We then have $\frac{1249^\circ - 100^\circ}{100^\circ - 50^\circ}$ = he quantity of water required to condense a cubic inch of water when formed into steam = 23 cubic inches nearly. Again, $\frac{11581{\cdot}05}{554} = 20{\cdot}724$ = the number of cubic inches of water which were admitted into the cylinder as steam, and $20{\cdot}724 \times 23 = 476{\cdot}652$ cubic inches of water will be required to condense the steam admitted into the cylinder during one stroke. "Young Engineer" does not give the number of strokes the engine makes in a minute. Therefore, I can't tell him whether the air-pump and injection-pipe are large enough, or otherwise.—A. Gray.

[56824.]—**Watch Work.**—Procure ruby pin of proper size, and lay it in so that it projects to proper length from face of roller; then get small piece of shellac and place it on. Now, if you put a piece of wire through the centre hole of table roller, and let the flame from gas play on the wire, the heat will be transmitted, and shellac will flow. Annie.

[56824.] — **Watch Work.** — Slightly different methods are employed to fix ruby pin in roller of lever watch; but the cement invariably used is shellac. The way I proceed is thus: Having found a pin to fit, and seen it is suited to the lever fork, remove the roller. (A special tool is made for this; but if "T. W." hasn't one, he can do with nippers if careful). Then put pin in position: put small piece of shellac on at back, and heat by means of a piece of steel wire, held midway over the gas, and touch with end. If found not quite upright, can easily be adjusted by gently pressing at side with heated wire. Care, of course, to see that no shellac on side or in crescent for guard pin.—Escapement.

[56824.]—**Watch Work.**—Take the roller off the staff, and put it on a tapering piece of steel wire; then warm the wire about 1in. below the roller, taking care not to heat it enough to colour the roller, but only to melt the shellac with which the pin is fastened in. Push out the piece of broken pin if it is still in the hole, and while the shellac is still hot put the new pin in the hole, and put a very little shellac on it (on the under side); move the pin up and down two or three times so as to work the shellac well into the hole, then push the pin in as high as you want it, and let it cool. Scrape off any shellac which may have got on the polished side of the roller with a knife. I may say that I shall be pleased to answer any questions respecting watch jobbing or finishing.—C. A. W.

[56825.]—**Mechanical Question.**—The answer given by "Dubliniensis" to this question is hardly such as will leave the inquirer any wiser. He states the answer without giving any reason for it. "Student" probably knows that the formula for expressing the strength of rectangular beams is $\frac{b d^2}{l}$ when $b$ = breadth in inches, $d$ depth in inches, and $l$ length in feet. The strength being directly as $b$, if we double the breadth, we double the resisting fibres as the square of $d$, as by doubling $d$ we not only double the resisting fibres, but double the leverage also; therefore, we have four times the resisting power. Inversely as $l$, as if double the length, half the strength. In this case, the beam being 10ft. long and supported at an inclination of 60°, the weight acting directly downwards, will fall at a point midway between the supports, which "Student" will find are 5ft. apart. The question therefore resolves itself into a beam 5ft. long supporting one ton at its centre, and by above formula

$$1 \text{ ton} = \frac{b d^2 \times \text{constant of strength}}{l}$$

$$\therefore 2240 = \frac{2 \times d^2 \times 450}{5}$$

$$= d^2 = \frac{112}{9} \therefore d = \sqrt{\frac{112}{9}} = 3{\cdot}53\text{in.}$$

—Fred. A. Robinson.

[56826.]—**Loss of Power.**—If "Student" should feel exercised by the difference between the 1,792 foot-pounds in David Stephen's reply to his query, and the 573·4 f.p. in my reply thereto, the explanation is this:—"D. S." took the coefficient of friction as ·1, which is a fair value for the c. of f. of repose in this case; but he should have taken the c. of f. of motion, which is about ·032, or only about one-third of the other. Probably there would not be time enough for the repose-coef. to get established at the end of each stroke; and even if there were, that coeff. would be completely abrogated before the mass had moved ·1in. after each fresh start; and, therefore, the additional work to be done in consequence of it would be quite inappreciable. All the calculations in "D. S.'s" reply are perfectly right.—Dubliniensis.

[56828.]—**Hot-Water Pipes.**—If you dip your pipes to go under the doorway, they will not work; but if you carry them over the doorway they will. If you are short of room above the door, as is often the case in greenhouses, use four stop ends, and screw into them wrought-iron barrel, half the size of your hot-water pipes to go over the door. You will find this about the only practical way to do your job.—Scott Mason.

[56830.] — **Pianoforte Making.** — To Mr. Davies.—In inquiring as to the back of a soundboard, "A Pianoforte" is probably thinking of double soundboards, which have occasionally been made something after the fashion of a violin. This principle has not, however, proved to be of service in a piano; and I think it questionable whether it is not wrongly applied, though not so palpably, in a violin. I have been in hopes that our esteemed correspondent, "Orderic Vital," would have had something to say on this subject, and trust that it is not yet too late. It is a very common mistake to suppose that the soundboard of a piano requires support against the downward pressure of the strings. Of course it is absolutely necessary to transfer the vibration of the strings to the soundboard, and for this purpose a close contact is required; but this may be obtained quite as effectually by the side bearing of the bridge pins as by the downward pressure of the strings. The traverse bars are therefore only necessary to maintain the rigidity of the soundboard, and are not needed to support it in any other way. It would hardly be worth while to repeat the directions and measurements given in Vol. XXXII., as many of them have since been improved upon; but I hope soon to contribute a series of articles on "The Mechanics and Reinforcement of Sound." Meantime, I shall be glad to send the printed directions referred to, though I cannot undertake to answer queries by post.—W. H. Davies, Irvine-street, Liverpool.

[56831.]—**Removing Zinc from Tin Solder.**—I have a method of removing zinc from lead; but cannot exactly say whether it will do the same for tin. Melt the mixed metals in a ladle, and pour them into any convenient mould (sand will do); the lead will sink to the bottom, and the zinc will come to the top. Before the zinc gets hard, put a piece of bent wire into it with which to raise it out of the mould as soon as it is sufficiently hard. Lift it by the wire, and you will find the molten lead at the bottom. Any lead adhering to the zinc can be brushed of at once, while it is hot. Keep the mixture steady on the ladle, and don't shake it up. It is probable the tin will remain with the lead; but that I can't say, as I have not tried it. Don't let the sand mould be wet, or you will get a lesson which you won't forget.—Os.

[56832.]—**Engine Query.**—Will you communicate with me, stating requirements, and I will do what I can for you.—C. Lilcock, High-street, Stony Stratford.

[56833.]—**Horizontal Engine.**—I do not remember a sketch of a similar engine complete in recent back numbers. But if you will tell me one or two particulars, I will try and help you to what you want. Tell me if the cylinder has feet to bolt to a bedplate or not? Have you not the connecting rod? or slide rod and eccentric? Tell me all the parts you now have, and the sizes, or rather lengths, between centres, and I will, if necessary, send line sketch of engine complete, so that you can finish it to a settled plan.—Invicta.

[56834.]—**Sun-Dials.**—There is a long and fully-illustrated article in Vol. VII. of the *Encyclopædia Britannica* (eighth edition), where the various writers on the subject are also detailed.—Arthur Mee.

[56836.]—**Telescope.**—Tell me the focal length of your 5in. o.g., and I will, with pleasure, give you all necessary instruction how to mount it for use? Also the necessary lenses for a Huyghenian eyepiece, and how to mount them for use. But without the focal length of the o.g. I cannot help you to instruction as to the tube and mountings.—Invicta.

[56836.]—**Telescope.**—The length of tube depends on the principal focus of the o.g., and should be a few inches less than such focus. Of eyepieces the Huyghenian is the one most used, and the proportions of the component lenses are given on an average once a month in these columns. As to powers, I notice that Wray supplies his 5in. telescopes with five—from 60 to 400.—Arthur Mee.

[56838.]—**Telescope.**—"Eyepiece" and others wanting to alter their telescopes would be much safer in intrusting the work to an optician than attempting it themselves, unless perfectly familiar with the whole affair. He may, however, obtain increased power with the least possible amount of tampering by removing from his present eyepiece the lens furthest from the eye, though the "field" will be rendered less perfect.—Arthur Mee.

[56838.]—**Telescope.**—Instead of cutting or altering the draw tube as this querist suggests, I can tell him of a better plan, I think; in fact give him a choice of at least two ways of doing what he wants. Supposing a moderate increase of power only is wanted, then increase the distance between the erector, which is the two lenses nearest the o.g., and the pair forming the eyepiece proper. This, by means of a short piece of tube to screw on, will increase the power. If this is not enough, then why not have a Barlow lens fitted? With this latter placed in a definite position, which he can be informed if he decides to adopt the plan of using a Barlow, the power of the existing eyepiece would be doubled. The Barlow, which is, or should be, a concave achromatic, is easily adapted to the existing tubes. If either of these suit him, I will with pleasure give further details if he proposes to do the work himself.—Invicta.

[56839.]—**Automatic Steering Gear.**—If I wanted to do such a thing to save time, I should try and get an old bottle-jack movement. This gives exactly what you want—viz., the motion reversed every so-long. With the aid of a fly you could also modify the time in which the clockwork would put the rudder over, whilst a wheel and pinion in addition would give additional power, and prevent its working too fast.—INVICTA.

[56840.] — **Rubber Stamps.**— Signatures are made in the same manner as in stereotype plates (of which rubber stamps are only a variation), viz., by getting a woodcut of the signature and proceeding as if it were in type. If "Autograph" does not know how to do woodcuts, he can refer to back numbers, or inquire again.—B.Sc., Plymouth.

[56844.]—**Mathematical.**—If $c$ is the length of the radius of the circle, the polar co-ordinates of the extremities of the chord are $(c, a - B)$ and $(c, a + B)$, and the equation of the straight line through these points is $c^2 \sin. 2B + rc \sin. (\theta - a - B) + rc \sin. (a - B - \theta) = 0$, and this easily reduces to $r = c \cos. B \sec. (\theta - a)$. If we put $B = 0$, we get $r = c \sec. (\theta - a)$, which is the polar equation of the tangent to the circle at the point $(c, a)$.—EAST ANGLIAN.

[56849.]— **Sewing-Machine Motor.** — Your batteries get polarised; they require a little modification. Instead of putting both plates in one cell with the acid, use a porous cell with dilute sulphuric acid in which to place the zinc, and in the outer cell place the carbons in the bichromate solution. You will find this last longer than the ordinary bichromate cell.— Os.

[56849.]—**Sewing-Machine Motor.**—The fault is in the battery, not the motor. The reason is that the plates polarise, and thus reduce the current to a mere nothing, so that the motor perforce slows and ultimately stops. Remedy: Use a constant form of battery. A Bunsen or Grove cell would work it all right.—INVICTA.

[56850.]—**Dynamo.**—To MR. BOTTONE.—Wire on armature rather fine for machine of such size. Of course it will work, if the F.M.'s be wound to approximately balance the resistance of armature when running, which will be about 1·25 ohm. Wind the fields with sufficient No. 14 to rather more than balance this—say, about 18lb. You may expect to find the machine heat considerably if run for any length of time at full speed. Wound as it is, it will light either arc or incandescent, the former perhaps the better of the two. — S. BOTTONE.

[56852.] — **Quart Size Bunsen Cells.**—To "SIGMA"—These questions, relating to special applications in which I have had little personal experience, would be better answered by those who are used to the particular application of the general principles. But the elements of the questions are not so given as to enable me to apply the general laws with which I am familiar. "Arc lamp" is a rather vague definition, as much would depend on the lamp available and the light required. Especially must the size of carbon be controlled by those considerations, and, as I have never had anything to do with the working of them, I should not like to give specific instructions on such details as the best size of carbon. In like manner the resistance of the 20 candle-power incandescent lamp is an essential element of the calculation, as each maker requires a particular E.M.F. and current. In fact, such a set of questions involves a considerable range of the subject of practical electric lighting.—SIGMA.

[56854.]—**Valves in Compound Engines.**—The valves of a compound engine are just the same as those of a simple engine. The cranks are set at right angles. The high-pressure cylinder on the leading cranks, and the exhaust of the h.p. connected to the steam side of the l.p. valve.—REGULATOR.

[56854.]—**Valves in Compound Condensing Engines.**—The valves in a compound engine are very much the same as are used in other engines—there is usually nothing special about them. The high-pressure cylinder is usually fitted with a cut-off valve on the back of the main slide, whilst the low-pressure valve is most usually an ordinary double-ported valve, just as would be used in any other large engine. In marine engines, when vertical, the weight of the slides and links are usually balanced in part by a balance-piston, the steam being, of course, admitted to the underside. These are also of proportionate area to the pressure in the respective valve-chests. The valves of the compound engine are now very much as in the earlier days of steam when used with large engines. If what I have stated does not make it clear to you, I will (supposing no other competent person does so), send a tracing of the valves of the engines of some well-known modern vessel as an example.—INVICTA.

[56855.]—**Inorganic Chemistry.** — Miller's "Elements of Chemistry," Part II. (Inorganic), Thorpe's "Inorganic Chemistry," Odling's "Outlines of Chemistry" (this is a capital book), Wurtz's "Atomic Theory, for Practical Analysis," Fresenius's "Qualitative and Quantitative Analysis." These are all good books, especially Odling's and Miller's.—R. A. R. BENNETT.

[56855.] — **Honours Examination in Chemistry.**—The querist should study the large work by Roscoe and Schorlemmer; also "Cooke's First Principles of Chemical Philosophy," giving special attention to the sums and questions in the latter. He should also read current chemical literature, so as to have some knowledge concerning recent researches.—WM. JOHN GREY, F.C.S. (1st class honours), Newcastle-upon-Tyne.

[56857.]—**Diminished Power of Engine.**—The reason is one of the simplest. It is because when the reversing lever is put in mid-gear or the central position, as our friend terms it, the slide-block being brought to the centre of the slot-link, and which necessarily is the centre of oscillation, receives no reciprocating motion, and hence, as the slide does not uncover the ports, no power is exerted on the piston. Owing to the movement due to the radius of the coupling links from the weigh bar some slight motion is given, generally sufficient to give a trifling admission of steam. Putting the reversing lever in mid-gear is in one sense somewhat similar to nearly closing the starting valve. But in the one case the steam is wiredrawn at the regulator, whilst the action of the slot-links wiredraw the steam at the slide-valves. If I have not made myself clear, shall be happy to further explain. —INVICTA.

[56858.] — **Horse-Power of Engine.** — The querist asks to be told the horse-power of an engine, but as he is entirely silent as to the bore of cylinder, length of stroke, revolutions per minute, ratio of expansion, &c., it would be only possible to give a theoretical reply; therefore, I cannot see my way to tell him the horse-power of an engine that he gives no data concerning. In fact, the query is not in a practical form such as his namesake would have put it. The theoretical horse-power of 100 cubic feet of steam per minute at 50lb. pressure is only one element in the calculation.—INVICTA.

[56858.] — **Horse-Power of Engine.**—Suppose the cylinder holds 100 cubic feet steam, then its length, multiplied by the area of the piston, = 100 cubic feet. Now the area of the piston multiplied by 144 (to bring to square inches), multiply by the length, by 50lb. = 500 × 144 × 50 = the number of foot-lbs. Now—

500 × 144 × 50 = 720,000 = 720,000ft.-lbs. per min.
But— 1h.p. = 33,000ft.-lbs. per min.

$$\therefore \frac{720{\cdot}000}{33\,000} = 21{\cdot}\dot{8}\dot{1}\text{ h.p.}$$

If the cylinder does not hold the 100 cubic feet of steam, but a less number of cubic feet, then 1 stroke will take less time than before. So the answer would have to be multiplied by 1 minute, and divided by the time of 1 stroke, which would come to the above answer.—H. F. L. K.

[56859.]—**Vertical Galvanometer.** — Some people seem to think that whatever appears in print must *ipse facto* be right. Now this is very far from correct; an instrument which is made to be used in a vertical position ought to be so used. It is evident from the query, that when the instrument is placed on its back, the needle falls out of place, probably touching the dial, or the inner needle touching the coil or some other point; the reason "its movements when horizontal are so uncertain," is because the whole thing is out of place (like a clock upside-down), and the best way to remedy same is to restore the instrument to its correct position and use it in the manner for which it was specially constructed. —Os.

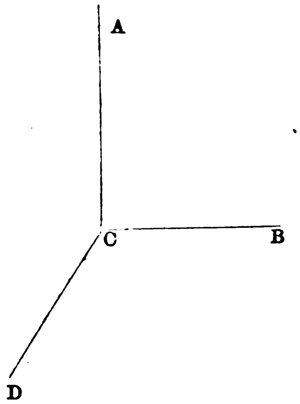
[56859.]—**Vertical Galvanometer.**—Placing a vertical detector on its back or at an angle increases its sensitiveness as a detector of current, but reduces its use as a measure and makes it nearly useless for detecting a lessened current, as the querist finds. In the vertical galvanometer the resistance to motion is that of gravity, the greater weight of the lower part of the needles; when laid on the back this is reduced to a minimum, and so there is nothing to bring the indicator back, while there is also little but friction to resist the pull of the current. In fact, when nearly horizontal the character of the instrument is entirely changed; if the two needles are nearly equal in power the system becomes "astatic," and can only be pulled across the wires by any current. If one needle is stronger magnetically the system obeys the earth's magnetism, like a single-needle common galvanometer, but under a lessened magnetic force to bring it to zero, and an increased electric influence tending to deflect.—SIGMA.

[56860.] — **L. and N.W.R. Compounds.**—There is no coupling on these engines; but they are fitted with extra large receivers, and blow-off valves in case of slipping.—REGULATOR.

[56860.]—**L. and N.W. Compound Locos.**—The engine you mention has no coupling rods, the absence of them being one of the points gained. But the two outside high-pressure cylinders being set at right angles, the engines of this class start freely enough. I have both seen the one you name, and also have frequently ridden behind similar ones working in this district. And the engines appear in every way most satisfactory.—INVICTA.

[56860.]—**L. and N.W.R. Compound Locos.** Although not connected with the L. and N.W.R., having seen several of the compound engines on that line, and also the "Marchioness of Stafford" at the Inventions Exhibition, perhaps I may be permitted to reply to "Crumby's" query respecting these engines. There is no coupling rod or other device to keep the low-pressure and two high-pressure cranks in any relative position. As "Crumby" may possibly know, the two high-pressure cylinders drive the trailing pair of wheels, and form one independent engine, and the low-pressure cylinder drives the centre pair of wheels, forming really a second engine, and each of these being able to run at what speed it can. Should the double cylinder or high-pressure engine slip, as this supplies the low-pressure single cylinder, more steam is sent into the eduction pipe (which acts as a receiver) than the large cylinder will take. The back pressure is increased, and helps to check the slipping, and the extra pressure on the low-pressure cylinder induces the centre wheels to slip also. If the low-pressure or single engine slips, it takes more steam than is supplied from the double engine; its own pressure, of course, drops, and the slipping ceases. In practice, each engine is found to control the other effectually, thus equalising the work of the two somewhat. I have myself noticed the effect before stated, when seeing a compound start with the Irish mail on a wet night, with slippery rails, the pressure on the single cylinder quickly reducing the slip of the other engine or h.p. cylinders, and aiding in getting the loco. itself off. I hope this explanation may give what "Crumby" wants to know.—W. H. THURLOW.

[56860.]—**L. and N. W. Compound Locos.**—The only connection between the high and low-pressure cylinders of the Marchioness of Stafford (and the same is the case with the other compound engines on this line) is in the rail, apart from the fact that the low-pressure engine receives its steam from the high-pressure exhaust. I should not think that the low-pressure crank is, as "Crumby" says, "at right angles to one high-pressure crank and opposite the other," for then there would be two dead points, should the engine stop with the opposite cranks on the centre—i.e., at the commencement or end of the stroke. The high-pressure crank being at right angles, is not the low-pressure crank midway between the remaining part of 360°? Thus: A C and C B being the rectangular position



of the high-pressure cranks, would not the position of the low-pressure crank be at D C, at an angle of 135° from either A C or C B? I am, of course, open to correction.—J. KEAN.

[56861.]—**Eccentric on Shaft.**—Will "S.L.N." advertise his address? I will communicate with him on the subject.—REGULATOR.

[56867.]—**Gas-Engines.**—I should much prefer that some one better acquainted with gas-engines than I am should answer W. Bundy's queries; but he is nevertheless welcome to my opinions, if he will take them for what they are worth. In regard to the 1st: The suction of the piston would be sufficient to charge the cylinder with gas; but it should be compressed afterwards. By exercising pressure a larger dilution of air can be employed, at the same time that the violence of the explosion arising from a less unequal mixture of gas and air is diminished. 2nd. An electric spark would ignite the gas, and numerous engines have been constructed in which the means of ignition was furnished by a battery; but a gas jet is cheaper and as effective. 3rd. Air is too bad a conductor for heat to be suitable for jacketing. 4th. The temperature would vary with the relative proportions of the charge; but it is often as high as 2,000° F. 5th. The mixture suggested would, I imagine, be useless.

Paraffin vapour and coal gas need air in order to explode, and the steam could not furnish the necessary oxygen, except at the temperature of dissociation, somewhere about 1,500° C. I, therefore, fail to see the reason of the suggestion. 6th. Yes; in so far as the pressure is greater.—J. H.

[56867.]—**Gas-Engines.**—To "J. H." AND OTHERS.—Yes; the charge is drawn in by the suction or partial vacuum due to the outstroke of the piston, in the Otto engine, for instance. And to your next, an electric spark has been used in the case of the Lenoir gas-engines; but it was not so satisfactory as the plan subsequently used—viz, that of a gas jet. Cooling the cylinder by means of air-current has already been tried and patented. The first form of the Bischopp engine had a somewhat similar plan of cooling by air. On the question of, say, three explosions on the one outstroke, I cannot see how it could be done, so can't give an opinion. What the temperature would rise to if the water supply was stopped I also can't say; but before it rose very high the engine would stop of itself. Paraffin oil would, no doubt, be nearly or quite vapourised. I may say I have seen paraffin oil decompose into a pungent smoke under such conditions by accident. The mixture you name of paraffin vapour, coal-gas, and steam would not explode; the two first would; whilst the steam could be admitted immediately after the explosion. But this has also been done. Coal-gas when heated with the air in a state of compression is advantageous; but this has long been done also. Heating the air also has been done successfully: when it is heated it assimilates better with the gas. —INVICTA.

[56868.]—**To Chemists and Metallurgists.**—The following method devised by Abel is given by Miller:—30 to 40 grammes of the metal are digested for three or four hours in the cold, with a smaller amount of a neutral solution of $AgNO_3$ than is necessary for dissolving the whole of the Cu. When the Ag is all precipitated, the residual copper is picked out, washed into the solution, dried, and weighed; the difference between this weight and that of the original mass giving that which has gone into solution. Now, if all the metal used was free of copper, the sole products of the reaction would be Ag and $Cu(NO_3)_2$; but if $Cu_2O$ was present, an insoluble basic nitrate would also have been formed, thus—

$$Cu_2O + 2AgNO_3 = Ag_2 + Cu(NO_3)_2CuO.$$

If, then, the mixed Ag and basic nitrate, left by decantation, be digested (with agitation) with a known volume of standard diluted $H_2SO_4$, a certain amount of the acid will be neutralised by the latter, and the amount left can be found by titration with standard alkali. By remembering that for every 98 parts of $H_2SO_4$ neutralised by the basic nitrate there were 143 parts of $Cu_2O$ (in the metal tested), the amount of the latter and its percentage can be calculated. As to the latter part of the query, I cannot speak positively, but should think it difficult, if not impossible, to get rid of As, Eb, &c., from such a large excessive metallic Cu by any ignition, however vigorous.—B. B.

[56869.]—**Grey Acetate of Lime.**—It is impossible to say what quantity of acetate of lime could be made from one ton of wood. The reason is, that if the wood be small, or very green, or slightly decayed, the quantity of acid would be very small compared with that obtained from a ton of large wood well seasoned. The subjoined is a tabular view of the amount and strength of the products obtained from the distillation of several varieties of wood, from which Marshall Reid can make his own calculations. I may say that the manufacture of acetate of lime in this country is almost a thing of the past, since American lime salts can be bought so cheap, and most of the works that did not make acetate of soda or acetic acid have had to close—that is, in South Wales:—

| Three hundred and thirty-six pounds of wood | Charcoal. | Charcoal per cwt. of wood. | Acid liquor. | S.p. gravity of acid liquor. | 1oz. neutralised grs. of bicarbonate potassa. | Dry acetate of lime produced. |
|---|---|---|---|---|---|---|
| Birch.......... | 84 | 28·00 | 180 | 1·029 | 9½ | 25 |
| Walnut ...... | 72 | 24·00 | 150 | 1·018 | 7 | 14½ |
| Birch, cut three years........ | 70 | 23·33 | 120 | 1·031 | 11 | 13 |
| Oak .......... | 91 | 30 33 | 190 | 1·022 | 8 | 24 |
| Ash .......... | 90 | 30·00 | 190 | 1·024 | 8 | 22 |
| Apple ........ | 70 | 23·33 | 200 | 1·017 | 6 | 18 |
| Wych elm .... | 70 | 23·33 | 180 | 1·018 | 8 | 16 |
| Maple ........ | 77 | 25 66 | 145 | 1 018 | 6 | 20 |

—CHEMICAL WORKS. —(Muspratt.)

[56871.]—**Whitewash.**—To make one that will not rub off, and will stand the weather, take freshly-burnt lime (Irish lime is very good) and soak for a night in as much water as will cover it. Then add buttermilk until it is the consistency of whitewash. Apply in the usual way.—B.Sc., Plymouth.

[56872.]—**Coil.**—The failure of this coil may arise from such causes as defective insulation, careless winding, or an unsuitable size of secondary. The secondary wire, in this case, seems to me to be too thick; the usual size being between Nos. 33 and 40, and always recommended to be silk-covered. The Daniell cell is also unsuitable. Try a bichromate.—BOBADIL.

[56872.]—**Coil.**—Your friend will require quite four times the amount of battery power he is now using for his coil, and he should use some double-fluid bichromate cells instead of the Daniells, as the former give a much higher E.M.F. It would have been better if he had not used so much insulation between the layers of his coil. Better try five or six double-fluid bichromate cells.—C. O. S.

[56872.]—**Coil.**— This correspondent does not state size of coil, or could advise better. Have made several powerful coils to work with two No. 2 Leclanché cells, as follows: Coil cheeks, 1½in. diam.; between cheeks, 3½in.; the usual bunch of iron wires for core, with brass tube for regulating strength of shock. Primary, four layers No. 18 silk-covered wire. Secondary, about 16 layers No. 38 silk-covered. It is not absolutely necessary to insulate each layer with paper. If whole be thoroughly soaked in paraffin wax, I should advise insulating primary from secondary with one layer of paper. The above gives powerful shock, with low battery power.—F. T. W. B.

[56872.]—**Coil.**—"Cymro" and his friend should read up some of the back numbers of "Ours" on intensity coils, and then try again; the present coil will be of no use. No. 28 c.c. is quite unsuitable for secondary; No. 36 s.c. should be substituted. Daniell's cells are not the batteries for coils; bichromates, Bunsens, or Groves are the proper ones to use on account of their vastly superior E. M. F. Nothing is said about a condenser, without which the spark will be a small one, and I expect the blotting-paper insulation is too clumsy between the secondary layers. The secondary also may not be properly insulated from the primary by a tube.—B. H.

[56872.]—**Coil.**—"Cymbro's" complaint as to his friend's coil leaves very little room for suggestions. The coil seems to have been built properly, and the battery power to be sufficient. All that I can say is, Be sure that the junctions of the wires with binding screws, &c., are clean, well made; if they are so, then I am afraid that at some spot or other in the secondary wire there is a break, occasioned in winding, and this may happen even with the greatest care. Is "Cymbro" able to tell us any more about the coil? Then perhaps I may be able to help him. He makes no mention of a piece of soft iron within the coil. I should suppose that he has it, as I don't know whether he works the contact breaker from a separate smaller magnet.—J. KEAN, Northampton.

[56874.]—**Estimation of Magnesia.**—This substance is usually precipitated as ammonium magnesium phosphate, and subsequently ignited, which converts the double salt into magnesium pyrophosphate, thus—

$$\begin{array}{ccccccc} 2AmMgPO_4 & = & Mg_2P_2O_7 & + & H_2O & + & 2NH_3. \\ 274 & & 222 & & 18 & & 34 \end{array}$$

The residue, after ignition, contains 36·036 per cent. of MgO.—WM. JOHN GREY, F.C.S., Analytical Chemist, Newcastle-upon-Tyne.

[56875.]—**Thymol.**—This aromatic alcohol is stated not to separate from its solution in alcohol on addition of water; but there are two varieties of thymol, both being methyl-propyl-phenol, one probably containing normal and the other isopropyl; and it is quite possible that one of them separates, although the other does not. Try warm water instead of cold, and add the water slowly to the alcoholic solution. Which variety of thymol are you using?—WM. JOHN GREY, F.C.S., Analytical Chemist, Newcastle-upon-Tyne.

[56876.]—**Reflectors.**—An astronomical friend some time since was asking my advice on the question of a tube for a 9in. reflector. As he desired to make it himself, I sketched him out an easy plan. The tube is made of wood in straight staves jointed up like a barrel. To hold it together stout brass bands with screw eyes for tightening up are used, whilst to stiffen it, three wrought-iron rings are placed inside and let in flush with the inner surface of the tube. Arrangements for ventilation were not made in the tube, but the mode of construction renders such very easy if thought desirable. The outside being polished and the brass bands got up bright and lacquered, the tube looks as well as it is useful. In my opinion it is superior to a riveted-up iron tube, besides looking better and being easily made by anyone who can use carpenters' tools.—INVICTA.

[56877.]—**Coil Winder.**—An automatic coil winder has been figured in these pages—I cannot say exactly how long since; it might be a couple of years.—Os.

[56878.]—**Mineral Water.**—I have no special knowledge as to the manufacture of mineral waters, but I am of opinion that it would not be possible to use acetic acid instead of citric acid.—WM. JOHN GREY, F.C.S., Analytical Chemist, Newcastle-upon-Tyne.

[56878.]—**Mineral Water.**—Most probably the citric acid is used for making lemonade, and it is the only acid suitable for the purpose, as it happens to be extracted from lemons and other similar fruit. Acetic acid is the acid which is contained in vinegar, so that if your customers like vinegar and water in place of lemonade, by all means use it. I may as well also mention, for the benefit of those whom it may concern, that lemonade, gingerbeer, and such like drinks are not mineral waters, as there is nothing mineral about them; the proper term for these effervescing liquors is aërated waters. —Os.

[56880.]—**Pyroligneous Acid.**—The most useful size of cylinder is 6ft. by 4ft. in diam., thickness of metal ⅛in. The doors: some are hinged, some the same as gas-retort doors, only no screw but wedges between the cross-bar and door: the doors are luted. Lute composed of sand, clay, lime, mixed with water and a little pyroligneous acid. But I would rather use ovens than cylinders. I find them more useful for mixed wood. Our ovens are 6ft. by 6ft. by 4ft. 6in., made of ½in. boiler plates. Each oven has two boxes, the one in at work, the other being filled ready for changing (each day). The condensers are made of copper, from three to four pounds per super. foot of the sheet; and ours vary from 12in. to 9in. in diameter. But I find 10in. diameter and 35ft. long (all condensers going into one lump and one return waste condenser the same length), the best working arrangement of condensers. About the stills I cannot say anything, not knowing the quantity of wood or the number of cylinders or ovens in use, or to be used. I shall be happy to give "Chemist" any further information, if required, in naphtha, acetate of lime, acetate of soda, or acetic acid (pure acetic acid).—CHEMICAL WORKS.

## UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

Since our last, "Glatton" has replied to 56031, 56039, 56068, 56090, 56141, 56154, 56188; "Invicta," 56540.

56359. Coiling Thin Metal Stripe, p. 156.
56361. Chemical Nature of Hemp, 156.
56366. Screwing Machine, 156.
56373. Cane Window Screens, 156.
56376. L.C. and D.R. Locos., 156.
56381. Legal, 156.
56382. The Solar Eclipse in September, 156.
56384. G.W.R. Speed, 156.
56385. Victoria Dynamo, 156.
56395. Microscopical Staining, 157.
56396. Carbon in Cast Iron, 157.
56405. Erecting Machinery, 157.
56406. Olive Oil for Calico Prints, 157.

56581. Warming Room, p. 243.
56588. Generator Gas Explosive Force, 243.
56591. Lee Boards to Boats, 243.
56594. Limelight, 243.
56595. Spectroscope, 243.
56600. Focal Distances of Images, 343.
56602. Cassegrain Telescope, 243.
56603. Spinning Wheel Loom, 243.
56606. Ink for Rubber Stamps, 244.
56608. Legal, 244.
56612. Copper Band, 244.
56621. Electric Light for the Optical Lantern, 244.
56623. Polishing Steel, 244.
56626. Fermentation in Horehound and Hop Beers, 244.
56627. Thoma Microtome, 244.
56629. Hydraulic Ram, 244.
56630. Brake Failures, 244.
56631. Photographic, 244.
56632. Water Line, 244.
56635. Clamp Burning, 244.

DR. W. COHN recently gave some figures which he obtained from a works in upper Silesia, where thirty coke ovens have been altered for the condensation of by-products. At those works 100 kilogrammes of coal yield 3 per cent. of tar, and 1 per cent. of ammonium sulphate. The thirty ovens coke daily 50,000 kilogrammes of coal. The price on the spot for tar is 4½ marks (1 mark equal 1 shilling) per 100 kilogrammes, and for ammonium sulphate 25 marks per 100 kilogrammes. It has been found that the treatment of the ammonia water costs for fuel, labour, &c., 9 marks per 100 kilogrammes of ammonium sulphate produced, so that the selling price being 25 marks, the profit is 16 marks per 100 kilogrammes.

# QUERIES.

[56881.]—**Observatory Dome.**—I should be obliged if "Invicta" would give me a few hints as to the construction of a light, revolving dome, 8ft. diameter, for a small observatory? I thought of a framework of angle iron, covered with sheet zinc, but am in a fix about it. —W. T. C.

[56882.]—**Catalogue for Lending Library.**—I should be obliged to anyone for telling me how to arrange a catalogue for a lending library, how to class the books, and which class to put first, or any information relating to the above subject?—LIBRARIAN.

[56883.]—**Portrait Photography.**—Will someone kindly help me in this difficulty? A few weeks ago I could get good negatives, now I am unable to do so, though I still keep to the same plates, viz., Fry's, and their sodic sulphite developer, which they supply. My apparatus is a ¼ Le Merveilleux. My plates require extraordinarily quick exposures to what they did; one second being too much in dull weather with ordinary plates. I find this difficult with a drop shutter; but when exposure appears correct they do not develop with sufficient density, and require no time in the fixing solution. How do plates perform that are fogged by damp or light? I now fail to get the white appearance at the back after development.—SEE BEE.

[56884.]—**Gramme Dynamo.**—Will Mr. Bottone kindly state the length required, and diameter in round section for the four field magnets of a Gramme dynamo having a Pacinotti ring 6in. in outside diameter, and 4in. long? Also required the depth of channels in ring, and substance of the ring body? This information will oblige—LITTLE DORRIT.

[56885.]—**Potato Cleaning.**—Will "Invicta," or any other reader tell me how I could make a machine to clean pototoes for the table—40 or 50lb. at one operation, or tell me if there is such a machine in use anywhere?—SUBSCRIBER.

[56886.]—**Model Boiler.**—Will someone kindly describe the best form of lamp to heat a vertical boiler of the following dimensions, by means of methylated spirit? Boiler, 8in. by 5in., with internal firebox 4in. wide by 3in. high, centre flue 1¾in. diameter. Spirit burnt in an open vessel in firebox raises steam quickly, but makes an awful smell. Gas is not available, and a fire is objectionable indoors. The boiler is made of copper, 18 B.W.G. throughout, all joints well riveted and soldered. Will 30lb. be a safe working pressure? I intend making the engine with cylinder ¾ bore and 1½ stroke. Have I heating surface enough for a cylinder 1in. bore?—F. C. P.

[56887.]—**Drying under Pressure.**—I have a substance to deal with that is capable of being dried very hard at 60deg. or 70deg. Fahr., but if this is exceeded it all cracks. This being very slow, I wish some of your readers could give me a plan whereby I could try drying it on a small scale under pressure; or any suggestion will be thankfully received.—SOUTER.

[56888.]—**Bicycle Turning.**—In turning in a circle, with the handle-bar of my bicycle turned round as far as it will lock, I find that both wheels make true circles to one centre. How can this be accounted for, with regard to the small wheel, which is kept rigidly by the backbone and its own forks, in a plane always at an angle with the driving wheel?—J. R. T.

[56889.]—**Protosulphide of Iron.**—Can any of your readers give me a good method for making protosulphide of iron (FeS) on the large scale, say one or two cwts. at a time?—C. D.

[56890.]—**Filtering.**—I want to filter considerable quantities of liquor, to hasten which I wish to produce a vacuum beneath the filtering medium. I know, of course, that this can be done by means of a suitable pump, but wish it possible to do it more cheaply by means of one of the well-known vacuum jets. Any reader who has worked with these would oblige me by giving a hint or two as to his experience with them.—C. D.

[56891.]—**Shocking Coil.**—I have finished making a shocking coil. I have two rows of primary, No. 18 c.c. and 12 rows of secondary. It is insulated with paraffin waxed paper, on an electro-magnet contract breaker, fixed to the base, and I cannot get any shock from it when I fix a pint Bunsen battery to it. Should I have another battery? Will any brother reader oblige by putting me right?—I. O. G. T.

[56892.]—**Tricycle Chain.**—The chain of my tricycle makes a loud, rattling noise when I am riding on rough roads. Will some reader tell me the cause, and how to correct it?—C. A. W.

[56893.]—**Astro.**—I am much obliged to "Fellow of the Royal Astronomical Society," and Mr. Saddler, for their answers to my query about Stellar Parallaxes, Binary Stars, place of Spica, &c. Would either of these gentlemen kindly inform me whether the star 61 Cygni is not a binary, as it is not in their lists, and also as to the smallest star visible in the daytime, with telescopes of various sizes? I have a 4¼in. refractor, and should be glad to know how faint stars I could see with that? What is the period of the shortest known double star?—M. ARKWRIGHT.

[56894.]—**Oils.**—Can any correspondent enlighten me on the best and cheapest method of thoroughly purifying and clarifying lubricating oils (mineral and vegetable) and grease mixed together, which have become thick, black, and dirty by use?—ONE IN A FIX.

[56895.]—**Cutting Wards of Keys.**—How is the above done in the shops? I cannot find any information in back numbers. I have occasionally to cut wards in field padlock keys, and find the ordinary way with a flat file, very tedious and troublesome. Could they be cut quickly on lathe, with circular saw, or small emery wheel? Directions would much oblige.—AGRICULTOR.

[56896.]—**Loco. Slide Valves.**—Will someone kindly tell me some methods of setting valves?—also of finding the lead? Also, if possible, inform me how to read and understand indicator diagrams?—A. M. P.

[56897.]—**Organic Chemistry Examination.**—Will any of our readers who sat for the examination in Practical Organic Chemistry, advanced stage, at South Kensington, kindly inform me what constituents were found in the substance given for analysis?—W. O. T.

[56898.]—**Naphtha.**—Can any reader inform me what causes the smell I sometimes perceive from some naphtha works about a mile away? Whether it is due to the escape of any gas, and if so, what gas? I should like to know of any books treating on the manufacture of naphtha.—F. S Sc.

[56899.]—**Boiler.**—To "INVICTA."—I have an egg-shaped boiler shell, 32in. long, 13in. diameter, 3-16in. plate, the end plates welded. Will you kindly inform me if the above can be made suitable to drive an engine 2½in. diameter, 5in. stroke, also the best way to supply the boiler with water?—C. J. F.

[56900.]—**Locomotive.**—To MR. STRETTON.—I was having an argument with a friend the other night, concerning the cost of a locomotive railway engine, who informed me that the average cost of same amounted to from £2,500 to £3,000. Is this correct?—if not, will you kindly let me know the average cost of an ordinary engine?—W. E. S.

[56901.]—**Irish Degrees.**—Can any of our readers inform me what colleges or universities in Ireland grant the degrees of LL.B. or LL.D., and if they require candidates for the same to attend lectures or classes there, before offering themselves for examination?—STUDENT.

[56902.]—**Electric Lighting on Trains.**—Last autumn some suburban trains on the G E.R. were lighted by electricity. A Tower high-speed spherical engine, coupled to a dynamo, were placed in a box on the top of the locomotive boiler barrel, and supplied the power direct, without any secondary battery, to the incandescent lamps in the carriages. When at Liverpool-street terminus a few weeks ago, I did not notice any train so fitted. Can anyone kindly say if this system is still in use on the G.E.R., or elsewhere? Perhaps it is only discontinued during the summer, or if given up entirely, is it because the light going out when the locomotive is disconnected from the train was considered a fatal objection to its general adoption. Any information respecting this will oblige.—W. H. THURLOW.

[56903.]—**Steam.**—Will some reader of the "E.M.", give me an answer to the following questions, asked at an examination on steam? Explain the difference between a non-condensing engine and a condensing engine? Show, by a diagram, that more work is obtained from a given quantity of steam in the latter class of engines. 2. Steam is admitted into a cylinder, 32in. long, at 40lb. pressure above that of the atmosphere (viz., 15lb. on the square inch) and is cut off at 1-5th of the stroke. The area of the piston being three square feet. Find the work done in one stroke, by dividing the stroke into five equal parts, and considering the pressure in each of the latter four parts to be the mean of the pressure at the beginning and end of same?—GOODEVE.

[56904.]—**Problem in Algebra.**—Can any of our mathematical correspondents help me with the following problem?—Prove that the coefficient of the middle term of

$$(x + a)^{4n} = 2^{2n}\frac{1.3.5\,7\ \ldots\ldots\ (4n-1)}{1.2.3\ldots\ldots\ldots\ 2n}$$

The denominator comes out all right, but I cannot get the numerator. If someone would help me with it, I shall be much oblig-d.—BUNSEN.

[56905.]—**Mal de Mer.**—Can any reader speak from personal experience, or by referring to the *British Medical Journal*, of Oct. 24th, 1881, p. 730 (which I cannot obtain) as to the efficacy of the alkaline bromides, in preventing seasickness? The passage referred to, I believe, recommends 60gr doses for two or three days before sailing; the ordinary dose is 2gr. to 6gr. I should be glad to hear of any medicine or treatment which has been found useful.—MON.

[56906.]—**Deed of Gift.**—Would Mr. Wetherfield please say if a deed of gift requires a stamp?—if so, of what value? Also, would he give a general idea of the wording to be legal?—X X. X.

[56907.]—**Electro Magnetism.**—I see by various scientific books, that an electro-magnet can easily be constructed to lift (and therefore I presume to move, if necessary) from one to two tons. Can any of your readers inform me whether there is any cheap way of keeping up the supply of electricity required, and what would be the best way of doing it, as this part appears to me to be a very expensive item?—ROMEO.

[56908.]—**Caloric Engine.**—I am having a Caloric engine constructed, and am now in a difficulty. I find the heat shrinks up the packing (asbestos) and causes leakage, and consequently loss of power. The loss of power also sustained by the engine is very great in working the pump, which has to keep up the supply of air. How are these difficulties to be overcome, and what packing should be used? Perhaps "Invicta," who, I know, is always ready to succour the distressed, or some other kind friend, may help me to solve this problem.—ROMEO.

[56909.]—**To Mr. Bottone.**—I am making a dynamo on the Gramme principle, with eight malleable round field-magnets, four at the top and four at the bottom; they have flanges ¼in. thick at each end (like cotton reels in appearance) the body of these F.M.'s is 1⅜in. diameter; length, including flange ends is 4½in. I intend to bolt pole pieces to these eight cores, so as to form one electro-magnet system. Before making the pole pieces, I should like to ask Mr. Bottone what would be the most suitable size of armature for this arrangement. I should mention that the fields are arranged in circular form, so as to give an even magnetism to the pole pieces; they will be wound in series form; the four top ones alike, the four lower ones also alike, only in different direction to the upper bars. If Mr. B. recommends a ring with cogs, will he kindly indicate the depth they should be, and the substance of the ring body in malleable iron.—SUBSCRIBER FROM No. 1.

[56910.]—**Flame.**—I have understood that the luminosity of a flame is caused by the incandescence of particles of carbon, which the combustive material contains, which I do not in the least doubt; but what becomes of the said carbon in an atmospheric gas burner, is it consumed?—The colour of the flame is that of pure hydrogen, the result is $CO_2$ not $OH_2$, I suppose.—AYLWARD.

[56911.]—**Writing on Glass.**—Can any obliging reader give a recipe for an ink suitable for writing fluently on glass, or else for writing on paper, to be transferred on glass?—CH. R.

[56912.]—**Jablochkoff's Battery.**—Will anyone kindly give me instructions for making the above? It was described in the "E.M." of the 5th inst.? Is it patented? How many cells required for a 2½-c.p. lamp?—J. H. G.

[56913.]—**Weatherproof Paint for White Marble Gravestones.**—Will some of your readers kindly inform me of the best mixture, and the best method of applying a paint to engraved letters on a white marble gravestone, that will withstand the weather for several years? The paint that has been used up to the present time is constantly washing off, and wants renewing every few months, if we wish it to look respectable. A few hints on the above would be gladly accepted.—E. HOLT.

[56914.]—**Socket Joint Making.**—Can anyone tell me how to make a cement that will make faulty socket-joints good and perfectly tight in hot-water apparatus, and how much of the old borings require to be got out, and how to apply the cement? I may add that the joints have been made and caulked with iron borings, and some leak very much, and as they are fixed they cannot now be got at to caulk, and those faulty joints are on the ground floor of a three-story building. So that the weight of the water above is upon them? Shall be glad of a sure cure.—ANXIOUS.

[56915.]—**Gas-Engines.**—To "J. K. P."—If it is not asking too much of you, and you are not taking out provisional protection for your new gas-engine, would you please send drawing and particulars to the "E.M.," as it is hardly possible for me to see your gas-engine, because I live in the country, and there are other circumstances which prevent me from seeing it.—THEO.

[56916.]—**Telescope Eye-tube.**—Will some correspondent kindly give me a description, with sizes and sketch, if possible, of eye-tube, suitable for a 6½in. reflecting telescope, with rack and pinion movements? Also the number of threads to the inch used for fitting eyepiece to eye-tube?—G. R.

[56917.]—**Plaster Ceiling Centres.**—I should much like to ask readers of your valuable paper, if those plaster ceiling ornaments, which are to be seen in some houses, are made out of moulds or stamped out by dies, and to obtain some explanation of how it is done? Does hair, straw, wool, &c., enter into the composition of the liquid plaster? An address or two of the best plaster of paris ornament makers would also be welcome.—THO. DULLYMAN, Maindee.

[56918.]—**Gas Engine.**—I should be obliged if "Invicta," or any other competent person, will state the proper diameter of bore of cylinder, and length of stroke of a two-man nominal power, simple non-compression gas-engine, also the best size and weight of flywheel to suit it?—CHIP.

[56919.]—**Electrical Weather Vane.**—Will some correspondent kindly explain to me, through these pages (with illustrations) how I can connect a weathercock electrically? As the vane is in the garden, I wish to connect it with an indicator in the hall.—H. POLLITT.

[56920.]—**Locomotive.**—Will some kind friend please inform me how often a locomotive boiler should be washed out when in regular use, and how the boiler should be treated in every way, how often should they be new tubed, &c.? The above would greatly oblige.—S. S.

[56921.]—**Heat for Workshop.**—Would some reader kindly tell me how to construct a lamp for a workshop, to supply the place of an ordinary gas-jet? It is not possible for me to have gas. I have tried the spirit-lamp, but cannot obtain the necessary heat for hardening drills, tools, &c., and one cannot always have a fire alight, especially summer weather. Any information will be thankfully received.—P.

[56922.]—**Twine.**—What kind of machines are used for making fine twine, such as used by druggists, grocers, &c., and how is it polished?—who makes the machines, &c.?—TWINE.

[56923.]—**Bleaching Shellac.**—In No. 991 of the "E. M.," for March 21st, 1884, there is a process given for the above, before trying which, I should like to be enlightened upon the following points, viz.—(1) It says "the liquid is boiled for a few minutes, and, while hot, a wooden air-tight cover is cemented on the vessel." What cement is used for this purpose? (2) How am I to tell when I have added enough dilute sulphuric acid to decompose "the clear filtrate"? (3) What is "glycerol?" (4) And would it be necessary to pull it (the shellac), should I require it very white? I have plenty of the best button lac at hand, and would like to do my own bleaching, as I use about a half-cwt. a week. Perhaps some of "ours" will kindly give the information required, or give some other process which is simple, cheap, and reliable.—J. L.

[56924.]—**Logwood and Gall Liquors.**—What instrument can I use to test the strength of each of the above after boiling? What is the difference in the strength of, say, 1lb. logwood, and 1lb. logwood extract? What is the best antiseptic (odourless) to use for preventing ink from turning mouldy?—J. L.

[56925.]—**Draught in Chimney.**—I have heard that by hanging a chain with a knot tied at its lower end, or a rod with a ball at one end, down a chimney, it will materially improve the draught. I shall be much obliged if any of your readers can give me the following informative on the subject:—(1) Should the knot or weight be near the top or bottom of the chimney? (2) The relative size of knot or weight to the chimney? (3) Does it make any material difference in the draught? (4) What is the principle on which it acts? I have a chimney 60ft. high, by 2ft. 3in. diameter for a boiler, with grate area of 18 square feet, and the draught is so sluggish that I cannot burn more than 10cwt. of coal in nine hours. I thought once of forcing the fire with a fan draught; but if this chain or ball arrangement will do, it is much simpler.—W. HOSKEN.

[56926.]—**Leaky Tank.**—I have a large wooden tank in which I keep a strong solution of soda-ash (30's) for cloth scouring purposes. I find that the alkali is slowly attacking the wood and causing it to be leaky. Will any contributor kindly inform me as to how I can best prevent this?—R. H.

[56927.]—**Co-ordinate Geometry.**—Having some time ago commenced the study of this science, and made some advance in it, I obtained a more advanced book, which treated on another method—that of trilinear co-ordinates and abridged notation. This latter method seems to me much more complicated and difficult, and I would wish to be informed if it would be worth while to undertake the task of mastering it for any special advantages it possesses over the other method, particularly as it seems to me that it is the ordinary system of co-ordinates that is adapted to the calculus.—Alpha.

[56928.] — **Resilvering Mirrors.** — What is the simplest and best way to resilver the concave mirror of a microscope? I have seen elaborate directions for silvering specula and large mirrors. I hope somebody will give me the necessary directions, solutions, &c., for resilvering small mirrors. I have two which require to be done, each about 1½in. in diameter.—Pathologist.

[56929.]—**Cork - cutting Machine.**—Will some friend kindly inform me a little in making the above machine, to cut from ⅜ to about 3in.? I have made a frame of wood 3ft. 6in. long and 10in. broad, and the sides 4in. deep. Will you kindly say what size wheels to use for turning the chucks, and the best way to shift the knife to any size or taper?—X. Y. Z.

[56930.]—**Three Problems.**—Problem 1. In three events where the odds are three to one against the first, five to one against the second, and seven to one against the third: what are the odds of winning some two out of the three? Problem 2. In three events where the odds are three to one against the first, five to one against the second, and seven to one against the third: what are the odds about winning two in succession? Problem 3. An event has to be decided by the winning of two heats out of three; the odds against the first is three to one, against the second, five to one, and against the third, seven to one. What are the odds about winning some two out of the three? Will someone kindly say how to calculate the above and give a rule proving the correctness of same—and oblige?—Perplexed.

[56931.] — **Bearing Grease.** — Presuming that "Essar" will give me a recipe for making this article, I beg to thank him beforehand. I wish to make the grease for my own use, at a cost of twopence per pound, for hot necks.—Inquisitor.

[56932.]—**To "M. I. C. E."**—Given a sphere 12in. diameter; it is required to draw a diametral hole through it, of such a size as to reduce the contents of the sphere by one half. I make the diameter of the hole, an arithmetical mean between the side of the pentagon inscribed in a great circle of the sphere, and the arc of the circle, of which such side forms the chord, but this is apparently only a chance and merely approximate coincidence, and I am anxious to know if any precise formula can be given. Here is a pretty result which I have never seen in print. From the hemisphere G A H, cut the sector E A F C, consisting of segments of height A D and cone of height D C together: this sector cut out leaves the socket E G C F H. Then as sector to socket, so is A D to D C. I think "M. I. C. E." will be able to draw the figure from the description. C being centre of circle; G C H, a vertical diameter of the sphere, and E D F, the line parallel to it representing the base of the cone: A D C, at right angles to E F and G H, being the axis of cone.—A. S. L.

[56933.]—**Mechanical.**—(1) Can any of the readers of this valuable paper inform me how to produce those moonlight effects in panoramic scenery? I am at present painting some scenes, and want to break monotony of entertainment by showing a scene representing day and then changing it to night. Any information how to manage these moonlights, or churches and palaces lit up, is kindly solicited. (2) My intention is to have the scenes all on one roller, but instead of running them across as most panoramas, I wish to roll them up. Can anyone suggest a frame to carry same, one that will be substantial, yet one that can readily be put together? A large gilt frame will stand in front of scene, bottom of which will be 2ft. from floor; length of scenes 15ft., height of same about 9ft. I have "E. M.'s" from 1872, to which I can refer if there is anything; if not, any information will be acceptable.—J. P. H. B.

[56934.]—**File Cutting Machines.**—Can any reader of the "E. M." give any description about the cutting machines, or the numbers of the patents, if such have been patented, and dates?—File Machine.

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## ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

### HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

*** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, June 24th, and unacknowledged elsewhere :—

G. Birch and Co.—T. Barker and Co.—W. H. Tulloch.—W. Nolan.—J. A. Campbell.—Foster and Williams.—H. W. Williams and Co.—J. K. Smythies.—Optical.—J. T. Gent and Co.—J. Calvert and Co.—W. Bradbury.—W. T. Glover and Co.—R. W., Newcastle-on-Tyne.—Conductor.—Sceptic.—D. K. M.—Excelsior.—A. B. C.—P. W. Stanley.—Accumulator.—An Old Subscriber.—D. W.—B. J. Hopkins.—John White.—A. Lester.—Lynton.—H. H.—Charles North.—W. P.—D. Booth.—Lever.—J. E. Gore.—St. Pancras.—J. H. Bowman.—W. E. T.—A Fellow of the Royal Astronomical Society.—F. A. Robinson.

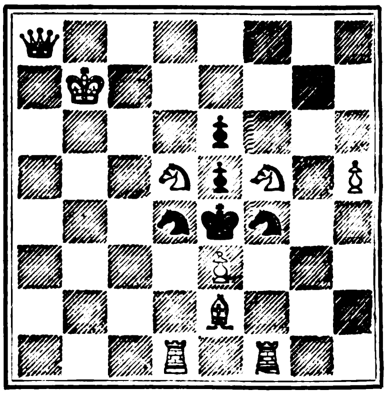
A Clerk. (If your physician can do nothing for you, how can you expect strangers to supply you with a remedy for your failing sight? You should consult an ophthalmologist.)—Creeping. (If your physician has advised you to try electricity, he will also tell you what appliances are required. You will find descriptions of such appliances in back numbers; but no one can recommend anything without knowing the nature of the "nervous trouble.")—Wildbank. (What difference can there be?)—Hugh. (It is constitutional. Any druggist will make you up a suitable astringent lotion, and for the rest you must do what is possible to improve the general tone of the system.)—R. E. N. C. (You do not seem to have read the letters on the subject. See p. 57.)—Edward Hawks. (How can readers criticise unless you supply a description of the new brake? That sent in is merely an indication of the principal features. Details are needed for any useful criticism.)—S. Barron. (Too late for last week. You must "relax" them by placing them on blotting paper laid over damp sand, or by attaching to pieces of cork and floating in a vessel of water covered with a damp towel. They must be afterwards treated with preservative solution and mounted in a proper manner. If you cannot see back volumes procure Dr. Knaggs's "Lepidopterist's Guide," J. Van Voorst.)—E. Williams. (If you mean preparations for freezing water, see the indices or answers to "An Inquirer," p. 312. The water or mixture to be frozen is put into a vessel of thin metal and surrounded by the refrigerating materials.)—L. B. (Procure the prospectuses of the Birkbeck Institute, Bream's-buildings, W.C.; the Working Man's College, Great Ormond-street, W.C.; and the Finsbury Technical College, Cowper-street, E.C. Laboratory practice is absolutely necessary, but it would be advisable to pass in the elementary stage before attempting the laboratory work, as it is only evenings that you have at liberty.)—Smasher. (We are afraid you must apply to the Master of the Mint for the list. Many of the coins made there are for colonies and dependencies.)—Lotus. (It is an hydrometer for taking the specific gravity of liquids; but of what pattern it is impossible to say from your description. They are called areometers, alcoholometers, densimeters, and various other names, according to the special purpose for which they are used. A dealer in such instruments would be able to give it a definite name on sight.)—Throat-hoarseness, &c. (No relief can be expected until a skilled diagnosis has been made. Probably considerable injury has been done by the vast quantity of medicines.)—A Subscriber to the "E. M." from Commencement of the Present June. (All particulars of the kind can be obtained on application to the Secretary of the Pharmaceutical Society, Bloomsbury-square, W.C.)—A. J. Hawkins. (You must, at least, give us some idea of how long ago.)—Asterisk. (If you procure the Rules, price 6d., you will have all the information you need. They are sold at the Sale Office of the Commissioners of Patents, Cursitor-street, W.C.)—W. L. B. (You can only blow them to pieces with gun-cotton, dynamite, or gunpowder. You will find a good deal of information on the subject in Vol. XXVIII., pp. 180, 229, 379, 476. See Hints No. 5.)—G. Andrews. (See indices. Do you mean a Fahrenheit thermometer, or a mercurial barometer, which has nothing to do with Fahrenheit. If the latter, you have merely to fill the tube with mercury, put your thumb on the top, and invert the end beneath mercury in a little cistern. Then remove your thumb, and the pressure of the atmosphere will support the mercury in the tube to a height of between 27 and 32in. Make a scale in inches and tenths, and fix it by comparing with a standard instrument. A tube 3ft. long is more than sufficient.)—Rover. (You are correct when you express the opinion that your idea will not work. Neither will the new one. See Dircks's "Perpetuum Mobile," or the back volumes.)—One who Would. (There has been a good deal about microscope construction in back volumes, but our columns are always open to those who will tell their fellow-readers how to make philosophical apparatus cheaply. If we may judge from the number of queries sent about it, many readers would like to know how to make a spectroscope for 5s., as mentioned recently at the Society of Arts. A query appeared on p. 243, but so far has not been answered.)—A Copper. (They are chosen from the ranks, except under very special circumstances. The pay is good.)—Alpha. (For tempering spiral springs see p. 519, No. 1,011, where you will find an illustration of the "cradle.")—Senex. (Surround the type with a frame higher than the surface of the letters. Fill up with melted wax to about a tenth of an inch from the top of the letters, and then pour the mixed plaster of Paris on. Level off when nearly dry.)—C. M. (Prof. E. C. Pickering, Harvard College Observatory, Cambridge, Mass. The other is professor at the U.S. Naval Observatory.)—T. R. (Ohm is the unit of resistance, volt the unit of electromotive force. See any textbook of the subject.)—J. R., Shoreditch. (See any of the indices, or recent back numbers.)—Evan, an L.M. (You can obtain all particulars on application to the captain of the Steam Reserve, at any of the Government Dockyards.)—Allegro. (See recent back numbers, and the last two volumes.)—A Constant Reader. (See the indices for a variety of methods of destroying blackbeetles. On p. 181, No. 1022, a correspondent said he had found red-lead and flour the best bait for cockroaches and crickets.)—A Five Years' Subscriber. (The pressure is the same per square inch. How could it be otherwise? 2. So far from being a bad plan, something similar is used on the underground railways. 3. If you are a five years' subscriber, what have you done with Vols. XXXIII. and XXXIV., which contain some excellent lessons in mechanical drawing? For books, see the publishers' lists.)—John Robertson. (We believe it is published by Ward, Lock, and Co., Stationers' Hall-court, E.C. See Hints, No. 5.)—Samolet. (Probably it would do; but much depends on the clay. See p. 180, Vol. XXVII., or Reid's book on the manufacture of Portland cement, published by E. and F. N. Spon.)—St. Pancras. (Too vague. There is scarcely a family that has not "money in Chancery"; but till something more definite is ascertained you would waste your time in pursuing a claim.)

## CHESS.

All Communications for this department must be addressed to J. Pierce, Langley House, Dorking.

### PROBLEM DCCCCXLV.—The Four Knights.

*Black.*



*White.* [9+5

**White to play and mate in two moves.**

Solution to 943.

| *White.* | *Black.* |
|---|---|
| 1. Q-Q 4 | 1. Anything |
| 2. Q, Kt., or P mates. | |

(Five variations.)

### NOTICES TO CORRESPONDENTS.

Correct solutions to 942 by H. Culmer, Streetgate (a capital problem), J. A. Miles, (very good and difficult), A. A. E. Lecluse (exquisite) and F. A. Vincent.

To 943 by J. A. Miles (a good problem), H. Culmer, Streetgate (very easy), Rev. W. Anderson (Old Romney), A. A. E. Lecluse (an easy key move), S. L. Chivers, F. A. Vincent, A. W. Orr, T. L. Robins, and F. O'N. H. (neat).

To 944 by E. S. Streetgate and O'N. H. (restricted).

J. A. Campbell.—If 1 $\frac{\text{K-Q B 7,}}{\text{R checks}}$ if 1 $\frac{\text{R-Ksq (ch)}}{\text{covers.}}$, how does Q mate, and where? If 1 $\frac{\text{R takes B}}{\text{K takes R}}$.

G. T. Stringfellow and T. L. Robins.—The problem is quite sound. In reply to 1 $\frac{}{\text{K takes K P}}$, 2 $\frac{\text{Kt-B 2}}{}$ is the correct play.

F. A. Vincent and J. H. Blake.—Thanks for games.

**Holloway's Pills.**—These pills purify the blood and act most powerfully on the liver, stomach, kidneys, and bowels, thus giving tone, energy, and vigour to the whole system. They are wonderfully efficacious in all ailments incidental to females, young or old, and as a general family medicine are unequalled.—[Advt.]

The English Mechanic
AND WORLD OF SCIENCE AND ART.
*FRIDAY, JULY* 3, 1885.

## ELECTRICITY AND "DUST."

IT will be remembered that at the Montreal meeting of the British Association Prof. Oliver J. Lodge was requested to deliver one of the evening discourses, and chose for his subject "Dust," a term apparently definite, but in reality covering a very large variety of organic and inorganic substances—the "floating matter of the air," as Tyndall puts it; though, as Prof. Lodge says, it should really be "sinking," for the dust floats only because it is prevented from sinking bodily by the currents of the atmosphere. Foreign particles in our aërial envelope, whether solid or liquid, are not floating, but slowly settling down, and where the air is still they lodge on any convenient spot, as the housewife knows. We recognise terrestrial dust and cosmic dust, and scientific men have been engaged for some time in studying the question whether the latter could be collected, its nature ascertained, and its amount calculated. As regards the latter point, we are not at present interested; but we are about to describe a remarkable instance of the rapid manner in which pure science is nowadays converted into applied science, and that in connection with the removal of dust from the air. Mr. Aitken, some time ago, showed that every spherule of mist, every particle of fog, must have condensed itself round a minute solid dust atom or nucleus, and it follows, then, that if dust could be removed from the atmosphere there could not well be a fog. The simpler methods of removing dust from the atmosphere are well known: it may be strained out by cotton wool, or allowed to settle by confining a portion of the air; it can be "washed out" by condensing vapour several times, it can be calcined, and, as Prof. Lodge has shown, it can be "settled" by discharging electricity into it. Tyndall's experiment of calcining air, as he called it, consisted in holding a hot body beneath a sunbeam, when dark interspaces of dust-free air make their appearance. A spiral of platinum wire placed in a bell-jar and made hot shows this phenomenon well, and Prof. Lodge and Mr. J. W. Clark proved that the clarification of the air was not due to combustion or evaporation, while Lord Rayleigh has demonstrated that a cold body is equally effective, as it produces a descending dust-free stream of air. A discharge of electric sparks through a dust-laden atmosphere will cause the dust to settle—a phenomenon which formed the subject of research by Prof. Lodge and J. W. Clark, with practical results which will be seen by-and-by. At the Montreal meeting, a continuous series of sparks were sent through a bell-jar filled with magnesium smoke, and in a very short time the air in the jar was cleared; similarly, when the jar was filled with steam, electrification caused the globules to aggregate into mist and fine rain, which rapidly fell. These observations are original to Mr. Clark and Prof. Lodge, and the latter, towards the conclusion of his lecture, advised his audience to "stick to the pure science, and the applications will take care of themselves." The truth of that dictum has been verified in a remarkable manner, for Prof. Lodge's lecture was read by the head of a firm of lead smelters in North Wales, who conceived the idea that if electricity could do so much in a laboratory experiment, it might be made to do something useful on a large scale. Most of our readers will know that in lead-smelting works the greatest difficulty is to deal in a satisfactory manner with the lead fume, or the volatilised lead, which passes off from the furnaces. Long condensing flues and chambers are employed; but even with the best arrangements a good deal of lead escapes to poison the atmosphere and to the loss of the manufacturers. At Bagillt, in North Wales, at the works of Walker, Parker, and Co., the flues and chambers have a total length of two miles, and even with that enormous length the purification of the vapours from lead is far from complete. Mr. Walker, having read the lecture delivered by Prof. Lodge, put himself into communication with that gentleman, and his scheme appeared so feasible that it was determined to make a practical trial. A large-sized wooden flue was constructed out of casks, and fitted with windows at opposite points throughout its length, so that the "fume" could be readily examined as it passed along. The experimental flue was fitted with dampers in such a manner that it could be filled with the fumes and closed at both ends, or could be used as a branch or loop in the main flues. The electrical machine had one pole connected to the ground and the other to an arrangement of metallic points placed inside the flue—a stout brass rod encircled by a glass tube to insulate it, being carried through the top of the flue, and held in the position desired for the discharging points. A well insulated copper wire connected this brass rod with the pole of the machine, which being kept warm and dry in a shed gave sparks in all weathers of about 4in. in length. Various modifications of the electrical arrangements were tried; but the experiments disclosed the fact that within certain limits, determined by the size of the electrical machine, the more points of discharge the greater or more rapid the effect produced. The first experiments were made upon the "fume" in a stagnant state, by filling the experimental flue with the gases from the main, and closing the dampers at each end. Viewed through the windows the fume had the appearance of a dense fog, but the moment the electric discharge commenced, a whirling movement was observed round the points, and in a very few seconds the foggy matter collected into flakes which were rapidly deposited on the sides and floor of the chamber and the atmosphere became clear. When the fume was permitted to pass through the temporary flue with the rapid motion due to the pressure of the furnace gases, no change was witnessed as it passed the windows, but at the outlet it was found that the foggy matter had been agglomerated into flakes, which in calm weather fell to the ground immediately on escaping from the flue. In this case the pressure forced the fume on too rapidly to allow of the effects of the electric discharge being witnessed through the windows; but it was, nevertheless, deemed satisfactory, and Mr. Walker determined to adopt the method of attacking the fume by the electrical method on the full working scale. At Bagillt there are nineteen furnaces, and the total length of the existing flues is, as we have mentioned above, rather more than two miles. It is calculated that two Wimshurst machines of the latest pattern, with discs 5ft. in diameter, will be able to supply a sufficient number of sparks when driven by a small steam engine, and we believe they have just been finished by Mr. Cribb, an engineer of Chester, who, under the guidance of Prof. Lodge and Mr. Clark, has the carrying out of the practical details of the electrical arrangement. The results obtained in actual practice will be awaited with interest, for if the electric discharge is so efficient with lead fume, it may be equally potent with other matters of a similar nature; indeed, Mr. Walker intends to try it in other branches of metallurgy—*e.g,,* for the condensation of oxide of zinc in the preparation of the zinc-white pigment and of arsenic in the copper-smelting industry. The working cost of the process is a mere nothing compared to the results obtained; while the electrical plant will probably save the great outlay now necessary in erecting the long lengths of flues and condensing chambers, though the lead recovered in these long flues will more than pay the interest on the capital necessary. Quite apart, however, from the commercial consideration of the question, we have the sanitary aspect, and in that view the discovery of Prof. Lodge and Mr. Clark is of the greatest value. In this country we have made the mistake of fouling the atmosphere, and it will take a long time to undo the mischief; but science is lending its valuable aid, and we may yet live to see the days when the sky over our manufacturing towns will be, at any rate, free from artificial "dust." It is not likely that the owners of boiler furnaces will adopt the electrical method of dealing with coal smoke; but there are many cases of manufacturing industries in which the application of the system will be found both beneficial and economical. The researches carried out by Dr. Lodge and Mr. Clark have covered a wider field than is indicated above; but they must be highly gratified that their labours in pure science have been so soon utilised in practical work. The experiment on which the method of dealing with lead fume is based is one of the simplest, and can be repeated readily by anyone possessing a bell-jar and an electric machine, for it is necessary only to fill the jar with a dense atmosphere, such as that produced by the burning of magnesium wire, and pass a series of sparks through it, to witness the remarkable effect of the discharge, and to appreciate the value of the discovery. In his lecture before the British Association, Prof. Lodge said: "It seems not impossible that some use may be made of this aggregating power of electricity on small bodies, such as smoke particles and mist globules"; and he ventured on the rather remarkable suggestion that it might be worth while trying it on even an Atlantic fog. If we recollect, he proposed to mount a Holtz or Wimshurst machine on the mast of a steamer and discharge the electric sparks through the atmosphere. If the effect were to keep a clear space near the vessel it would be useful; but, as most steamers are pushed on, even in spite of fog, it is not easy to understand of what practical utility the experiment would be, for even if the atmosphere were cleared, the steamers would be continually leaving the cleared portion behind. Still, an application of a discovery of pure science having once been made, there is every possibility that its utilisation will develop, although it is not to be expected that every laboratory experiment will receive so remarkable a recognition as that made by Prof. Lodge and Mr. Clark on the effect of electricity upon dust.

## THE INTERNATIONAL INVENTIONS EXHIBITION.—IX.

### Electricity.

ELECTRICITY is nowadays connected more or less intimately with so many of the arts that, although it has its special group (XIII.) in the East Arcade, it is to be found in one or other of its applications all over the buildings and in the grounds. Illumination by electricity is one of the features of the exhibition, and it must be confessed that in this respect the "Inventions" has the finest installation ever seen; but it also possesses a full-size electric tramcar on Mr. Holroyd Smith's plan in the South Promenade, a large-size model of the Portrush and Giant's Causeway electric tramway exhibited by Mr. W. A. Traill, and a working model of the late Prof. Fleeming Jenkin's "telpher" line—the two latter in the East Avenue and East Gallery, immediately adjoining the East Arcade. Several of the exhibitors in the group have cause to complain of the darkness of the spot allotted to them for their stands; but it is probable the authorities considered that there would be a sufficient number of electric lights to illuminate all the stands. Electric lights, however, cost a good deal of money, and exhibitors do not care to run them throughout the day merely for the benefit of those who, having no light themselves, are unfortunately placed in the darker parts of the Arcade. So far as the Exhibition is concerned, the exhibits in the group are all, without exception, "inventions" since 1862; but so much attention has been devoted to electrical appliances in the technical and even in the newspaper press, that there are comparatively few novelties to be seen. Nevertheless, the visitor has an opportunity of inspecting the actual apparatus and familiarising himself with details of applications of the current which he has already studied in black and white. Entering the East Arcade, he will find an attractive exhibit set out by Messrs. Coxeter and Son, of Grafton-street East, W.C., consisting of a collection of apparatus used in medical electricity, with a curiosity in the shape of an ingenious contrivance for driving a small dynamo by means of water, the speed being regulated by the tap on the supply pipe. Where a current is required for a short time only at intervals this arrangement will probably be found economical and practicable whereever a sufficient pressure of water can be obtained. Electric bells, dynamos, arc lamps, incandescent lamps, portable lamps, switches, lampholders, &c., are shown by several exhibitors; but most of the arrangements are well known, and do not require any special notice. Crompton and Co., of Chelmsford, show on their stand a collection of apparatus, which is of historical importance, indicating the improvements which have taken place within the last five or six years in the manufacture of the Crompton Bürgin machine, the latest form of which has a drum armature with a core of soft iron discs, spaced at intervals to afford free ventilation. A series of arc lamps is instructive, because it shows how, when Necessity calls, Invention answers, and provides increased efficiency with greater simplicity. Mr. S. A. Varley, of Highbury, exhibits machines and appliances which have become historical, and the Anglo-American Brush Electric Light Corporation have a collection to illustrate the construction of the famous Brush machine, including the new armature, which we illustrated on p. 384, Vol. XXXIX. An exhibit which will attract attention is a fine electrical turret clock, by Mr. C. Shepherd, of Alexandra-road, N.W., which strikes the hours and quarters. The armature is somewhat of an ∞-shape, the bent ends entering alternately hollow electromagnets, while the oscillation gives motion to a crank which drives the clock movement. The Electrical Power Storage Co. have a fine exhibit of their secondary batteries, an arrangement of 30 cells being employed to work a number of lamps and a couple of Reckenzaun motors of 1½ and 3 horse-power respectively, the latter being shown attached to a propeller, and of the exact dimensions suitable for a 40ft. launch. Examples of Mr. Sellon's heater applied to the so-called Tobin ventilating tube, to foot warmers, for beds and railway carriages, to an incubating machine, &c., will attract attention. The heater consists of one or more reticulated fireclay slabs, the interstices of which contain coils of iron wire, which offer considerable resistance to the passage of the current. The heat thus generated is absorbed by the fireclay, and air passing through can be heated to 200° Fahr. One horse-power taken from an axle is sufficient to heat nine of the railway foot warmers. A portable accumulator lamp will attract much attention, as it is put up in a neat box for domestic purposes. The lamp gives five candles for six hours, and the accumulator can be charged with five cells of Bunsen or bichromate type. For those who require a portable electric lamp and prefer to carry an accumulator instead of a primary battery, this arrangement is well adapted, and is, we should say, cheap. At the adjoining stand Mr. Sarney, of Ablett-street, South Bermondsey, exhibits his improvements in secondary or storage batteries, which consist in a special form of lead plate and a porous composition, the particulars of which cannot be given until the patent is completed. The lead plate is something in the form of chevaux de frise, the solid rod extending from top to bottom, affording an excellent conductor to all parts of the electrode. The blades or leaves of the chevaux de frise offer an excellent means of retaining the porous composition in place, and when they are pressed as nearly flat as possible, the plate occupies but little space, while exposing a large surface from which the composition cannot fall off. Mr. Sarney's wood cells deserve a word or two of notice. Parts are simply recessed to take the edges of other parts, which, instead of being cut to fit are forcibly compressed, so that when they are swollen by the fluid they form perfectly tight joints, and the cell is retained in shape by a few bolts and nuts. A common ochre paint is found to be a sufficient dressing, and is proof against the acid for a very long time. The School of Electrical Engineering and the Primary Battery Co., Princes-street, Hanover-square, W., exhibit the siphon recorder and other telegraph appliances, with the primary batteries which "work for long periods without recharging," and the waste products of which are allowed for when returned. A. R. Sennett and Co., of Hatton-garden, have a patent primary battery, too, and also exhibit a patent accumulator, and sundry apparatus and fittings. Of other exhibitors much the same may be said, and so far as the public is concerned it is a pity that explanations are not appended to the articles, for the attendants, when any are attached, are not always in the way. We have no doubt that most of the patent batteries have been described in our columns, as has the patent ozokerited core exhibited by W. T. Henley's Telegraph Works Company, at whose stand an interesting object will be found in the magneto-exploder used in 1858 for firing the charges in breaking down the rocks for Portland Breakwater. Specimens of the ozokerited core, according to high testimony, have withstood 14,000 volts without breaking down, and have given an insulation of 40,000 megohms per knot. At the adjoining stand is shown Callender's compound for insulating telegraph and other electrical conductors. For this it is stated that when applied with the troughs containing a tolerably thick mass of the compound, the loss on a current of 2,000 ampères is less than 8 per cent. in 100 yards. The United Telephone Co. have an historical collection of telephones—not the actual instruments, but others made to pattern. Thus the earliest form of Bell's telephone, before any published description had appeared, was of the vertical pattern with the membrane armature; then the famous horizontal pattern known as the ENGLISH MECHANIC telephone, which was exhibited by Sir W. Thomson, in Glasgow, in 1876, and lastly the modern forms finished and in skeleton. Edison's most notable telephones are also exhibited, including a fine specimen of the phonograph—an instrument which has at present failed to find any useful application. The Bernstein Electric Lamp Company exhibit their incandescent lamp, and a neat model of a portion of a city illuminated by incandescent lamps carried on the ordinary posts. Mr. J. H. A. Macdonald, of Edinburgh, exhibits his holophote course indicator in this group. It consists of an electric arc lamp with a reflector, which is so connected to the helm that it indicates by its sweeping movement the side to which the vessel's head is being turned. Prof. G. Forbes exhibits the first model of his non-polar dynamo, which is especially suitable for electroplating, and for refining metals. At 2,000 revolutions it is said to give two volts and 5,000 ampères. The stand of Mr. J. W. Swan is for many reasons the most attractive in the group. It is one of the largest and it is one of the most varied, for incandescent lamps of all sizes are shown applied to different purposes. There is a 100-candle lamp with a reflector attached to a magic-lantern; a portable miner's lamp worked by an accumulator, which gives 2½ candles for four hours; microscope lamps and fairy lamps by the hundred, and a binocular microscope fitted with incandescent lamps in the manner described by Mr. C. H. Stearn, F.R.M.S., in the illustrated paper which we reprinted in No. 933. The surgeon's electric lamp, designed by Mr. J. B. Payne, and made by Mawson and Swan, Newcastle-on-Tyne, is intended for illuminating cavities in the body, and the small lamp is inclosed in a tube which is kept cool by the circulation of water. Mr. Swan also exhibits an ingenious surgeon's lamp devised by Mr. P. Ward, in which the light is sent by reflection down a glass rod, which can thus be introduced to any part without transmitting heat. The utilisation of the incandescent lamp in articles of ornament or decoration has been carried to a high degree of perfection, as can be seen at this stand—the illuminated pearl in the oyster-shell being an interesting example. Samples of the new filament material—cellulose forced through a plate as in wire drawing—are also shown in the thread form and woven into a handkerchief. Laing, Wharton, and Down, of Holborn Viaduct, exhibit the Thomson-Houston system of electric lighting for the first time in England. The system is automatic, and light can be turned on or off without attending to the dynamo. Lamps and other fittings are shown at the stand, with the automatic current regulators, and, as a novelty, some Swan lamps which have been in use at Hatfield House for upwards of four years. On the opposite side of the Arcade, Mr. Crookes has an interesting collection of specimens, including the radiometer and sundry samples of earths and chemicals with which his name is identified. He also shows incandescent lamps in various stages of manufacture, and his cellulose filaments, with a selection of carbon threads, some of them tied in knots after carbonisation to exhibit their flexibility. L. B. Miller, of Hatton-garden, shows in a case some electro-motors and electric meters which deserve attention, but which would require more space than we can afford here to explain; and E. Oppermann, of Spencer-street, E.C., has some improved batteries and a speed governor which will attract notice. A curious exhibit is that of A. J. Kendall, Middlesbrough, which is of more than passing interest, for it is an attempt to provide a means of converting the combustion of fuel directly into electric energy. This is a subject which is engaging the earnest attention of investigators, and though Grove's gas battery is perhaps the nearest approach to a solution of the problem that we have at present, there is reason to think that by-and-by someone will discover a means of using coal directly, instead of passing its potential energy through a steam-engine and a dynamo, and consequently losing a high percentage of the available power. Mr. Kendall's battery is based on the fact that hydrogen passes through a red-hot platinum plate. He uses two platinum tubes, one within the other, and separated by a fluid medium of fused glass. The tubes are closed at one end, and the inner is fed continuously with hydrogen, and kept at a high temperature by means of a gas blowpipe or a furnace. The absorption of hydrogen by the platinum is accompanied by the generation of an electric current, which is led away in the usual manner by wires. Mr. F. Walker, of Spondon-road, Tottenham, exhibits his watt meter, which consists of a drum carrying a ruled sheet of paper and a couple of solenoids, one of which is free to move up and down within the other upon a fixed iron core. When no current is passing a spring keeps the movable solenoid out of the other, and the stylus marks a zero line on the drum; when, on the contrary, a current is passing, the two solenoids act in a compound manner, as it were, and the stylus traces a curve on the drum, which is directly proportional to the energy developed in the circuit, and consequently variations are recorded. The instrument can be used in the laboratory, or as a meter in a working circuit for lighting or power, as the slightest fluctuation is correctly registered in the curve traced on the paper. The Globe Electrical and Engineering Company, Dartmouth-street, S.W., amongst their exhibits show samples of Mr. Killingworth Hedges's fusible safety plugs with mica foil, which we believe are found very efficient. H. and E. J. Dale, of Ludgate-hill, have an interesting collection of apparatus, and they are also agents for Bayley's patent electric clutch motor shown at another stand. This is said to be the most efficient electric motor in the market, and is self-starting at full power. It is exhibited by Bayley and Son, of Poole, and consists of an electromagnet provided with an armature, spring, and contact-breaker. In front is placed another magnet, which, with its axis, is free to revolve, and that has a loose disc armature, which is connected by a rod to the vibrating armature of the fixed magnet. The current passing through both magnets, both attract their armatures, and the pull of the fixed magnet causes the revolving magnet to turn on its axis until the spring breaking circuit the loose disc armature is released, only to be immediately attracted again, so that a continuous rotary movement is imparted to the revolving magnet. Mr. R. Grant, Woolwich, exhibits an electro-motor which is said to give 8,000lb. of momentic force per minute with three quart Bunsens, and General R. Macleod Fraser, of Dorset-square, shows a double-action electro-motor, without dead points; but as it is in a case, we can give no details. Mr. Brailsford's electrical tide-gauge and register is shown at one of the stands, and Mr. Thorpe, of Theobald's-road, W.C., exhibits his semaphore indicator and other specialities, including an arrangement for ringing any number of bells continuously. The Kinetic Engineering Co., Brooke-street, E.C., exhibit the Berthoud-Borel cables, and a Breguet-Gramme pedal dynamo for laboratory use, noticeable for the fittings. Gerard and Co. also show laboratory machines, and those who have occasion to employ a current from a dynamo for a short time should not fail to see these arrangements. W. E. Irish, Sunderland, has a collection of his ingenious appliances, including the telephonograph; and F. M. Rogers, of Finsbury-pavement, exhibits his railway station indicator for use in carriages, showing the "next station," his arc lamp for photographic purposes, and his patent electrical weather vane for indicating within a house the position of a wind vane placed outside. Mr. Strangways shows his loud-speaking, long-distance telephone, complete and in parts (we illustrated this in No. 953); and Mr. F. Aylmer, of Leadenhall-buildings, E.C., shows an interesting collection of Trouvé's inventions, including the electric jewellery and dining and drawing-room ornaments. The portable lamp devised by Trouvé is a neat and handy article, and is said to give five candles for 3½ hours. The mere act of lifting it puts the plates into the battery, and the lamp immediately becomes incandescent. Trouvé's motor, with propeller attached, is shown full size, and the exhibitor hopes to obtain permission to attach it to a boat on the lake. A device which will attract the attention of volunteers is the self-indicating electric target of Mr. J. H. Jack, Edinburgh. The target is in segments which when driven in by the compact of the bullet make contact with brass tongue-pieces connected to a series of electro-magnets. The armatures of these magnets, when actuated by the circuit being closed, operate the index of a dial which is divided in colours to show "bulls," "inners," "outers," &c., and also the exact segment of the target which was struck. Davis and Timmins show a large collection of binding screws, terminals, &c., and coils of arsenical bronze and chromium bronze wire for telegraphic and other purposes. We have endeavoured to give an idea of what is to be seen in the group devoted to electricity; but although it is a comparatively small one, considering the area occupied, we have been unable to do more than mention a few of the large number of minor exhibits which will interest all who are studying the various uses to which the current is now applied.

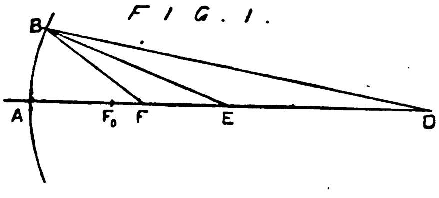
## ON SOME MATTERS IN THE THEORY OF MIRRORS.—I.

By W. BRADBURY.

THERE are a few matters connected with the theory of mirrors, which appear to need further treatment. This is especially the case as regards their aberrational errors, and I take up the subject in the hope of inducing others to carry the analysis further than what I myself am able to do.

In those arrangements of reflecting telescopes in which two curved mirrors are employed, it will always be a difficult and troublesome task to decide when the proportions are at their best. Nevertheless, it is not improbable that theory may yield some useful results, and help the operator to guide his manipulative processes in the right direction.

FIG. 1.



First, we will consider the problem:—

§ 1. To determine the simple focal properties of a spherical mirror.

In Fig. 1, let the curved line, B A C, represent a section through the face of a concave spherical mirror, whose axis is A D, and radius of curvature, A E, or B E. Suppose a ray of light, starting from the point D, and falling on the mirror at B, to be reflected in direction B F, cutting the axis in F. Then F is a focus, and we require to find its position.

From the properties of the triangles, B F E and B D E, and the equality of the angles F B E and E B D, it is easily shown that

$$\frac{FB}{FE} = \frac{DB}{DE} \quad \dots\dots\dots\dots \quad (1)$$

This is a fundamental equation, to which we shall return presently.

If we assume that the mirror has a certain angular aperture, or, in other words, that the angle A E B has a certain value $\theta$; we can, by including this angle in the formula, directly calculate the position of F for any aperture. The equation is:—

$$\frac{1}{FE} = \frac{1}{DE} + \frac{2 \cos.\ \theta}{AE} \quad \dots\dots\dots\dots \quad (2)$$

This formula is one which is very little used, for it will be noticed that the variable distances are measured from the centre E, whereas it is the general practice to reckon them from the vertex A.

In equation (1), it will be seen that two of the chief lines are measured from a point in the curve of the mirror, and will, therefore, alter in length with every change in the position of the point B. As a first approximation, let us suppose that B is so very near to A, that distances measured from either point are practically alike. Then the equation becomes—

$$\frac{AF}{FE} = \frac{AD}{DE}$$

Now $FE = AE - AF$, and $DE = AD - AE$. Making these substitutions and inverting, we have—

$$\frac{AE-AF}{AF} = \frac{AD-AE}{AD} \text{ or } \frac{1}{AF} + \frac{1}{AD} = \frac{2}{AE} \quad \dots \quad (3)$$

This is the common approximate rule for finding the positions of the conjugate foci of a mirror; and is expressed in words by saying that the sum of the reciprocals of the conjugate focal lengths is equal to twice the reciprocal of the radius of curvature.

When the rays are parallel, the reciprocal of A D vanishes, and we have—

$$\frac{1}{AF} = \frac{2}{AE} \quad \dots\dots\dots\dots \quad (4)$$

that is, the focal distance A F is then equal to half the radius of curvature. This is called the principal focal length of the mirror, and is generally represented by F or $f$. For the present we shall represent it by $f$, the radius A E by $r$, and the conjugate focal lengths A D and A F by $u$ and $v$ respectively.

Equation (3) may then take the following form:—

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} \quad \dots\dots\dots\dots \quad (5)$$

Referring to Fig. 1, we see that this is the equation for diverging rays on a concave mirror, the point of divergence being without or beyond the centre of curvature. The distances $v$, $f$, and $u$, are measured in the same direction, that is, these points lie on the *same* side of the vertex of the mirror; and we must be careful to notice that equation (5) represents them in this position. The second part of the equation is, of course, the most important, as it governs the sign of the first part; for, in general, $f$ and $u$ are given, and from them $v$ is to be determined.

It is evident from equation (5) that so long as $u$ is greater than $f$, $v$ will be positive; when $u = f$, the reflected rays are parallel; and when $u$ is less than $f$, the reflected rays diverge from the mirror, and their virtual focus, or the position of $v$, is on the opposite side of the mirror. The values of $u$, corresponding to real values of $v$, are limited between the points $F_0$ and E, the former being the principal focal point. It need scarcely be remarked that the course of the rays traced either way is alike—that is to say, if D be a radiant point, the rays from which come to a focus at F, then conversely D is a focus for rays diverging from F.

When the incident rays are converging, the point D is located behind the mirror, so that A D or $u$ is measured in the opposite direction: hence the sign of $u$ in the focal equation must be changed, and it becomes

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u} \quad \dots\dots\dots\dots \quad (6)$$

which shows that whenever converging rays fall on a concave mirror, there will always be a real focus, situated between the principal focus and the vertex.

This concludes the cases of reflection by a concave mirror.

§2. To find the corresponding formulæ for a convex mirror.

In this case the radius $r$, and, consequently, the principal focal length $f$, are measured in the opposite direction; and when the corresponding change is made in equation (5), it becomes—

$$\frac{1}{v} = -\frac{1}{f} - \frac{1}{u} \quad \dots\dots\dots\dots \quad (7)$$

This shows that whenever diverging rays fall on a convex mirror, the focus is always virtual and behind the mirror at a less distance from it than its principal focus. For, in the above eqn., since both $f$ and $u$ have negative signs, $v$ must always be negative also.

Secondly, for converging rays we must change the sign of $u$ in eqn. (7), and we have—

$$\frac{1}{v} = -\frac{1}{f} + \frac{1}{u} \quad \dots\dots\dots\dots \quad (8)$$

which indicates that we can only have a real focus when $u$ is less than $f$. If $u = f$ then the reflected rays are thrown paralled from the mirror; or if $u$ is greater than $f$, then both incident and reflected rays have virtual foci behind the mirror.

TABLE OF FOCAL EQUATIONS.

CONCAVE MIRROR.

| | | | |
|---|---|---|---|
| 1 | Parallel Rays .. | $f = r \div 2$ | The focus is positive or real |
| 2 | Diverging Rays | $\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$ | $v$ is real when $f < u$<br>$v$ is negative when $f > u$ |
| 3 | Converging Rays | $\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$ | $v$ is real in all cases |

CONVEX MIRROR.

| | | | |
|---|---|---|---|
| 4 | Parallel Rays .. | $-f = r \div 2$ | The focus is negative or virtual |
| 5 | Diverging Rays | $\frac{1}{v} = -\frac{1}{f} - \frac{1}{u}$ | $v$ is virtual in all cases<br>$v$ is virtual when $f < u$ |
| 6 | Converging Rays | $\frac{1}{v} = -\frac{1}{f} + \frac{1}{u}$ | $v$ is real when $f > u$ |

CORRESPONDING POSITIONS OF THE CONJUGATE FOCI:—

Concave Mirror.

$$u \dots\ \frac{f}{2},\ f,\ \tfrac{3}{2}f,\ r,\ 3f,\ \infty,\ -\frac{f}{2}$$

$$v \dots\ \frac{f}{2},\ \infty,\ 3f,\ r,\ \tfrac{3}{2}f,\ f,\ \ \frac{f}{2}$$

Convex Mirror.

$$u \dots\ \frac{f}{2},\ f,\ \infty,\ -r,\ -f,\ -\frac{f}{2},\ -\frac{f}{3}$$

$$v -\ \frac{f}{3},\ -\frac{f}{2},\ -f,\ -r,\ \infty,\ f,\ \frac{f}{2}$$

In the equations of conjugate foci it is usual to employ an auxiliary quantity $a$, determined as follows:—If we suppose—

$$\frac{1}{u} = \frac{1+a}{2f}$$

It follows from equ. (5) that—

$$\frac{1}{v} = \frac{1-a}{2f}$$

since the sum of these two quantities is the reciprocal of $f$. Hence, instead of $u$ and $v$, we may employ the single term $a$, and thus often simplify the calculations. When we are given any value of $u$, that of $a$ may be readily found, since—

$$a = \frac{2f}{u} - 1 \quad \dots\dots\dots\dots \quad (9).$$

Let us find what are the values of $a$, corresponding to the values of $u$ given above.

Concave Mirror.

$$u \dots\ \frac{f}{2},\ f,\ \tfrac{3}{2}f,\ r,\ 3f,\ \infty,\ -\frac{f}{2}$$

$$a \dots\ 3,\ 1,\ \tfrac{1}{3},\ 0,\ -\tfrac{1}{3}\ -1,\ -5$$

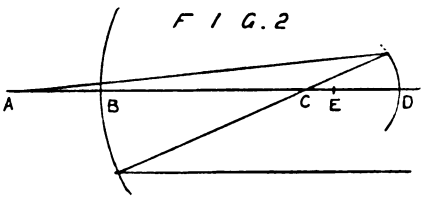
Convex Mirror.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $u$.... | $\frac{f}{2}$, | $f$, | $\infty$, | $-r$, | $-f$, | $-\frac{f}{2}$, | $-\frac{f}{3}$ |
| $a$.... | $-5$, | $-3$, | $-1$, | $0$, | $1$, | $3$, | $5$ |

§ 3. To apply the preceding formulæ to the Gregorian telescope.

In this case we have a pair of concave mirrors, so arranged as to bring the final focus at or beyond the vertex of the greater mirror. Let Fig. 2 represent such an arrangement, A

FIG. 2



being the final focus, B the vertex of the large speculum, and C its focal point; D the vertex of the small speculum, and E the place of its principal focus. Let A B = $a$, B C = F, C D = $u$, A D = $v = a + F + u$, D E = $f$. Parallel rays falling on the large speculum are brought to a focus at C; from here they diverge upon the small speculum, are reflected back, and brought to a focus at A, the place of the eye-piece. Hence this case of reflection comes under eqn. (3), bearing in mind what is there said respecting the interchangeability of the focal and radiant points A and C. Since, in this case, C D = $u$, A D = $v = a + F + u$, we have:

$$\frac{1}{u} + \frac{1}{v} = \frac{1}{u} + \frac{1}{a + F + u} = \frac{1}{f} \quad \ldots\ldots\ldots(10)$$

or in a simpler form—

$$u^2 + u(F + a - 2f) = f(F + a)$$

a quadratic equation giving the value of $u$.

The value of F is always known, as is also that of $a$; for the problem is, in fact, to find how far the mirrors must be apart so as to cause the final focus to fall at a certain assigned position. We can, therefore, within certain practical limits, give $a$ any positive value down to zero; and since F and $a$, when once decided on, have a constant value, let us represent them both by one term $m$, that is $(F + a) = m$. Then we have—

$$u^2 + u(m - 2f) = fm.$$

The solution of this equation gives—

$$u = f - \frac{m}{2} \pm \frac{\sqrt{m^2 + 4f^2}}{2} \quad \ldots\ldots\ldots\ldots\ldots(11)$$

But B D, the distance apart of the mirrors, is obviously equal to (F + $u$). Hence, adding F to both sides of the above result and replacing $m$ by (F + $a$).

$$BD = F + f + \tfrac{1}{2}\left\{\sqrt{(F+a)^2 + 4f^2} - (F + a)\right\} \quad ..(12)$$

Also C E, the distance apart of the principal foci of the mirrors is $(u - f)$, or—

$$CE = \tfrac{1}{2}\left\{\sqrt{(F + a)^2 + 4f^2} - (F + a)\right\} \quad \ldots.(13)$$

Hence it appears that the distance apart of the mirrors is always slightly in excess of the sum of their foci. We might, in fact, express the quantity under the vinculum in the form of a series, the second and other terms showing its excess above (F + $a$); which excess is the amount B D exceeds (F + $f$).

As a special case, suppose that the point A coincides with B, so that the value of $a$ is 0; then we have—

$$BD = F + f + \tfrac{1}{2}\left\{\sqrt{F^2 + 4f^2} - F\right\}$$

Also let us assume that the ratio of the foci of the great and small mirrors is $r$, that is $(f \div F) = r$, then—

$$BD = F\left[1 + r + \tfrac{1}{2}\left(\sqrt{1 + 4r^2} - 1\right)\right] \quad \ldots.(14)$$

This is the exact value of B D for the above position of A; but we may find an approximate one in the following manner:—

$$\sqrt{1 + 4r^2} = 1 + 2r^2 - 2r^4 + \&c.$$

Therefore, by introducing these three terms in the above eqn.—

$$BD = F(1 + r + r^2 - r^4) \quad \ldots\ldots\ldots\ldots\ldots(15)$$

This gives the separation in terms of the focal length F and the ratio F/$f$. In ordinary cases the error introduced by using rule (15), instead of (14), is very small. Thus, suppose $r = \frac{1}{3}$,

$$BD \text{ from } (14) = F \times 1{\cdot}4341$$
$$BD \text{ from } (15) = F \times 1{\cdot}4320$$

The error in this case is only about $\frac{1}{300}$ part of F.

It must be observed the eqns. (14) and (15) apply only to the case when the final focus is at the vertex of the large mirror. Under any other circumstance the focal excess C E must be calculated by eqn. (13), and this, added to (F + $f$) is the distance apart of the mirrors.

(*To be continued.*)

## ENGINE-MAKING AT HOME—VII.

### Fitting the Cylinder.

THIS is a nice little bit of fitting, and I should remark that it does not much matter whether we bore or file it first of all; but in practice it is usual to bore first, to ascertain whether the metal is sound, and to use the bore as a basis of measurement when planing the faces and feet. The boring I shall suppose to be done in a lathe, and not in a special boring machine.

With a slide-rest and a lathe, the accuracy of which can be depended upon, a small cylinder such as this is can be bored very well while held in the jaws of the face-plate. The flange affords a very convenient means of attachment, the jaws pinching it upon the outside. Or with a slotted face-plate simply, without jaws, the flange is held by means of two strips of iron plate clipping the flange upon its inner face, themselves being held tightly with bolts passing through the slot holes.

Then the head metal is cut off with a parting tool, and one flange—the outer one—is faced. The cylinder is then bored with a roughing tool first, and finished with a fine cut in the second traverse of the rest. It is afterwards rechucked by the face flange, and the opposite flange turned.

Another way, and one somewhat better than the last, is to remove the upper parts of the slide-rest and to block up and bolt the cylinder to the saddle (Fig. 84), and to bore with a cutter wedged or screwed in a cutter bar (Figs. 85, 86), or with a cutter-head affixed to a mandrel (Figs. 87, 88). Here the cylinder travels while the cutters simply revolve. The stouter the cutter-bar, or the mandrel which carries the cutter-head, the less chatter will there be in the tool. There may be one only, or two cutting edges in the tool wedged in the bar. I have shown two in Fig. 85, and one in Fig. 86. There may be one, Fig. 88, in the boring head, or more, depending upon the diameter and the rate of travel, since the greater the number of cutters the less work each has to do, and the quicker the feed that may be imparted to the head. Three cutters are shown in the head (Fig. 87). The cutters, it will be observed, are ground to an obtuse angle at the front or cutting edges *a*, *a*, *a*, and having no true cutting angle on their faces, they act simply as scraping tools. The sides, *b*, *b*, *b*, which follow the cutting points, merely act as steadies by filling up the bore, and are not intended to cut at all. The cutter head is better than the bar for this reason. It consists simply of a block of cast iron, slotted, to receive the cutters and bored for the mandrel. The cutters are held in place with wedges, having the slightest possible quantity of taper. A cutter and wedge are shown enlarged at Fig. 89. When one cutter only is employed in the head, the remaining grooves are occupied with steady blocks of hard wood.

The head metal must be cut off with a parting tool before the boring commences, the cylinder being held temporarily on the face-plate for that purpose. The bore will be enlarged at each end for about ⅜in. (Fig. 90), the purpose of which is to prevent the formation of a shoulder in the cylinder, as it becomes worn by the friction of the piston.

The flanges can be faced in two or three ways. They might be faced on the plate before the cylinder is removed to the saddle, or they might be faced on the saddle, as is often done by a star wheel and screw arrangement. But as this means making a special apparatus, I should face them by means of a cutter set in the block, and standing far enough out to embrace the diameter of the flange (Fig. 91). By taking light cuts, it would scrape the whole surface of the flange at once, and by making it double-ended, we can face the opposite flange by simply sliding the cutter head along on its mandrel. This will be the best way in this instance; for, being all worked at one setting—we shall be certain that the faces of the flanges will be at exact right angles with the cylinder bore.

Or, again, the cylinder after being bored may be removed from the saddle and bolted to the face-plate, the end against the face-plate being set true concentrically. But the end farthest from the plate may be out of centre by reason of the unevenness of the flange face, so the cylinder is run round, and tried with the point of a scriber to find the amount of eccentricity of the bore at the front end, and the flange next the plate is packed until the front as well as the back of the bore runs truly circular. Then the flange is faced with a cutter fixed in the slide-rest and traversed, and a centre line is marked for the bolt holes to 4⅝in. diameter. A very light cut taken off the diameter of the flange, and an application of emery cloth will improve its appearance. The cylinder is then reversed, the faced flange bolted in turn to the plate, and the second flange faced, and its circle of hole centres marked.

Next try with the square the holding down flange relatively to the steam-chest flange, and if these faces are not at right angles with each other, divide the amount of error between the two when filing. File the holding-down flange first, to its dimensions, and fit its edges into the guides upon the bed. Much depends on the parallelism of these strips with the bore of the cylinder, for any slight inaccuracy here will be multiplied by the length of the piston and connecting rods. The way to insure truthful results is to fit a slip of wood at each end of the cylinder bore, and mark thereon the exact centre of the hole. Then to cut out of thick stuff, 1in. or 1¼in. thick, two semi-circular hollowed pieces of blocking (Fig. 92), and to lay the cylinder upon these foot upwards, shaving down the blocks until the centres marked on each end of the cylinder measure exactly the same height from a level plate when tried with a scribing block (Fig. 90). Having these level, chalk the ends of the cylinder feet, and scribe a line along on both ends at a height of 2$\frac{9}{16}$in. above the centre (Fig. 92). This is the line to which the bottoms of the feet are to be filed. Then, with a set square, raise a line up through the cylinder centre upon the flange faces, and from each side of the centre line so obtained, mark off $\frac{7}{16}$in, equal to one-half the width of the guide strip. At the same time scribe up the ends of the steam-chest flange with the set square to a distance of 3¼in. from the centre (Fig. 92). Centre pop all these lines at intervals of about an ⅛in., and if these are filed accurately to, there should be no need of fudging afterwards. When the steam-chest flange has been filed true, the valve face will follow, being reduced until it stands at exactly an ⅛in. above the flange face, such thickness being gauged by a slip of metal slid underneath a straightedge, whose face is held against the valve face. Measurement may also be taken at the same time to the cylinder bore. The bounding edges of the valve face will be filed also to 3¾in. by 2$\frac{3}{16}$in., the longitudinal edges being checked first from the cylinder foot, and the transverse edges with a square laid against those first named, or with a scribing block.

Returning the cylinder to its blocks, get the centres levelled once more by the scriber point set against the horizontal line marked on the temporary slips of wood driven into the cylinder ends. Erect a centre line upon the slide-valve face, which should be the centre alike of the exhaust port and the faces of the cover flanges. From this centre mark the width of the exhaust = ⅜in. to right and left of the centre line, then $\frac{5}{16}$in. = the width of the bars, then ⅜in. = the width of ports, and scribe up lines to these divisions. Chip lightly if the metal will allow of chipping, or file if the cores are nearly to the finished size, having much regard to the exactitude of the outside port edges. Afterwards file the pump facings square with the cylinder foot to a distance of 2¾in. from the centre, and also the flange of the exhaust-pipe square with the valve face. Then at this stage the cylinder will be put aside for a few hours while the covers are being prepared.

The covers will be turned to the sectional dimensions (Figs. 93, 94). The outside faces and the edges may as well be polished as is customary, for appearance sake. Of course, there are different ways of chucking, but I should proceed thus, taking the bottom cover first:—Clip the edge of the cover in the jaws of the face-plate, letting the inner face of the cover stand outwards, and turn that face first. Then clip the shouldered portion with the dogs, or drive it into

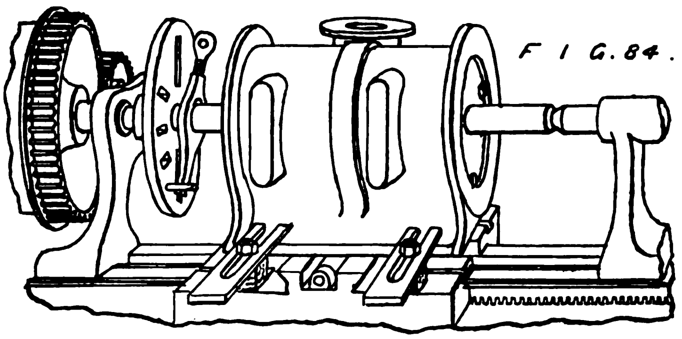


FIG. 84.

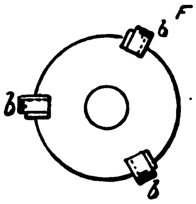
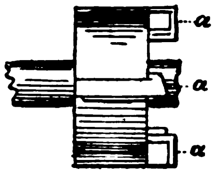


FIG. 87.



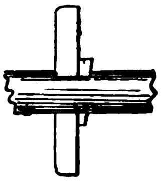


FIG. 85.

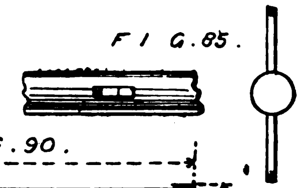


FIG. 85.

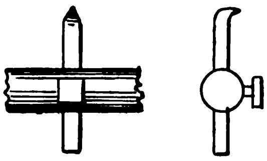


FIG. 86.

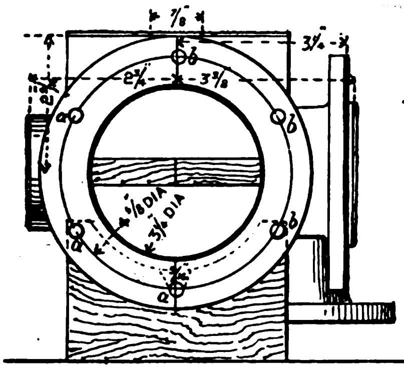


FIG. 92.

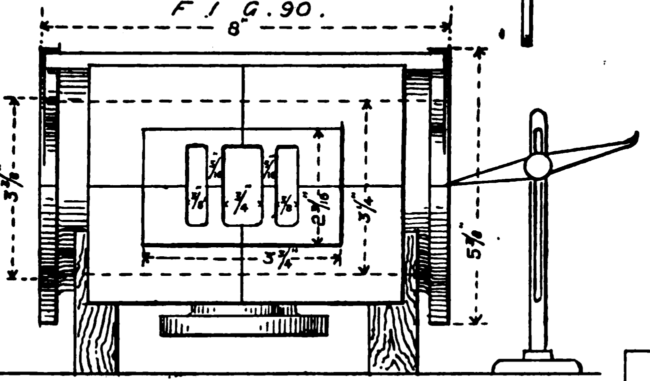


FIG. 90.

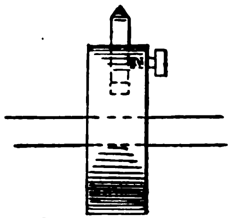


FIG. 92.

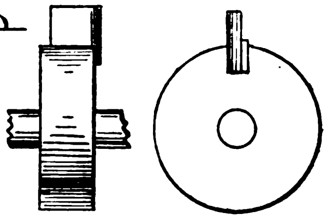
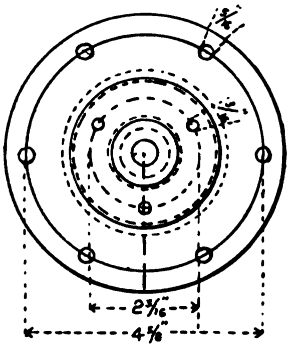


FIG. 91.



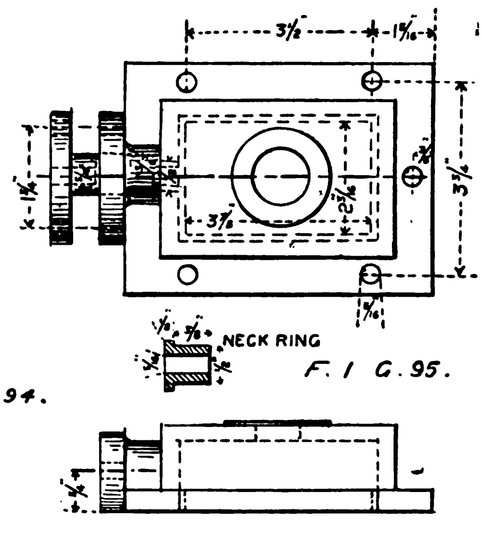


FIG. 95.

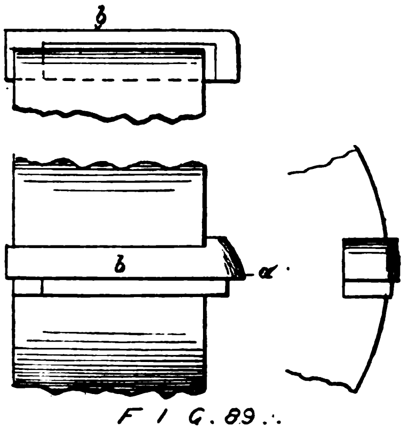


FIG. 89.

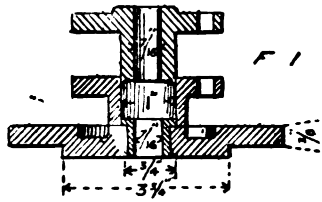


FIG. 94.

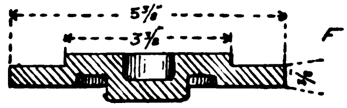


FIG. 93.

a recess in a hardwood chuck, and skim over and polish the edge and the outside face. The second cover, Fig. 94, will be turned similarly so far as the polishing of the face and edge. But at that stage the clips should be applied to the turned edge for the more secure grip while the stuffing-box is turned and bored. The stuffing-box will be bored with an ordinary turning tool to 1in. diameter, and the blank metal at the bottom will be drilled in the lathe to ⅝in. diameter. Run a line round for the bolt centres on the flanges to 4⅝in. diameter, and another on the flange of the stuffing-box to 2 3/16in. diameter, and remove from the lathe. From a bit of solid brass rod turn a neck ring to the dimensions (Fig. 94), and drive it tightly into the drilled hole at the bottom of the stuffing-box. Mark out the centres of six holes equidistantly from one another upon the 4⅝in. diameters struck on the flanges, and on each of these centres strike a 3/16in. circle. Centre-pop these circles and drill. Mark three 3/16in. holes upon the stuffing-box flange and drill. Drop the covers into their respective ends, and starting in each case with two of the holes exactly plumb (Fig. 92), use the holes already drilled in the covers as the templet or guide for marking those which have to be drilled in the flanges. Centre-pop, and drill those marked *a*, *a*, *a*, to 3/16in. for the reception of bolts, *b*, *b*, *b* being drilled to ⅛in. only, to be tapped for the reception of studs — the employment of studs being necessary because the presence of metal behind the flanges in these points prevents the employment of nuts.

Turn and bore the gland (Fig. 94), to the dimensions there given, its flange being clipped by the dogs while the hole is being bored, the body turned, and the under shoulder faced. With a twist drill in good order, held in the slide-rest, the hole for the piston can be drilled through directly without any need of boring proper. It must be rechucked, and the body clipped in order to turn the top face and edge of the flange. Three ⅛in. holes will be drilled to correspond with those in the flange of the stuffing-box for the gland bolts.

The steam-chest, Fig. 95, may receive our next attention. File the face of its flange, and also the four strips around its inner edges, taking most pains with the facings against which the edges of the slide-valve travel. Chalk the face of the stuffing-box, and measuring equidistantly from the edges of the guide strips against which the edges of the slide-valve travel, draw a centre line along the face of the flanges and up the stuffing-box face. Intersect this last with another centre line scribed horizontally at a distance of ⅝in. from the flange face. Then bolt an angle plate to the face-plate of the lathe, and laying the surface of the flange just now filed against the angle plate, adjust the latter in one direction, or radially, and the former in the traverse direction, until the intersection of the centres upon the stuffing-box coincides with the lathe centre. Drill to the dimensions, Fig. 95, turn a neck ring of brass, as figured, and the gland also, as in the case of the cylinder cover. Two 3/16 holes will be drilled in the flange of the stuffing-box, and tapped to ¼in., and two ¼in. holes in the gland to slip over the studs. Five 3/16in. holes drilled in the flange for attachment to the cylinder will complete the work on the steam-chest for the present.

---

**CHIMNEY** area is calculated by allowing 3¼ square feet for every full-sized boiler—i.e., 28ft. by 7ft., and 4 square feet for one boiler.

## SIMPLE EXERCISES IN TECHNICAL ANALYSIS.—VIII.

By An Analytical Chemist.

### Section II.—Pigments.

THE subject of paints having been now dealt with at sufficient length to meet the requirements of all who are interested in the examination of the quality and the adulteration of these substances, our attention must now be directed to the methods employed for estimating the value of the pigments used in painting. In the colour trade small dealers seldom subject pigments to any but a rough-and-ready mechanical test, and frequently to no test at all. They buy them relying on the respectability of the wholesale dealer, and, without inquiring further into their value, pass them on to the consumer. But dealers who buy in large quantities, and who are anxious to establish or maintain a good reputation, are always careful to submit their pigments to examination, and by so doing not only add largely to their fame but to their profits as well. The opinion of experienced chemists can be obtained for a mere trifle compared with the loss which might be sustained by the purchase of one expensive pigment which turned out to be of inferior quality; and all large purchases are now consequently bought subject to analytical examination. The real value of most pigments—especially the expensive ones—can only be ascertained by experienced chemists and by careful chemical examination.

The number of pigments is very great, but we shall confine ourselves to those commonly used in ordinary painting.

### White Pigments.

(110.) The most important of the white pigments in use at the present time are White Lead and Zinc White. The former surpasses all other pigments in covering power, but is open to the objection that it blackens in atmospheres containing sulphuretted hydrogen gas. Zinc white is free from this objection, but it is deficient in covering power. Zinc sulphide, and a mixture of zinc oxide and sulphide, or oxysulphide of zinc, as well as oxide of zinc, are all sold under the name of Zinc White.

Chalk, Sulphate of Lime, Sulphate of Baryta, and Sulphate of Lead are white pigments seldom used alone, but chiefly as adulterants of White Lead and Zinc White. Of white pigments not in common use may be mentioned the following lead salts: The Basic Chloride, Tungstate, Antimonite, Antimoniate, and Antimony Whites. A qualitative examination is all that is necessary for chalk, sulphate of lime, &c.

### White Lead.

(111.) *Adulterants:—*

1. Insoluble silicates.
2. Sulphate of baryta.
3. Sulphate of lead.
4. Chalk.

(112.) *Composition:—*

Dry white lead should contain nothing but lead carbonate or hydrate, and should be of a pure white colour.

Mixed white lead should contain about 90 per cent. of white lead, calculated in the manner described in Art. 7, and 10 per cent. oil.

For method of analysis see Arts. 1 to 11.

### Zinc White.

(113.) The examination of zinc white has been described in Arts. 12 to 21.

(113*a*.) *Adulterants:—*

1. White lead.
2. Sulphate of baryta.
3. Chalk.
4. Insoluble silicates.
5. Magnesia (occasionally).

Pure samples of zinc white consist wholly of zinc oxide, zinc sulphide, or a mixture of both (zincic-oxy-sulphide).

### Yellow Pigments.

(114.) The most important yellow pigments are:—

1. **Chrome yellows and other chromates.**
2. **Ochres.**
3. **Italian and Sienna Earths.**
4. **Vienna red, Antwerp red, Terra Rosa.**
5. **Mars yellows.**
6. **Lakes.**
7. **Orpiment.**
8. **Massicot.**

**Other yellows are:—**

9. **Cassel yellow (oxide and chloride of lead).**
10. **Naples yellow (antimoniate of lead).**
11. **Ultramarine yellow (chromate of baryta).**

### Chrome Yellows.

(115.) For method of testing see Art 38, et seq. The examination of chrome yellows is most important, owing to the variation in the price of the various qualities. Their value depends solely on the per centage of chromate of lead present. The following instructive table shows the results of the analysis of special samples:—

Chrome Yellows.

(Quality as stated.)

| | 1st | 1st | 2nd | 2nd | 3rd | 3rd |
|---|---|---|---|---|---|---|
| Sulphate of Lime | — | — | 70·6 | 13·21 | 88·3 | 25·86 |
| Chromate of Lead | 100 | 53·03 | 29·4 | 82·43 | 11·7 | 66·98 |
| Moisture ........ | — | 1·42 | — | 4·36 | — | 7·16 |
| White Lead .... | — | 19·10 | — | — | — | — |
| Chalk .......... | — | 26·45 | — | — | — | — |
| | 100 | 100 | 100 | 100 | 100 | 100 |

The following table shows the composition of samples of which the quality was not stated:—

Chrome Yellows.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sulphate of lime .... | 25 | — | — | 30·6 | — | tr. | 54·4 | — |
| Chromate of lead .... | 75 | 65 | 97 | 69·4 | 70 | 21 | 45·6 | 94·08 |
| Sulphate of baryta ... | — | — | 3 | — | — | — | — | — |
| White lead and chalk | — | 35 | — | — | 30 | — | — | 5·92 |
| Chromate of potash ... | — | — | — | — | — | 79 | — | — |
| | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

From the above it is evident that nothing short of chemical examination can determine the real value of chrome yellows. And as the price varies from 28s. to 108s. per cwt., it is also evident that an enormous loss might be sustained by purchasing unknowingly a sample of inferior quality. It is indeed a difficult matter to obtain a sample of pure chrome yellow at the colour shop. The writer of these articles could relate many sad experiences in connection with chrome-yellows. One colourman frankly informed him that he never knew what a chrome-yellow was; another guaranteed that his was pure, but was "only cast on barytes." For very good reasons these four words are indelibly engraved in the writer's memory. First quality chrome-yellow should be pure; second quality should contain about 80 per cent.; and third quality 60 per cent., of chromate of lead. Those containing less should be sold as special mixtures, and not as chrome-yellows.

### Lemon Chrome.

(116.) *Composition:—*

| | | | |
|---|---|---|---|
| **Chromate of lead ....** | 51·5 | 43·14 | 68·32 |
| **Sulphate of lead ....** | 47·0 | 54·86 | — |
| **Chalk, water ........** | 1·5 | 2·00 | 31·68 |
| | 100 | 100 | 100 |

(117.) Adulterants the same as for chrome yellows, viz.:

**Sulphate of lime.**
**Sulphate of baryta.**
**White lead.**
**Chalk.**

### Other Chromates.

(118.) Chief among these is the basic chromate of lead. The hues vary from a reddish-yellow to a vermilion red.

When pure—which is seldom the case—they consist of oxide of chromium, with a greater or less excess of oxide of lead. The various tints now usually sold are prepared by mixing the various chromates with other colours.

### Yellow Ochres.

(119.) *Composition:—*

| Water: | | | | | | |
|---|---|---|---|---|---|---|
| Hygroscopic | 4·60 | 3·2 | 7·53 | 9·84 | 10·64 | 5·7 |
| Combined .. | 4·06 | 4·8 | | | | |
| Insoluble silicates, &c. .. | 74·86 | 73·5 | 71·13 | 71·85 | 75·46 | 71·0 |
| Oxide of Iron. | 14·96 | 18·5 | 20·40 | 15·80 | 13·90 | 20·6 |
| Chalk ........ | 1·52 | — | ·94 | 2·61 | — | 2·7 |
| | 100 | 100 | 100 | 100 | 100 | 100 |

For method of analysis see Arts. 29 to 36.

### Italian and Sienna Earths.

(120.) Treat same as ochres.

### Vienna Red, &c.

(121.) See Art. 51.

### Mars Yellow.

(122.) This pigment is of variable composition. It contains oxide and carbonate of iron, and alumina.

### Lakes.

(123.) These are seldom used except for very delicate tints. There are mineral lakes and vegetable lakes. The latter are mixtures of alumina, with colouring matters derived from the vegetable kingdom.

### Orpiment.

(124.) This beautiful pigment is chemically distinguished by the name of arsenious sulphide ($As_2S_3$).

(125.) The usual impurities are:—

1. Arsenious acid.
2. Sand, clay, &c.
3. Chalk or lime.
4. Free S

(126.) Tests for:—

1. *Arsenious Acid.*—Boil the sample in dilute hydrochloric acid, add a little $SH_2$ water. A yellow precipitate indicates arsenious acid.

2 and 3 are insoluble in caustic soda. Test further, as in examples already described.

4. Free sulphur is detected by treating a little of the sample with sulphide of carbon, decanting the liquid, and evaporating to dryness. A yellow residue burning with a blue flame and a suffocating smell is sulphur.

(127.) The samples in the market are usually of good quality. Recently a sample was examined which contained 7 per cent. of lime—an excessive and unusual amount of adulteration in a sample of King's yellow.

### Massicot or Litharge.

(128.) This is oxide of lead. It should be perfectly soluble in nitric acid without effervescence.

(129.) *Adulterants:—*

Chalk.
Earthy substances.

(130.) The latter are usually insoluble in nitric acid, or if soluble may be detected after the lead is precipitated by $SH_2$, as in Art 11.

(131.) The presence of chalk is indicated by effervescence on adding an acid to the sample, by precipitating the chalk, together with the lead, by means of sulphuric acid, washing the precipitate, boiling it in a concentrated solution of ammoniac acetate, filtering, adding to the filtrate oxalate of ammonia, a white precipitate giving a brick-red flame at the blowpipe, the presence of chalk may be confirmed.

### Naples Yellow.

(132.) See Art. 47.

### Ultramarine Yellow.

(133.) This is chromate of baryta—a beautiful lemon yellow pigment. It is completely soluble in hydrochloric acid. The chromium may be estimated as in Art. 34, treating it exactly similar to the precipitate mentioned in that article; and the barium may be estimated by adding dilute sulphuric acid to the filtrate, filtering, drying, and weighing the precipitated sulphate of baryta. Having estimated these, it should be seen that they exist in the proper proportion to form normal chromate of barium. If not, further investigation is necessary; chalk, sulphate of baryta, and sulphate of lime are occasionally present.

The other yellow pigments are rarely met with.

## THE VACUUM CONTINUOUS AUTOMATIC BRAKE.*

UNDER the title above given the Vacuum Brake Company have recently issued a descriptive pamphlet of the mechanism of the continuous automatic brake, with large-sized coloured diagrams which enable the reader to comprehend and thoroughly understand the arrangement and working of the brake. The automatic vacuum brake is applied by the driver or the guard, and is self-acting in case of accidental parting of the train or of damage to the brake itself. It is worked by a combination ejector placed on the engine, and controlled by one handle. This ejector exhausts air from the main pipe running through the train, and so produces a vacuum of about 20in. to 24in. on the top sides of the pistons in the brake-cylinders. When the handle of the ejector is moved to "brake on" air flows to the lower sides of the pistons, which are driven in upon the vacuum, and levers being connected, the brake-blocks are applied to the wheels. The pistons are kept air-tight to their cylinders by means of rolling rings, and there is consequently little friction and loss of power. The diagrams show in full size the ball-valve, the only acting portion of which is the rolling ball; the combination-ejector in one-third size; the guard's valve, the drip-trap, and the universal hose-coupling half size; while the brake-cylinders are shown on the scale of 3in. to the foot. The general arrangements of the brake, as applied to engines and coaches, are drawn on a scale of ½in. to the foot, so that those who desire to understand the mechanism of the Automatic Vacuum-brake will have no difficulty in comprehending its action. In the present practically perfected vacuum arrangement the brake can be applied any number of times without exhausting its power, and as the power is atmospheric pressure, joints are easily kept tight, there being an entire immunity from any tendency to burst the connecting hose, the coupling of which is an ingenious yet simple arrangement which cannot possibly be put together except in the proper manner. The brake is stated to meet all the requirements of the Board of Trade, and as a small ejector is capable of maintaining the vacuum, there is economy in the use of steam.

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* The Vacuum Continuous Automatic Brake, with Universal Coupling. London: The Vacuum Brake Co., Limited.

## COMMERCIAL ORGANIC ANALYSIS.*

WHEN the first edition of this book appeared some years ago, we expressed, in almost unqualified terms, our appreciation of its usefulness and the care and ability with which it had been written. In reviewing the second edition we are glad to be able to indorse every word we then wrote, and in addition to congratulate the author on the alterations he has had the courage to make in the arrangement of the subject matter, so that each volume should treat more especially of kindred products. Thus, the volume now under notice is devoted chiefly to the consideration of bodies of the fatty series and of vegetable origin; while the second volume, the publication of which is promised shortly, will contain information on oils, hydrocarbons, coal-tar products, and colouring matters. A third volume the author promises to devote to the consideration of nitrogenised organic substances, including cyanogen compounds, alkaloids, and organic bases, albuminoids, &c. We have no doubt this rearrangement of the subject matter will be of great advantage to the reader, by rendering the book more convenient for reference, while adapting each particular volume to the special requirements of certain users.

The volume now issued is divided into six main sections or chapters. The "Introduction" deals mainly with the methods of determining specific gravity, melting and boiling points, specific rotatory power, elementary [composition, &c., of organic substances. Very useful tables are given showing the behaviour of various organic bodies with solvents, and concise directions for searchings for poisonous metals present as impurities in organic matters.

In the chapter on "Alcohols" the various methods of alcoholometry are described, and extended tables of densities of diluted alcohol are given. The articles on wine and beer make their first appearance in this edition, and contain several items of information not generally to be met with. The sections on spirits, liqueurs, and tinctures have undergone little alteration.

Under "Neutral Alcoholic Derivatives," Mr. Allen describes the methods of examining aldehyde, chloral, chloroform, ether, and the various compound ethers employed in medicine and the arts. The section on spirit of nitrous ether probably contains the fullest account of that preparation hitherto published.

The "Sugars" meet with very thorough description. The chapter has been transferred from the second volume of the first edition, and has evidently undergone careful revision. The section on commercial glucose is especially complete, and contains suggestions which we may expect to see utilised for the assay of similar materials. The author describes the inversion of cane sugar by "invertin"—the soluble ferment of yeast, and shows how it may be applied in analysis. An ingenious method of determining cellulose in a complex mixture of sugars is also given. Gallisin and saccharin are fully described, and a remarkably complete account is given of maltose, and the methods of assaying malt products. Here the practical advantage of including the sugars in the same volume as the alcohols becomes fully evident.

Under "Starch and its Isomers," Mr. Allen describes the microscopic examination of starches, the proximate analysis of plants, the detection of adulterants in flour and bread, the analysis of wood tissues, and the assay of gun-cotton, dextrine, gum arabic, and other bodies. Though affording less scope for original treatment than other portions of the book, the chapter contains a mass of information, and is enriched with various tables and a steel engraving showing the microscopic appearance of the adulterants of arrowroot.

The last chapter of the book treats of the "Acid Derivatives of Alcohols and Vegetable Acids." Broadly speaking, it is little changed from the first edition; but in the details of arrangement and in the methods described there are numerous changes. A copious index completes the volume.

In compiling his unique work Mr. Allen has collected items of information from a great variety of sources, and, as he states in the preface, has received the assistance of a considerable number of chemists of special experience in particular directions. This fact adds materially to the value of the book which will certainly maintain the position as a standard work which was attained by the former edition. In a book of so technical a nature, and containing such a multiplicity of formulæ and figures, mistakes are certain to occur, though we are bound to say that a careful inspection has revealed very few of them; but the accuracy and attention to detail shown by the author are the best guarantees that errors and misstatements of all kinds are reduced to a minimum. Thanks to Mr. Allen, the professional chemists, manufacturers, and pharmacists now have a book to which they can refer with confidence, and a certainty of finding everything of value known respecting the composition and assay of organic products.

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* Commercial Organic Analysis. By ALFRED H. ALLEN, F.I.C., F.C.S., Public Analyst for the Borough of Sheffield, &c. Second Edition, Volume I. London: J. and A. Churchill.

## THE ELEMENTARY PRINCIPLES OF THE GAS ENGINE.*

BEFORE the invention of the steam-engine, the only powers employed in mechanics were those of wind and water mills and animal power. In the first two no conversion of one force into another took place; they were mere kinematic devices for employing the mechanical force already existing in the gale of wind and the head of water. With regard to the power developed by man and other animals, we had in them examples of most efficient heat-engines, converting into power a large percentage of the fuel burnt in the lungs. But animal power is small in amount, and it is expensive for two reasons—first, because the agents require long intervals of rest, during which they still burn fuel; the next, because the fuel they require is very expensive. A pound of bread, or beef, or oats or beans, costs a great deal more than a pound of coal; while it does not, by its combustion, generate nearly so much heat. The steam-engine, therefore, took the place of animal power, and for a long time stood alone; and nearly all the motive power derived from heat is still produced by the mechanism which Watt brought to such great efficiency in so short a time. Now the practical question for all designers and employers of heat-engines is to determine how the greatest quantity of motive force can be developed from the heat evolved from a given kind of fuel; and coal being the cheapest of all, we will see what are the results obtainable from it by the steam-engine. In this we have three efficiencies to consider—those of the furnace, the boiler, and the cylinder. First, with respect to the furnace, the object is to combine the carbon and the hydrogen of the coal with a sufficient quantity of the oxygen of the air to effect complete combustion into carbonic acid and water. In order to do this, we have to use a quantity of air much larger than is theoretically necessary, and also to heat an amount of inert nitrogen five times greater than the necessary oxygen; and we are therefore obliged to create a draught which carries away to the chimney a considerable portion of the heat developed. The combustion, moreover, is never perfect, and some heat is lost by conduction and radiation. The principal loss is by hot gases escaping from the flues to the chimney. Even with well-set boilers, the temperature in the chimney varies from 400° to 600°. Taking the mean of 500°, this would represent a large proportion of the total heat, even if the combustion were perfect; for, as a general rule, the supply of air to a furnace is double that which is theoretically necessary. For our present purpose it will be sufficient to see how much the whole loss is, without dividing it under the several heads of "imperfect combustion," "radiation," and "convection," by the heated gases passing to the chimney.

With a very good boiler and furnace, each pound of coal evaporates 10lb. of water from 62°, changing it into steam of 65lb. pressure at a temperature of 312°, or 250° above that of the water from which it is generated. Besides these 250°, each pound of steam contains 894 units of latent heat, or 1,144 units in all. A very good condensing engine will work with 2·2lb. of coal and 22lb. of steam per horse per hour. Now, 1lb. of good coal will, by its combustion, produce 14,000 heat-units, and the 2·2lb. of coal multiplied by 14,000 represent 30,800 heat-units. Of these we find in the boiler 22 × 1,144, or 25,168 units, or about 81½ per cent. of the whole heat of combustion; so that the difference (5,632 units, or 18½ per cent.) has been lost by imperfect combustion, radiation, or convection. The water required for condensing this quantity of steam is 550lb.; and taking the temperature in the hot well as 102°, 550lb. have been raised 40° from 62°. Thus we account for 550 × 40 = 22,000, or (say) 71½ per cent. still remaining as heat. If we add this 71½ per cent. to 18½, we have 90 per cent., and there remain only 10 per cent. of the heat that can possibly have been converted into power. But some of this has been lost by radiation from steam pipes, cylinder, &c. Allowing but 1 per cent. for this, we have only 9 per cent. as the efficiency of a really good condensing engine. This estimate agrees very closely with the actual result; for the 2·2lb. of coal would develop 30,800 heat-units; and this multiplied by Joule's equivalent amounts to nearly 24 millions of foot-pounds. As 1 horse-power is a little less than 2 million foot-pounds per hour, only one-twelfth, or a little more than 8 per cent., of the total heat is converted; so that whether we look at the total quantity of heat which we show unconverted, or the total heat converted, we find that each supplements and corroborates the other. If we take the efficiency of the engine alone, without considering the loss caused by the boiler, we find that the 25,168 heat-units which entered the boiler should have given 19,429,696 ft.-lb.; so that the 2 millions given by the engine represent about 10 per cent. of the heat which has left the boiler. The foregoing figures refer to large stationary or marine engines, with first-rate boilers. When, however, we come to high-pressure engines of the best type, the consumption of coal is twice as much; and for those of any ordinary type it is usual to calculate 1 cubic foot, or 62½lb., of water evaporated per horse-power. This would reduce the efficiency to about 6 per cent. for the best and 3 per cent. for ordinary non-condensing engines; and if to this we add the inefficiency of some boilers, it is certain that many small engines do not convert into power more than 2 per cent. of the potential energy contained in the coal.

Before explaining the principle upon which the gas-engine and every other hot-air engine depends, I shall remind you of a few data with which most of you are already familiar. The volume of every gas increases with the temperature; and this increase was the basis of the air thermometer—the first ever used. It is to be regretted that it was not the foundation of all others, for it is based on a physical principle universally applicable. Although the volume increases with the temperature, it does not increase in proportion to the degrees of any ordinary scale, but much more slowly. Now, if to each of the terms of an arithmetical series we add the same number, the new series so formed increases or decreases more slowly than the original; and it was discovered that by adding 461 to the degrees of Fahrenheit's scale, the new scale so formed represented exactly the increment of volume caused by increase of temperature. This scale, proposed by Sir W. Thomson in 1848, is called the "scale of absolute temperature"; its zero, called the "absolute zero," is 461° below the zero of Fahrenheit, or 493° below the freezing point of water; and the degree of heat measured by it is termed the "absolute temperature." It is often convenient to refer to 39° Fahr. (which happens to be the point at which water attains its maximum density), as this is the same as 500° absolute, for, counting from this datum level, a volume of air expands exactly 1 per cent. for 5°, and would be doubled at 1000° absolute, or 539° Fahr.

Whenever any body is compressed, its specific heat is diminished, and the surplus portion is, as it were, pushed out of the body, appearing as sensible heat; and whenever any body is expanded its specific heat is increased, and the additional quantity of heat requisite is, as it were, sucked in from surrounding bodies, so producing cold. This action may be compared to that of a wet sponge from which, when compressed, a portion of the water is forced out, and when the sponge is allowed to expand the water is drawn back. This effect is manifested by the increase of temperature in air-compressing machines, and the cold produced by allowing or forcing air to expand in air-cooling machines. At 39° Fahr. 1lb. of air measures 12½ cubic feet. Let us suppose that 1lb. of air at 39° Fahr. = 500° absolute, is contained in a non-conducting cylinder of 1ft. area and 12½ft. deep under a counterpoised piston. The pressure of the atmosphere on the piston = 144 square inches × 14·7lb., or 2,116lb. If the air be now heated up to 539° Fahr. = 1000° absolute, and at the same time the piston is not allowed to move, the pressure is doubled; and when the piston is released it would rise 12½ft. provided that the temperature remained constant, and the indicator would describe a hyperbolic curve called an "isothermal," because the temperature would have remained equal throughout. But, in fact, the temperature is lowered, because expansion has taken place, and the indicator curve which would then be described is called an "adiabatic curve," which is more inclined to the horizontal lines when the volumes are represented by horizontal and the pressures by vertical co-ordinates. In this case it is supposed that there is no conduction or transmission (diabasis) of heat through the sides of the containing vessel. If, however, an *additional* quantity of heat be communicated to the air, so as to maintain the temperature at 1000° absolute, the piston will rise until it is 12½ft. above its original position, and the indicator will describe an isothermal curve. Now mark the difference. When the piston was fixed, only a heating effect resulted; but when the piston moved up 12½ft., not only a heating, but a mechanical—in fact, a thermo-dynamo—effect was produced, for the weight of the atmosphere (2,116lb.) was lifted 12½ft. = 26,450 foot-pounds.

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* The substance of a paper by Mr. DENNY LANE, Cork, read before the Gas Institute.

The specific heat of air at constant pressure has been proved by the experiments of Regnault to be 0·2378, or something less than one-fourth of that of water—a result arrived at by Rankine from totally different data. In the case we have taken there have been expended 500 × 0·2378, or (say) 118·9 heat-units to produce 26,450 foot-pounds. Each unit has, therefore, produced $\frac{26{,}450}{118{\cdot}9} = 222{\cdot}5$ foot-pounds, instead of 772 foot-pounds, which would have been rendered if every unit had been converted into power. We therefore conclude that $\frac{222{\cdot}5}{772} = 29$ per cent. of the total heat has been converted. The residue, or 71 per cent., remains unchanged as heat, and may be partly saved by a regenerator, or applied to other purposes for which a moderate heat is required.

The quantity of heat necessary to raise the heat of air at a constant volume is only 71 per cent. of that required to raise to the same temperature the same weight of air under constant pressure. This is exactly the result which Laplace arrived at from observations on the velocity of sound, and may be stated thus:—

| | Specific Heat. | | Foot Pounds. | Per Cent. |
|---|---|---|---|---|
| $K_p$ = 1lb. of air at constant pressure.. | 0·2378 | × 772 = | 183·5 = | 100 |
| $K_v$ = 1lb. of air at constant volume.. | 0·1688 | × 772 = | 130·3 = | 71 |
| Difference being heat converted into power.... | 0·0690 | × 772 = | 53·2 = | 29 |

Or, in a hot-air engine without regeneration, the maximum effect of 1lb. of air heated 1° Fahr. would be 53·2 f.p. The quantity of heat $K_v$ necessary to heat air under constant volume is to $K_p$, or that necessary to heat it under constant pressure, as 71 : 100, or as 1 : 1·408, or very nearly as 1 : $\sqrt{2}$—a result which was arrived at by Masson from theoretical considerations. The 71 per cent. escaping as heat may be utilised in place of other fuel, and with the first hot-air engine I ever saw it was employed for drying blocks of wood. In the same way, the unconverted heat of the exhaust steam from a high-pressure engine, or the heated gases and water passing away from a gas-engine, may be employed.

When I first wrote on this subject I relied upon some data which led me to suppose that the heating power of ordinary coal gas was higher than it really is. At our last meeting, Mr. Hartley proved, by experiments with his calorimeter, that gas of 16 or 17 candles gave only about 630 units of heat per cubic foot. Now, if all this heat could be converted into power, it would yield 630 × 772, or 486,360 f.p., and it would require only $\left(\frac{1{,}980{,}000}{486{,}360}\right) = 4{\cdot}07$ cubic feet to produce 1 indicated horse-power. Some recent tests have shown that, with gas of similar heating power, 18 cubic feet have given 1 indicated horse-power, and therefore $\frac{4{\cdot}07}{18} = 22{\cdot}6$ of the whole heat has been converted—a truly wonderful proportion when compared with steam-engines of a similar power, showing only an efficiency of 2 to 4 per cent.

The first gas-engine which came into practical use was Lenoir's, invented about 1866, in which the mixture of gas and air drawn in for part of the stroke at atmospheric pressure was inflamed by the spark from an induction coil. This required a couple of cells of a strong Bunsen battery, was apt to miss fire, and used about 90 cubic feet per horse-power. This was succeeded by Hugon's engine, in which the ignition was caused by a small gas-flame, and the consumption was reduced to 80 cubic feet. In 1864 Otto's atmospheric engine was invented, in which a heavily-loaded piston was forced upwards by an explosion of gas and air drawn in at atmospheric pressure. In its upward stroke the piston was free to move; but in its downward stroke it was connected with a ratchet, and the partial vacuum formed after the explosion beneath the piston, together with its own weight in falling, operated through a rack, and caused rotation of the fly-wheel. This engine (which, in an improved form, uses only 20 cubic feet of gas) is still largely employed, some 1,600 having been constructed. The great objection to it was the noise it produced, and the wear and tear of the ratchet and rack arrangements. In 1876 the Otto-Crossley silent engine was introduced. As you are aware, it is a single-acting engine, in which the gas and air are drawn in by the first outward and compressed by the first inward stroke. The compressed mixture is then ignited, and, being expanded by heat, drives the piston outwards by the second outward stroke. Near the end of this stroke the exhaust-valve is opened, the products of combustion partly escape, and are partly driven out by the second inward stroke. I say partly, for a considerable clearance space, equal to 0·38 per cent. of the whole cylinder volume, remains unexhausted at the inner end of the cylinder. When working to full power, only one stroke out of every four is effective; but this engine works with only 18 to 22 cubic feet of gas per horse-power. Up to the present time I am informed that about 18,000 of these engines have been manufactured. Several other compression engines have been introduced, of which the best known is Mr. Dugald Clerk's, using about 20ft. of Glasgow cannel gas. It gives one effective stroke for every revolution; the mixture being compressed in a separate air-pump. But this arrangement leads to additional friction; and the power measured by the brake is a smaller percentage of the indicated horse-power than in the Otto-Crossley engine. A number of gas-engines—such as Bisschop's (much used for very small powers), Robson's (at present undergoing transformation in the able hands of Messrs. Tangye), Korting's, and others—are in use; but, so far as I can learn, all require a larger quantity of gas than those previously referred to.

I have all along spoken of efficiency as a percentage of the total quantity of heat evolved by the fuel; and this is, in the eyes of a manufacturer, the essential question. Other things being equal, that engine is the most economical which requires the smallest quantity of coal or of gas. But men of science often employ the term efficiency in another sense, which I will explain. If I wind a clock, I have spent a certain amount of energy lifting the weight. This is called "energy of position"; and it is returned, by the fall of the weight, to its original level. In the same way if I heat air or water I communicate to it energy of heat, which remains potential as long as the temperature does not fall, but which can be spent again by a decrease of temperature. In every heat-engine, therefore, there must be a fall from a higher to a lower temperature, otherwise no work could be done. If the water in the condenser of a steam-engine were as hot as that in the boiler, there would be equal pressure on both sides of the piston, and consequently the engine would remain at rest. Now, the greater the fall, the greater the power developed; for a smaller proportion of the heat remains as heat. If we call the higher temperature T and the lower T′ on the absolute scale, T − T′ is the difference; and the ratio of this to the higher temperature is called the "efficiency." This is the foundation of the formula we meet so often: $E = \frac{T - T'}{T}$ A perfect heat-engine would, therefore, be one in which the temperature of the absolute zero would be attained, for $\frac{T - O}{T} = 1$ per cent. This low temperature, however, has never been reached; and in all practical cases we are confined within much narrower limits. Taking the case of the condensing engine, the limits were 312° to 102°, or 773° and 563° absolute, respectively. The equation then becomes $\frac{773 - 563}{773} = \frac{210}{773}$ or (say) 27 per cent. With non-condensing engines the temperatures may be taken as 312° and 212°, or 773° and 673° absolute, respectively. The equation then becomes $\frac{773 - 673}{773} = \frac{100}{773^\circ}$ or nearly 13 per cent. The practical efficiencies are not nearly this; but they are in about the same ratio, $\frac{27}{13}$; and if we multiply the theoretical efficiencies by 0·37, we get the practical efficiencies, say 10 per cent. and 5 per cent., and it is in the former sense that M. Witz calculated the efficiency of the steam-engine at 35 per cent.—a statment which, I own, puzzled me a little when I first met it. These efficiencies do not take any account of loss of heat before the boiler. In the case of the gas-engine the question is much more complicated on account of the large clearance space, and the early opening of the exhaust. The highest temperature has been calculated by the American observers at 3443° absolute, and the observed temperatures of the exhaust gases was 1229°. The fraction then becomes $\frac{3443 - 1229}{3443} = 64$ per cent. If we multiply this by 0·37, as we did in the case of the steam-engine, we get 23·7 per cent., or approximately the same as that arrived at by direct experience. Indeed, if the consumption is, as stated sometimes, less than 18ft., the two percentages would be exactly the same. I do not put this forward as scientifically true; but the coincidence is at least striking.

I have spoken of the illuminating power of the gas as of importance; for the richer gases have also more calorific power, and an engine would, of course, require a smaller quantity of them. The heat-giving power does not, however, vary as the illuminating power, but at a much slower rate; and, adopting the same contrivance as that on which the absolute scale of temperature is formed, I would suggest a formula of the following type: $H = C(I + K)$, in which H represents the number of heat-units given out by the combustion of one cubic foot of gas, I is the illuminating power in candles, and C and K two constants to be determined by experiment. If we take the value for motive power of the different qualities of gas as given in Mr. Charles Hunt's interesting paper in our *Transactions* for 1882, C might, without any great error, be taken as 22 and K as 7·5. With Pintsch's oil gas, however, as compared with coal gas, this formula does not hold, and C should be taken much lower and K much higher than the figures given above; that is to say, the heating power increases in a slower progression. The data available, however, are few; but I trust Mr. Hartley will on this, as he has done on so many other scientific subjects, come to our aid.

I will now refer to the valuable experiments of Messrs. Brooks and Steward, which were most carefully made. Everything was measured—the gas by a 60-light and the air by a 300-light meter; the indicated horse-power, by a steam-engine indicator; the useful work, by a Prony brake; the temperature of the water, by a standard thermometer; and that of the escaping gases by a pyrometer. The gas itself was analysed, and its heating power calculated from its composition as 617·50. Its specific gravity was 0·464, and the volume of air was about seven times that of the gas used (or one-eighth of the mixture), and was only 11½ per cent. by weight more than was needed for perfect combustion. The results arrived at were as follows:—

| | |
|---|---|
| Converted into indicated horse-power, including friction, &c. ............... | 17·0 |
| Escaped with the exhaust gas ......... | 15·5 |
| Do. in radiation ............... | 15·5 |
| Communicated to water in the jacket | 52·0 |

It will thus be seen that more than half of the heat is communicated to the water in the jacket. Now, this is the opposite of the steam-engine, where the jacket is used to transmit heat *to* the cylinder, and not *from* it. This cooling is rendered necessary, because without it the oil would be carbonised, and lubrication of the cylinder rendered impossible. Indeed, a similar difficulty has occurred with all hot-air engines, and is, I think, the reason they have not been more generally adopted. I felt this so strongly that, for some time after the introduction of the gas-engine, I was very cautious in recommending those who consulted me to adopt it. I was afraid that the wear and tear would be excessive. I have, however, for some time past been thoroughly satisfied that this fear was needless, as I am satisfied that a well-made gas-engine is as durable as a steam-engine, and the parts subject to wear can be replaced at a moderate cost. We have no boiler, no feed pump, no stuffing boxes to attend to—no water gauges, pressure gauges, safety valve, or throttle valve to look after. The governor is of a very simple construction, and the slide valve may be removed and replaced in a few minutes. An occasional cleaning out of the cylinder at considerable intervals is all the supervision that the engine requires.

The very large percentage of heat absorbed by the water-jacket should point out to the ingenuity of inventors the first problem to be attacked—viz., how to save this heat without wasting the lubricant or making it inoperative; and in the solution of this problem I look for the most important improvement to be expected in the engine. The most obvious contrivance would be some sort of intercepting shield, which would save the walls of the cylinder and the rings of the piston from the heat of the ignited gases. I have just learned that something of the kind is under trial. Another solution may possibly be found in the employment of a fluid piston; but here we are placed in a dilemma between the liquids that are decomposed and the metals that are oxidised at high temperatures. Next, the loss by radiation—15 per cent.—seems large; but this is to be attributed to the fact that the inside surface of the cylinder is at each inward stroke exposed to the atmosphere—an influence which contributes to the cooling necessary for lubrication. The remaining 15 per cent., which is carried away by the exhaust, is small compared with the proportion passing away with the exhaust steam of a high pressure, or the water of a condensing engine. As the water in the jacket can be safely raised to 212° Fahr. the whole of the jacket heat can be utilised where hot water is required for other purposes; and this, with the exhaust gases, has been used for drying and heating purposes.

With such advantages, it may be asked: Why does not the gas-engine everywhere supersede the steam-engine? My answer is a simple one: The gas we manufacture is a dear fuel compared with coal. Ordinary coal-gas measures 30 cubic feet to the pound; 1,000 cubic feet, therefore, weighs 33lb.; and taking the price at 2s. 9d. per 1,000 cubic feet, it costs 1d. per lb. The 30 cubic feet at 6,300 give 190,000 all available heat. Although good coal may yield 14,000 units by its combuston, only about 11,000 of these reach the boiler; so that the ratio of the useful heat is $\frac{11}{19}$. The thermal efficiency of the best non-condensing engine to that of the gas engine is in the ration $\frac{4}{22}$. Multiplying together these two ratio, we get $\frac{11}{19} \times \frac{4}{22\frac{1}{2}} = \frac{44}{428}$. That is, speaking roughly, 1lb. of gas gives about ten times as much power as 1lb. of coal does in a good non-condensing engine. But at 18s. 1d. a ton we get 10lb. of coal for 1d.; so that with these figures the cheapness of the coal would just compensate for the efficiency of the gas. As to the waste heat passing away from the engine being utilised, here the gas-engine has no advantage; and, so far as this is concerned, the gas is about eight times dearer than coal. The prices of gas and coal vary so much in different places, that it is hard to determine in what cases gas or coal will be the dearer fuel, considering this point alone.

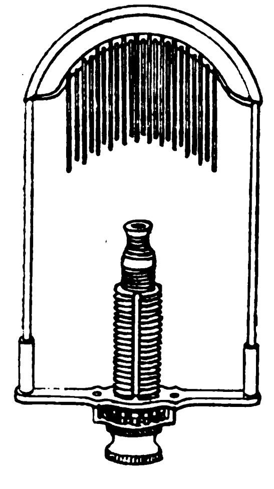
But there are other kinds of non-illuminating gases—such as Wilson's, Strong's, and Dowson's—which are now coming into use; and at Messrs. Crossley's works you will have an opportunity of seeing a large engineering factory employing several hundred mechanics, and without a chimney, in which every shaft and tool is driven by gas-engines supplied by Dowson's gas, and in which the consumption of coal is only 1·21b. per horse-power. The greatest economy ever claimed for the steam-engine was a consumption of 1·6lb., and this with steam of very high pressure, expanded in three cylinders successively. Thus in a quarter of a century the gas-engine has beaten in the race the steam-engine; although from Watt's first idea of improvement nearly a century and a quarter have elapsed.

As regards the steam-engine, it is the opinion of competent authorities that the limits of temperature between which it works are so restricted, and so much of the heat is expended in producing a change of state from liquor to vapour, that little further improvement can be made. With respect to gas-engines, the limits of temperature are much further apart. A change of state is not required, and so very great improvement may still be looked for; and it is not impossible that some of the younger members of our body may live to see that period foretold by one of the greatest of our civil engineers—that the happy time when boiler explosions will be matters of history—that period, not a millennium removed by a thousand years, but an era deferred perhaps by only half a dozen decades, when the use of the gas-engine will be universal, and "a steam-engine can be found only in a cabinet of antiquities."

## THE WATER-GAS INCANDESCENT LIGHT.

THE following description of the Fahnebjelm water-gas incandescent light, which has lately been utilised with much success in Germany, is contained in a paper read by Prof. R. W. Raymond, of New York, before the American Institute of Mining Engineers:—

The idea of obtaining light from incandescent solids is not new; nor is it new to make such bodies incandescent by holding them in a heating flame. But the successful combination of the right substance and form of the body to be heated with the right kind of flame, and the right means of adjustment, has not, to my knowledge, been accomplished heretofore; and it seems to me that the water-gas incandescent light of Mr. Otto Fahnehjelm, of Sweden, in which these objects appear to have been secured, is destined to become both famous and useful. The first fact upon which this invention is based is the intense temperature of the flame of water-gas. The combustion of this gas through an ordinary coal-gas burner, without blast or aid of any kind, will melt platinum wire. The next important basis of the invention is the form of the incandescent body. This is shown in the accompanying cut, which represents an ordinary fantail gas-burner, fitted with the necessary apparatus for producing the new incandescent light. A frame, movable by means of a screw up and down along the burner, carries at its two extremities sockets to receive two iron wire standards, which carry a curved back, provided with two rows of long teeth. By turning the screw, these teeth can be brought as near the tip of the burner as may be desired. They are composed of magnesia, which has been first baked at a high temperature, then ground, and then moulded under high pressure, and with some agglutinated material, such as starch. The flat flame of the water-gas passes up between the two rows of vertical teeth, which thus receive its greatest heat, and do not come into contact with its comparatively cooler interior. They become immediately and beautifully luminous, with a perfectly white light, which does not, like gas or candle light, change the daylight appearance of colours, and which can even be used for photographing. It is steadier than the incandescent electric. The flickering of the gas flame (which is non-luminous, and, when the comb is glowing, quite invisible) does not at all affect the steadiness of the light. If the gas is blown out, or if, by the use of a cock without a stop, it is turned off and then unwittingly on again, no evil results can follow in this case, for the comb goes on glowing for several seconds, and the gas consequently relights itself. The magnesia teeth have before use the appearance of starch. When thoroughly well prepared, they should possess considerable strength. The best that have been made thus far, I believe, would sustain eight ounces avoirdupois hung from the middle of the needle which was laid across supports 1in. apart. Since the diameter is less than $\frac{1}{16}$in., this indicates a good degree of strength. The needles are held in a composition of plaster of Paris, which fills the curved back of the comb. This back, like the side wires, is of iron; and the whole comb, with its side wires, costs about three cents. Apart from accidental breakage, such a comb endures from 80 to 150 hours incandescence before it must be removed. The first effect of the high white heat upon the needles is to make them translucent, like porcelain. Probably this change is really a condensation, fusing into a continuous mass what had previously been but a compressed aggregate of particles. The result is a gradual shortening of the needles, so that after about 15 hours it is necessary to turn the screw and bring the comb down towards the flame. This process is repeated from time to time, until at last the needles have become so short that the iron back would be in danger from the flame if they were brought fairly into it. Then the comb must be taken out, and a new long-toothed one substituted. Exact photomeric and economic tests have yet to be made under American conditions, and for water-gas produced by different processes. Speaking in a general way, I should say that the quantity of pure water-gas required to produce a given amount of light by this system is about four-fifths (in volume) the quantity of carburetted water-gas, like the Tessié gas of the Municipal Company of New York, required to give the same amount of light. The cost of the non-carburetted water-gas is, of course, much smaller. It can be sold to large profit for 50 cents per thousand cubic feet. We have, then, in this invention, a light which is actually much cheaper than ordinary gas light, while in quality it equals, and in steadiness, uniformity, and simplicity of management far surpasses, the electric incandescent light.



## THE PROPER CARE AND USE OF MICROSCOPE LENSES.*

By William Wales.

HOWEVER good the lenses of an instrument may be, they will not do their best work except when properly cared for and properly used. Yet I have met with reputable microscopists who do not in practice appreciate this obvious truth. Let me show you how a lens is cleaned. My implements are four—an old, soft, silk handkerchief, a small stick of soft wood, a phial of alcohol, and a watchmaker's glass of two powers. I have here an eyepiece. I will first examine it with the magnifying glass, by reflected light, to learn its condition. If it be found to need cleaning, alcohol is to be applied with the handkerchief. This liquid must not be allowed to touch the lacquer; but the cell which holds the lens will not be harmed by it, since that has been burned black with acid. If, after the cleaning, fibres from the cloth be found adhering to the lens, they may be blown off by a quick breath.

I have brought an objective which was sent to me to be cleaned. I will attach it to an instrument, and will place under it a slide of familiar diatoms. Now view the object through the lens. It looks so obscure that you will all exclaim, "Well, this is a very poor objective;" whereas it is of excellent quality, as you shall presently see. In it are eight pieces of glass. The back combination is composed of two crowns and the flint; the middle, of a double-concave flint and a double-convex crown; the front, of two crowns, with a flint between them. It has, probably, not been cleaned for twenty years. Suppose your watch to have been thus neglected! I will now clean this objective. I begin the work by unscrewing the cells. I then moisten a part of the handkerchief with alcohol, and with the help, if needed, of the stick of wood in searching the corners, carefully clean each combination, and I then screw each cell back accurately to its place. The work is now finished, and I will attach the objective again to the microscope, and will again ask you to view the slide of diatoms through it. The dimness is now, you perceive, all gone. Indeed, you can hardly believe it the same objective; and you have ocular proof that cleanliness is essential to the best performance of a lens, and are witnessing an instance of the dependence of important results on attention to little things.

Several years ago, while I was getting ready to visit England, the owner of a Powell and Lealand objective wished me to take the lens to its makers for correction or exchange. "It is a poor lens," he said. I could not credit his statement, for I knew the work of the Messrs. Powell and Lealand to be faultless. I called on those gentlemen. We examined the objective together, and discovered on one of the combinations a film of some substance which could not be removed except with alcohol. In five minutes the lens was clean and in perfect order; and to this day the owner refuses to believe that the lens which I brought back to him is the same that I took abroad. Never trust the cleaning of your objectives to the brass-worker, or to any person who does not know how carefully a lens ought to be handled. The brass-worker will polish the outside of the objective, but will get the lenses out of centre. To my great disgust, I once found a brass-worker subjecting one of my 4-10th-inch lenses to that treatment. I asked, "What are you doing with that objective?" "Putting it in order at the request of its owner," he said; "he wants to sell it." Taking the lens, I cleaned it for him without charge. A camel's-hair brush can neither completely nor safely remove the film of dust with which the exposed surface of the back combination of an objective is sometimes found to be coated. It will make a series of rings on the surface of the lens, and it may, if grit be present, scratch the glass. Nor should the handkerchief, either wet or dry, be introduced into the tube of any but a low-power objective. The cells must first be unscrewed from their mountings, and then the cleaning can be done properly. But, let me add, an objective ought never to be taken apart by anyone but its maker. He has the lathe upon which it was made, and he alone, when the parts have been separated, can replace them in their original adjustment to the optical centre. Any other person will be likely to screw in the cells either too tightly or not tightly enough, and will thus throw the combinations out of their necessary delicate relation to one another. Besides, unless skill and care be exercised in screwing the parts together, the front and the middle combinations will sometimes be brought in contact, and the flint glass, which is very thin at the centre, will be broken. The screw-thread of the cells is very delicate. Yet some persons, after failing to catch it, apply force enough to break it. Such carelessness passes comprehension.

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* A paper read before the New York Microscopical Society.

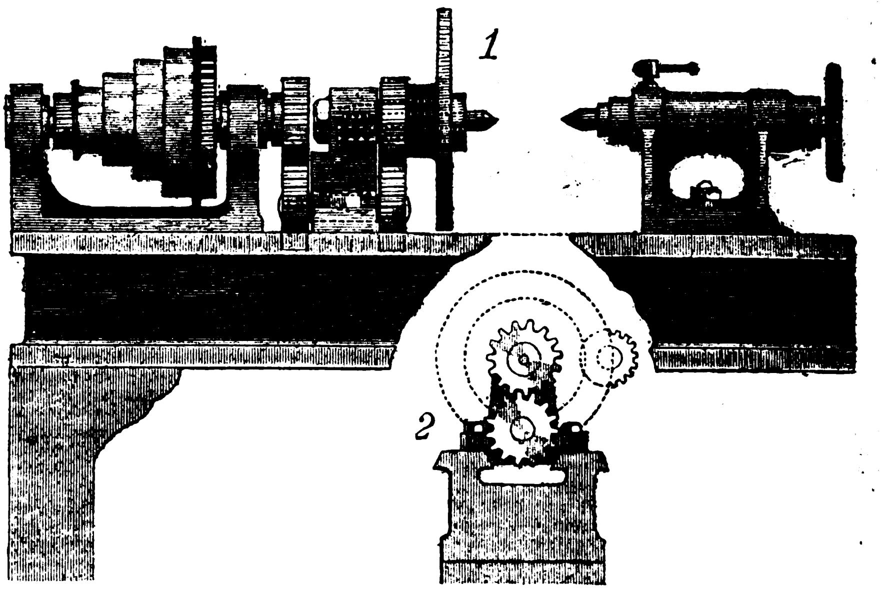
A large angle oil-immersion lens gets out of order easily. If you find the definition of such objective to have lost its sharpness, you may know that the front lens is out of centre. It has come in contact with the slide. A very slight pressure is sufficient to work the mischief. This susceptibility to injury is unavoidable, as every optician will tell you. It is incident to the requirements of high-angle construction. A few days ago an objective was sent to me with the request that the front lens should be reset. It had in some way been forced out of its place. I reset it as well as I could. But that objective, even if it had been repaired by its makers, the Messrs. Powell and Lealand, can never be what it was before the injury. The only way of repairing it was by inserting a ring of cement which, projecting slightly through the shoulder, necessarily cut down the angle. A heavy shoulder means, of course, a low angular aperture. A novel method of using an immersion lens came under my notice recently. A water-immersion objective had been ordered. It was made and sent, but it did not give satisfaction. I inquired by letter, "In what way do you proceed to work with it?" "I fill it with distilled water, and then screw it to the instrument," was the reply. An objective is sometimes almost ruined through sheer carelessness. I made a costly lens for a New York optician. He tossed it several times in his hand, and finally dropped it upon the floor. "Oh," he said, "that will not harm it!" I looked at it, and found the front combination tilted at an angle of about 45°. This act of carelessness cost that optician twenty-five dollars.

I have here the back setting of a 1½in. lens which was made by me several years ago. The purchaser of the lens had screwed it so tightly to his microscope that he could not, with his hand, unscrew it. So he used a pair of heavy gasfitter's pliers, and succeeded in pulling the tube of the fine adjustment out of the body of the instrument. This rude handling damaged the microscope to the amount of forty-five dollars. Quite recently the owner of an instrument which cost three hundred and fifty dollars told me that he had a wonderfully clever son. "Why," he exclaimed, "he has, with a screw-driver, taken the microscope all apart! He is unable, however, to put it together again." This outrage illustrates the incapacity of some people, old as well as young, to appreciate the products of fine workmanship. I do not favour the nose-piece. If you must have one, choose one that is of good design and thoroughly well made. Lenses, especially those of high power, ought not to be tested with the use of this accessory. A superior lens, worked by an illustrious microscopist, becomes its maker's best advertisement. But when it falls into the hands of a careless or incompetent person, and is not carefully used or regularly and properly cleaned, to hold the maker responsible for its consequent unsatisfactory performance is to do him great wrong.

## PREVENTING COLLISIONS WITH ICEBERGS IN A FOG.*

By PROF. GRAHAM BELL.

THE recent accident to the steamer *City of Berlin* emphasises the importance of devising practical methods of ascertaining the proximity of icebergs in a fog. The precautions adopted by Captain Laud, though they saved the lives of more than fourteen hundred passengers, and prevented serious damage to the vessel, did not prevent contact with the berg. Even the "lookouts" were unaware of the proximity of the iceberg until it was actually upon them. Under these circumstances, the method proposed by Mr. Frank Della Torre, of Baltimore, deserves consideration. His experiments indicate the possibility of obtaining an echo from an iceberg when in dangerous proximity to a ship. Mr. Della Torre believes that even an object offering so small a surface as a floating wreck may in this way be detected during a fog in time to prevent collision. However this may be, it is certain that his method is worthy of careful trial at sea, and that preliminary experiments recently made in the presence of Professor Rowland, of Johns Hopkins University, and the present writer, have demonstrated the feasibility of producing well-marked echoes from sailing vessels and steamboats at considerable distances away. These experiments were made on the River Patapsco, near the head of Chesapeake Bay, at a point about seven miles from the city of Baltimore. The party proceeded down the river in a steam launch to the selected place, where the distance from shore to shore appeared to be about three miles. The launch was kept so far from land as to prevent the possibility of mistaking an echo from the shore for one produced by a passing vessel. The apparatus employed consisted of a musket, to the muzzle of which a speaking trumpet had been attached. This gun was aimed at passing vessels, while blank cartridges were fired. After a longer or shorter time, according to the distance of the vessel, an echo was returned. The ordinary river steamboats, and schooners with large sails, returned perfectly distinct echoes, even when apparently about a mile distant. At shorter distances the effects were, of course, still more striking. In order to test the effects under the most disadvantageous circumstances, blank cartridges were fired in the direction of an approaching tugboat. The surface presented was, of course, much smaller than if the boat had presented its broadside to the launch. As the boat approached bow on, it corresponded to a target somewhere about 6ft. square, presenting a convex surface to the impinging sound wave. Even in this case a feeble echo was perceived when the boat was at a considerable distance (estimated to be nearly one-quarter of a mile). That any echo should have been perceived at all under such circumstances was a surprise. The sound was heard only by the closest attention, but in the case of larger vessels the effects were very distinct and striking. Experiments were made which demonstrated the fact that the speaking trumpet attached to the gun was of material assistance in giving direction to the sound impulse, and in intensifying the audible effect. Mr. Della Torre claims that a steam whistle or siren, combined with a projecting apparatus like a speaking trumpet, will prove as efficient as the gun. During the experiments on the Patapsco River, a curious rumbling effect, like the rolling of thunder, was often observed, which continued for some seconds. A similar sound was also noticed, as an echo from a well-wooded shore; but the effect alluded to above could not have been due in any way to the land, as the sound commenced immediately upon the firing of the gun, whereas the shore was distant at least a mile or a mile and a half. The sound was probably due to the presence of ripples on the surface of the water, as the effect was much less marked when the surface was smooth. Such a sound might prove a disturbing element of importance in a rough sea, but would hardly be sufficient to prevent the detection of an echo from a large iceberg. Had shots been fired periodically from the bow of the *City of Berlin*, it can hardly be doubted that the presence of an obstacle ahead would have been discovered in time to prevent the collision that actually occurred.



## HAMPSON'S DEAD-CENTRE FOR LATHES.

THE invention herewith illustrated relates to an attachment to any lathe for turning wood or metal, by which it can be changed from a live-centre or revolving centre lathe to a dead-centre lathe. Fig. 1 is a side view of a lathe provided with this attachment, and Fig. 2 is an end view of the lathe bed and a front view of the attachment.

In place of a face plate on the end of the spindle is a spur wheel, which gears into another wheel of the same size, placed just below the first. A standard, resting upon and fitted to the lathe bed, carries a shaft, on one end of which is the second spur wheel. A third spur wheel is fastened upon the opposite end of the shaft, and meshes with a fourth wheel (the wheels are all alike) upon a cylindrical pin forming the forward part of a stud fitted conically in the standard; this stud is placed perfectly in line with the centre of the spindle and centre of the tail stock. The fourth wheel is secured to a face plate, and both are kept in place by a shoulder on the front end of the pin. Conically fitted in the stud, which is stationary, is a centre, whose point is in line with the centre in the tail stock. When the lathe is set in motion, the face plate revolves in the same way as if it were fastened to the spindle in the usual manner. Both centres are now stationary, and anything turned on the centres must run perfectly true when reversed on them. The standard, being only bolted to the lathe bed, can be removed with the gears, and if a face plate is put on the spindle in place of the spur wheel, and a centre inserted in the spindle, the lathe is reduced to a live-centre one; while, by replacing the standard and gears, a dead-centre lathe may be formed. The use of this attachment insures the accuracy of the work, since both centres stand still, while the piece being turned revolves, and although the piece may be reversed, it will always run true on the centres. All trouble caused by a spindle running untrue is thus avoided. Further particulars regarding this invention can be obtained from the patentee, Mr. Joseph Hampson, of Newburg, N.Y.—*Scientific American.*

## WATER-CHAMBERS IN SHIPS.

THERE have been added to the exhibits of the Lords of the Admiralty in the Queen's-gate Annexe at the Inventions Exhibition two models prepared for the purpose of illustrating the use of the motion of water within a ship to moderate the disturbing influence of the waves on vessels having a large natural stability. It was in experiments made with a model of the *Inflexible*, where the great metacentric height the designers had been driven to accept threatened heavy rolling among certain waves, that this mode of quelling the rolling was discovered. The models representing sections of ships, one with, the other without, a water-chamber, are so mounted as to be easily made to oscillate in imitation of the roll of a ship at sea, and if the two models are inclined to the same angle and then allowed to oscillate freely it will be found that the one to which a water-chamber is fixed very quickly comes to a state of rest, while the other continues to roll for many minutes.

Mr. Froude, in the valuable series of experiments he made in the investigation of the subject, found that there is a certain depth of water in the chamber which gives the *maximum* effect, this being dependent upon the width of the chamber and the period of the ship. With this depth of water the growth of resistance to rolling begins almost at zero of angle, whereas with either a greater or less depth there is practically no resistance at all due to the water up to a certain angle, which angle increases with increase of departure from the proper depth. At larger angles of roll, however, the disadvantage of departure from the proper depth of water is not marked. Lastly, he observed that the resistance of water in a chamber does not increase at all uniformly with increase of angle of roll, but increases rapidly at first and at the larger angles becomes more nearly constant for all angles. A comparison was made with the steadying effect, obtained from bilge keels, with the result of showing that, while an addition of 2ft. to the breadth of the bilge keel added, in round numbers, two-thirds to the existing extinguishing power of hull and bilge keels on the *Edinburgh* at all angles of rolling, the fully-extended water-chamber added at 3° of roll about six times, and at 5° about three times that power. At 12° the chamber added no more than 2ft. of bilge keel, while at 18° it only added half as much. It is, therefore, evident, as Mr. Froude has pointed out, that while both are valuable, the water-chamber is, for most kinds of service, much the more valuable of the two. Explaining the cause of the phenomena in his report, he said:—"The extinguishing or quelling effect of water depends, of course, *cæteris paribus*, upon the value of the moment represented by the transference of water from side to side—*i.e.*, with a given quantity of water, upon the distance moved by its centre of gravity. This distance increases with increase of angle of roll, and consequently the extinction similarly increases up to a certain point, where we appear to have approximately reached the *maximum* possible transference of water, and consequently the *maximum* extinction of which the quantity of water is capable with the dimensions of the chamber. This point occurs generally at a moderate angle, and above this angle the extinction becomes practically constant. But the extinguishing effect of the water, of course, largely depends also upon the timing of its motion from side to side, the extinction being greatest when that motion takes place most nearly at the time of extreme angle of ship—i.e., in such a manner as that the water may be as much as possible running down-hill when it is moving across, and as much as possible upon the rising side of the ship when it is stationary. If, on the other hand, the motion of the water across were to take place when the ship is quite upright, the extinction would be *nil*. It is, therefore, conceivable that for the same total degree of motion or transference of water we may have a very different degree of extinction, according to the timing of that motion. In the motion of the water energy is necessarily wasted, and it is clear that if we are dealing with a permanent condition of things—i.e., if the ship is being steadily maintained at a constant angle of roll—this waste of energy in each run of water from side to side must be exactly equal to the energy taken out of the ship in each swing by the extinction. The motion of the water may be, and generally is, of a type very wasteful of energy, the water either rushing across in a mass and consuming its energy by breaking with great violence against the opposite side, as it does at the larger angles of rolling, or, at more moderate angles, running across in a breaking wave or bore, which consumes its energy as it goes in its own internal resistance; and under these circumstances, the timing of the motion appears invariably to approach pretty nearly to that giving the *maximum* extinction for the degree of motion. But the motion of the water sometimes takes the form of a mere alternating slope of surface, or tidal swing from side to side, and here there is very little waste of energy, the energy of motion of the flow of water in one direction being converted into potential energy in the shape of a rise of water at the side, and then given out again to the water flowing back to the other side, and so on. The waste of energy in this form of motion being almost *nil*, the timing is almost exactly that appropriate to no extinction, the water being in the middle of its passage across and the surface being level when the ship is upright." It will be readily seen that the value of the chamber increases as its length in the direction of the keel of the ship increases. These water-chambers have been fitted in the Inflexible, Ajax, Agamemnon, Colossus, Edinburgh, Collingwood, Rodney, Howe, Anson, Benbow, and Camperdown, and it is stated that they will be placed in the new armoured single-barbette ships Renown and Sans Pareil.

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* From *Science.*

**High Railway Speed in the United States.**—From the *New York Herald* of June 19th we learn that, according to its official record the Michigan Central "flyer," drawn by engine No. 415, Isaac Dyell, engineer, leaving St. Thomas last Tuesday 55 minutes late, made the run of 111 miles to Detroit, on the Canada division, in 115 minutes, eight minutes being deducted for two stops, which is said to be the fastest time ever made by a regular train. The first 55 miles were made in 57 minutes, and eight miles were made at the rate of 57½ seconds to the mile.

COAL-TAR colours, especially eosine reds, have been employed in the artificial flower manufacture. They are found to produce colic and painful spots on the skin of those employed. This is due to the lead used in the eosine colours; aluminous lakes would not be productive of those annoying affections.

PARIAN is a white cement said to be a mixture of plaster of Paris and borax. Four bushels of Parian with an equal quantity of clean sand will cover 10 yards super. half-inch thick.

# SCIENTIFIC NEWS.

THE death is announced of M. Henri Tresca, the distinguished French physicist and engineer, who was born at Dunkirk in 1814. Leaving the Polytechnic school, he entered the corps of the Ponts et Chaussées; but soon quitted the service to devote himself to scientific pursuits. In 1850 he was appointed principal inspector of the French section of the exhibition at London. He afterwards became sub-director of the Conservatoire des Arts et Métiers, and he there filled with great distinction the chair of Industrial Mechanics. During the Commune he displayed much courage in shutting the doors of the Conservatoire, and preventing the Anarchists from obtaining the cannon in the possession of the establishment. In 1865 he was created an officer of the Legion of Honour, and in 1872 he was elected a member of the French Academy. Of his numerous works may be mentioned his "Cours de Mécanique Appliquée." and his "Ecoulement des Liquides." His classical investigations into the "Flow of Solids" are well known, and are alone sufficient to mark him out as a distinguished worker in the search for knowledge.

We stated last week that Dr. Riebeck would, in the autumn, commence another voyage round the world; but, unfortunately, Emil Riebeck died suddenly at Feldkirch, at about the time the note was being written.

Mr. William Sandys Wright Vaux, F.R.S., the numismatist and Oriental scholar, died suddenly last week in his 67th year. Mr. Vaux was first employed in the department of Antiquities in the British Museum, and in 1861 became Keeper of the Coins and Medals—a post he resigned in 1870. During 1871-76 he was engaged in cataloguing the coins in the Bodleian library, Oxford, and as Secretary to the Royal Asiatic Society he did a great deal of valuable work.

It is stated that Prof. Huxley retires from the various posts he holds under Government on a pension of £1,200 a year.

The chair of chemistry at South Kensington, vacant by the resignation of Dr. Frankland, has been conferred upon Prof. Thorpe, of the Yorkshire College, Leeds; but it is understood tha the salary will in future be the same as that of the other professors—viz., £800.

Mr. W. Stroud, B.A., B.Sc., has been appointed Professor of Physics in the Yorkshire College, in the place of Prof. Rücker, resigned.

Recent colliery explosions have stirred the *Times* into the remark that the hands of the Home Secretary "cannot be too promptly and too vigorously strengthened to stay a hideous barter of human lives for cheapened blood-stained coal." Shot-firing should be prohibited in all mines of which there is the least suspicion; but the Clifton Hall disaster occurred in a district in which shot-firing is said to be prohibited except when the bulk of the workers are above ground. Explosions have occurred, too, when coal was at high prices, and the miners were said to be revelling in luxury, so that the reflection above quoted scarcely applies.

The discussion about musical pitch has recommenced in earnest, and there will probably be a lively controversy. Dr. W. H. Stone writes that on the Wednesday of the Handel Festival, with the temperature at 82° Fahr., the A of the organ and the orchestra gave 446 double vibrations per second; when the second part began the temperature had fallen to 81°, but the organ and the band had risen nine vibrations, or A 455. He suggests that the heat in the organ must have increased, probably from friction, though he notes that it had been surrounded for two hours by several tons of human flesh at an average temperature of 97° Fahr. The French normal diapason is 435 vibrations, so that the performers were called upon for much more work than they would have been if we had a lower pitch. Dr. Stone's observations were made with a Scheibler's tonometer. Mr. Best replies that Dr. Stone must be aware that the record of the tonometer is only partially correct, and that a section only of the orchestral instruments has an increased pitch, while another has a lower rate of vibration. The organ, too, rises in one part and falls in another. Mr. Best declares for what is known as the Society of Arts pitch. Dr. Stone, returning to the question, replies that the orchestra rises as a whole, and not in one section, and that the organ also rises as a whole, the flue pipes more than the reeds. The tonometer, he thinks, is more trustworthy than the unassisted ear. Dr. Stone thinks the French normal diapason is the only "standard" which can be generally adopted.

The *Times* gives an account of the new Jablochkoff auto-accumulator, which it may be hoped is more trustworthy than many of the statements made in reference to electrical matters in that journal. The battery is composed of a number of cells or shallow trays, 4in. square and ½in. deep, of impermeable carbon, in each of which is placed a small quantity of iron turnings or zinc clippings. Over these is placed a covering of thick, coarse canves, saturated with a solution of chloride of calcium, upon which is laid a row of very porous carbon tubes, about 3in. long and ⅜in. in diameter outside, which are similarly saturated. In this way a cell is formed with three electrodes, one of which oxidises, a second becomes polarised, and the third forms a positive pole with the second, the first two forming a couple with a constantly closed circuit. For service a number of these cells—nine or ten—are placed within a metallic framing, after the fashion of a voltaic pile, the bottom cell resting on a metal plate forming one of the poles. The top cell is covered with a plate of carbon to which a terminal is fixed, and this forms the other pole. The auto-accumulator produces alternately a primary and a secondary current, the latter only being employed in the external circuit, while the former serves to produce the hydrogen necessary to polarise the electrodes. This action stops as soon as polarisation is complete, and is resumed when depolarisation takes place, so that short and frequent intervals of rest are necessary for the battery to re-form itself for the production of the useful current." It will be seen that this description is different to that given by M. Jablochkoff himself, which we reproduced on p. 297. Probably the first arrangement did not work so well as he thought it would.

MM. E. and H. Becquerel have communicated to the Academy of Sciences of Paris a memoir on the temperature of the atmosphere and ground at the Paris Natural History Museum during the years 1883 and 1884. These observations form a continuation of those commenced by M. A. C. Becquerel twenty-two years since with thermo-electric apparatus invented by himself.

In reference to his experiments on the production of anæsthesia with a mixture of chloroform and atmospheric air, M. Paul Bert presented, at a recent meeting of the Academy of Sciences, a very ingenious and convenient apparatus, invented by M. Raphael Dubois, by which the quantity of chloroform and air may be regulated at will. M. Bert states that, if the patient is not addicted to spirits, he should have a mixture containing ten grammes of chloroform to a hundred litres of air, and seven or eight minutes suffice to produce anæsthesia; whereas an alcoholic subject would require ten to twelve minutes. As soon as sleep is obtained, by a special arrangement of the apparatus the strength of the mixture is reduced to six grammes to the hundred litres, which is sufficient to maintain the anæsthesia.

The committee of the Berlin Gesellschaft für Erdkunde have resolved to erect a monument to Dr. Gustav Nachtigal upon the spot where he died, at Cape Palmas. A bust of the traveller is also to be placed in the society's library. An appeal for contributions has been sent out to the German geographical societies. A monument is also projected for his native town, Stendal.

The tail of the human embryo has formed the subject of lengthened investigations by M. H. Fol, and he has recently presented an account of his work to the Academy of Sciences, Paris. M. Fol says, at an early period of development—about the fifth or sixth week—there are several distinct caudal vertebræ behind the sacrum. The embryo is then from nine to ten millimètres long, but when it attains a length of twelve millimètres the total number of vertebræ is already reduced from thirty-eight to thirty-five. At a later stage, when the embryo measures nineteen millimètres, only thirty-four vertebræ can be distinguished, the thirty-fourth being obviously made up by the fusions of the four terminal ones.

Thursday last was prize day at King's College, and on the Saturday previous the work accomplished by the students of the engineering classes was inspected by a party of engineers and others, and during the week it has been on view to the public. The work exhibited is alike creditable to the pupils and the teacher, and shows what can be done by novices under careful training. Some of the joiners' work would be considered good if turned out by a practised hand, and much of that in metal was highly creditable to the students. At King's College Workshops the students are supplied with castings, and the articles made by them are their own property, so that while we are sure to find several engines we may expect also to see some lathes in a more or less complete state. As a matter of fact this year there were several which will doubtless be treasured by their owners as long as they live. Under Prof. Shelley students obtain a sound grounding in the theory, and under Mr. Walker, the superintendent of the workshops, they acquire an amount of practical skill which would scarcely be supposed possible in the time. The evening classes in the workshops are well attended, and some of the best exhibits were the work of those who can only attend in the evening. With such institutions as King's College, not to mention others, it is matter for regret that so much has been spent on that Technical Institute at South Kensington.

Dr. A. L. Esperon, of Havannah, uses parthenin in cases of neuralgia with much success. The drug is obtained from a plant known in Cuba as bitter broom (*escoba amarga*), but its botanical name is not mentioned.

**A Big Ship.**—There is building at Rockport, Maine, the second largest sailing ship ever built in America. She will carry for lower masts four sticks of Oregon pine, which will trim up as follows: Main and fore-masts 90ft. long, 36in. diameter, and jigger 88ft. long, 28in. diameter. These big sticks were towed down from Boston by a tugboat, and were hauled out of the water by a long string of oxen. The mizzen, main, and fore masts will be square rigged, the lower and topsail yards being also of Oregon pine, while the jigger mast will be fore-and-aft rigged. The main top will be 16ft. across, and there will be room enough up there for pretty nearly the whole ship's company. A good idea of the vessel's size, and of the spread of sail she will carry, may be had from the fact that it is 185ft. from the deck to the main truck, while her lower yards are about 90ft. long.

**Range of Guns.**—In answering a question on the range of modern guns in the American Navy, the American *Army and Navy Journal* says that the ranges of modern heavy guns are not tested for extreme ranges and at high elevations. Krupp, "Experiences de Tir," No. xlvii., Meppen, 17 Août, 1883, gives the range of the 30·5cm. rifle, 35 calibres long, at an elevation of 14 deg., as 10,165 mètres. No. 44, Meppen, July 31st, 1883, that of the 26cm. rifle of 35 calibres length, with an elevation 20 deg., as 11,526 mètres; projectile, 275 kilogs.; initial velocity, 530 mètres. At Gâvre, 1880, the French 34cm. steel rifle, with an elevation 38 deg., showed a range of 12,918 mètres. The authority, Hélie Balestique II. pp. 204 and 278. The "Revue Maritime et Colonial" for May, 1885, gives the range of the new French rifled 21 cm. mortar as 3,944 mètres, with 45 deg. elevation, and 3,212 with 60 deg. elevation. In his prize essay on "Improvements in the Art of War," Military Service Institution, 1882, Colonel Lazelle reports the following ranges: — Krupp rifled 28cm. (11in.) howitzer of 1879, elevation 28½ deg., 8,000 yards; Krupp's 15cm. B L. howitzer, steel, 45 deg., 6,550 yards; 200lb. Parrott, 4,272 yards, 11 deg. 47 min. elevation. American muzzle-loader, 11in. rifle, altered, 6,038 yards with 14 deg. elevation; 8in., 9,419 yards, with 27½ deg. elevation. Of ten shots from Krupp's 4½in. field gun fired at a horizontal target 10,300 yards distant, nine were included within 18 yards of lateral deviation. The greatest effective ranges of the European field guns firing common shell is given at from 5,000 to 8,000 yards; using shrapnel shell, 3,000 to 3,800 yards. Greene gives the following ranges of Russian guns: Bronze, 9lb., 5,000 yards; bronze, 4lb., 3,800 yards; steel, 4lb., 7,000 yards. Maguire, in his "Attack and Defence of Coast Fortifications," gives the maximum range of the Krupp 15cm. and 28cm. guns with shell as 8,000 yards. None of these authors cite their authorities. The new French long-range cannon, De Bange system, sent to the Antwerp Exhibition, weighs 37 tons, is a fraction under 37ft. in length, and throws a 1000lb. projectile a distance of 12 miles 752 yards (20 kilos). The author of this new piece destined for coast defence is the ex-Colonel De Bange, now at the head of a large private firm, who is said to have retired from the service in disgust, and yet his guns, from the smallest mountain to the largest position piece, have been adopted by an ungrateful country.

# LETTERS TO THE EDITOR.

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*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

*All Cheques and Post-office Orders to be made payable to* J. PASSMORE EDWARDS.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

◆

## THE APPARENT ENLARGEMENT OF CELESTIAL OBJECTS AS THEY APPROACH THE HORIZON—SEPARATING POWER OF OBJECT-GLASSES—THE SUGGESTED LARGE TELESCOPE FOR THE ROYAL OBSERVATORY—LIGHTNING A DIFFICULTY—SUNDIALS—AN ASTRONOMICAL TELESCOPE — SCRAPING METAL SURFACES — TELESCOPIC APERTURE — SIZE OF FIELD IN AN OPERA-GLASS —WHAT IS "CREATION"?—100 TO THE INCH OF APERTURE—61 CYGNI —SEEING STARS IN DAYLIGHT—A BINARY STAR OF SHORT PERIOD.

[24416.]—IN letter 23918, on p. 30, I invited attention to some very remarkable experiments made by M. Paul Stroobant, to illustrate the cause, or causes, which he believes to be operative in producing the illusion of the enlargement of the sun, moon, and constellations as they approach the horizon. The number of *Ciel et Terre* for June 15th contains another paper on the same subject by M. F. Frenay, in which he traces this effect to the manner in which the eye is educated. The major portion of our estimates of distances, says M. Frenay, are made horizontally. A man of ordinary height 328ft. off subtends an angle approximately of 1°. At double the distance, or 656ft., he subtends an angle of only ½°. Yet, as the result of long practice and the exercise of reason, we seem to see the same sized man at both distances. When, though, we come to look up at a very high steeple things at the top look very little indeed, because practice in estimating size in a vertical direction is almost wholly wanting. For the way in which this notion is developed the reader should study the original essay itself. I have served my purpose in directing attention to it here.

In reply to Mr. Sadler's query in letter 24369 (p. 346), I am unaware whether Dallmeyer's formula, which I gave, ever appeared in print. I myself heard it from his own lips at the meeting of the Royal Astronomical Society, on May 10th, 1867, at which I happened to be present. I have to thank Mr. Sadler for reminding me of Mr. Stone's paper and the discussion which followed it, which do seem to throw a certain amount of doubt upon Mr. Knott's results. If Mr. Nelson can obtain access to Vol. XXVI. of the *R.A.S. Monthly Notices* he will scarcely fail to be interested by the perusal of Mr. Stone's essay and the report of the subsequent debate.

Mr. W. S. Franks (letter 24374, p. 347) has apparently only seen your précis of the Astronomer Royal's Report, on p. 319, and not the actual Report itself. The price quoted from Grubb's Catalogue is for a completely mounted 27in. achromatic, furnished with all possible appliances; whereas Mr. Christie's very modest demand is for an object-glass and tube only. Here are his exact words: "After careful consideration of the conditions, I have satisfied myself that an object-glass of 28in. aperture and of 28ft. focal length, could be mounted in the south-east equatoreal, in place of the present object-glass of less than half that aperture; and I have ascertained that Mr. Grubb would be prepared to undertake the construction of such an object-glass with a tube suited to the special requirements of the case, so that the telescope would be equally available for eye observation or for use with the spectroscope." It seems impossible that the Treasury can refuse the relatively small sum required for such a purpose.

The reply (56682) of Mr. Taylor, on p. 352, reminds me a little of the old woman whom the sympathising young lady recommended to try electricity for her deafness; and who after three or four shouted reiterations of the suggestion, replied, "Lor bless yer, I *was* struck by lightnin', two or three weeks ago, and it didn't do me a bit of good!"

"Rosicrucian" (query 56834, p. 354) may consult Vol. XXXVI. of the ENGLISH MECHANIC, where, on p. 316, he will find as plain a description of the method of constructing a sundial as it is in my power to give (a typographical erratum in this will be found subsequently corrected on p. 356 of the same volume). Or he may buy No. 32 of Weale's Series, "Mathematical Instruments," by Heather, published by Crosby Lockwood and Co.; or pick up Ferguson's book or Leybourn's "Art of Dyalling" at some bookstall.

"E. R. H." (query 56836, p. 354) carefully withholds the one piece of information needed by anyone who is to answer him—I mean the focal length of his object-glass, because his tube will have to be a little longer than that. He will need (several) Huyghenian eyepieces—described over and over again in these columns—for astronomical work.

"E. C. B." (query 56862, p. 355) will find some useful information in Shelley's "Workshop Appliances," published in the series of Longmans' Text-Books of Science.

Merely as a matter of course, Mr. Baird Gemmill is right in the supposition he expresses in the concluding paragraph of his letter (24390) on p. 364. In speaking of the aperture of an object-glass or mirror, its clear working aperture is invariably meant, and it is wholly illegitimate to include in such stated aperture the smallest portion of the objective cut off by its mounting, by diaphragms in the tube, or by anything else whatever.

While heartily endorsing every word that "Montmartre" says (in letter 24393, p. 365) as to the value and advantage of increased power in field-glasses for outdoor use, I cannot help thinking that he is not sufficiently alive to the importance of a large field for a glass to be employed at the theatre. Of course, if the object of the user of an opera-glass be merely to scan the features of a performer, then the higher the power he uses the better; but where (as in my own case) people are short-sighted, and require the aid of glasses to see anything at all sharply on the stage, a very constricted field becomes a nuisance, and an instrument that dichotomises every actor and actress, a weariness of the flesh. Of course, I may be told that I can see (say) Miss Connie Gilchrist's head and shoulders at one view, and her lower extremities at a second; but personally I object to taking that charming young actress by instalments as it were, in any such fashion.

I am very glad to learn from letter 24398 (p. 365) that it has been decided to accede to the request of the Astronomer Royal for a suitable telescope at Greenwich. As may be inferred from paragraph three above, I wrote what appeared on p. 346 with the words quoted by "S. R." before me; but asking for money for a legitimate scientific purpose in this country by no means always means getting it; and Mr. Christie has not yet been sufficiently corrupted by communication with his allies at Brompton to follow their evil fashion of spending money first and asking for it afterwards.

"H B. F.," letter 24408 (p. 367), must forgive me if I say that he is only evading the difficulty I suggested; and by no means meeting it. If albinos and brackish-water mollusca modified from marine forms, are "attributable to heredity by reversion," their progenitors $x$ generations back must have had white hair and red eyes, and the fluviatile type of organisations respectively. To say that a single specimen of either of these aberrant forms was suddenly "created," is to speak with an amount of assurance which is assuredly not scientific —whatever else it may be.

On reading Mr. Franks's admirable letter (24409) on p. 368, the first exclamation that rises to one's lips is, "How in the world is it that no one ever thought of this before?"

In reply to query 56893 (p. 375), 61 Cygni is a binary star of very long period. It is far from easy to say precisely what stars are visible in bright daylight with a given aperture, as so many elements enter into the perceptibility of a star when the sun is above the horizon—its distance from him among the very first. Mr. Arkwright ought to see the Pole star in sunlight of a clear day with his telescope, and he might—I do not say would—be able to pick up a 3rd mag. star at an equal distance from the sun. That, however, would be his limit in this climate. As far as I know, δ Equulei has the shortest period (at present imperfectly determined) of any binary star. The orbit may be described either in 7 or 14 years.

**A Fellow of the Royal Astronomical Society.**

## α DRACONIS—STARS IN COMA BERRNICES.

[24417.]—I REGRET to say I cannot give Mr. Gemmill (letter 24390) any information with reference to Baron de Zach's observation of this star. I may add that I have not very much confidence in the accuracy of the Baron's estimate of 2 3m., although I have no doubt it was made in good faith.

With reference to the stars in Coma, referred to by Mr. Gemmill, the following measures from the Harvard photometry may be of interest:

| Star | Measures | Estimates |
|---|---|---|
| 15 Comæ | 4·73 | 4 7 |
| 14 „ | 5·13 | 4·9 |
| 16 „ | 5 09 | 4·9 |
| 13 „ | 5·09 | 4·9 |
| 12 „ | 4·75 | 4·7 |
| 17 „ | 5·18 | 4 9 |
| 21 „ | 5·49 | 5·6 |
| 18 „ | 5·50 | 5·5 |
| 43 „ (β) | 4·38 | 4·3 |
| 41 „ | 4·89 | 4·5 |

It will be seen from the above that, according to the *measures*, 15 Comæ is the lucida; but according to the estimates it is equal to 12. With reference to 12, Smyth says (Bedford Catalogue, p. 267): "A bright star, with a distant companion in the middle of the Tresses; about 1½° south-west of the lucida." This seems to have been Webb's authority for the statement. With reference to 41 and 43, it seems worthy of notice that in Harding's Atlas 41 is 4m., and 43 5m. I found "43 considerably brighter than 41" in May, 1877, and August, 1877.

June 27. **J. E. Gore.**

### LUNAR GLACIATION.

[24418.]—IN reply to "F.R.A.S.," 24136, p. 167, I should say that the decline of lunar atmosphere was general, and not local. An atmosphere in patches, with vacuum in between, is not easy to understand.

This decline seems to have been very considerable ere yet the poles were finally surfaced, as we see them, and which would be after the termination of what I call the "erosive period," and when there would possibly be little land surface exposed, and no winds.

There would be a large circular area some 1,500 miles in diameter, on which the heating effect of the solar rays would be at a maximum, and which would slowly pass round the lunar globe, and outside of which the solar rays would produce little effect. Within it there would be a certain amount of aqueous vapour raised and diffused in the then rarefied air, which would become deposited, more or less, around the margin, and what fell to north and south would tend to remain. This is what I meant by saying that the aqueous vapour raised over equatorial seas was deposited on the poles.

The large *mares* had not then been restricted as we now see them.

These polar caps in slowly extending would have irregular margins, and bays be seen here and there, where either the water was deeper, or where heat vents retarded glaciation, and we have submarine volcanoes in our Arctic regions as proof that such are possible.

As glaciation went on the horns of these bays (as in a form like Frascatorius), would meet and inclose a lagoon. Aqueous vapour would rise off this liquid surface, and become diffused in the air; but failing in transport, be soon precipitated around the margin, to pile as a wall.

It could not travel far inland over a surface of lower temperature—thus craters and walled plains would form on the poles first, and as the cap grew in size, older formations—at any distance—would not be overlaid by newer deposit.

Some of these lagoons, as heat vents closed, would glaciate sooner than others, and if vents opened near, other, and generally smaller, lagoons would melt out segments, or in freezing over, pools be left open at the vents to form smaller rings or craterlets, as in the floor of Clavius, &c. Where these heat-vents persisted over vast periods of time, we should see repeated contraction of area and concentric rings, the floor becoming steadily deeper, as in Tycho.

The extension of the S. polar cap seems to have been along a submerged shoal, or water parting, between two seas, Nectaris and Nubium, where, as in our Andes, there had been meridional series of heat-vents, causing the chains of walled plains there seen. The Altai seems to have been the border of Nectaris at one time.

The great littoral ranges I should suppose were not laid until the glaciation of the surface had reached their vicinity. Long retarded by solar heat, this latter would, at last, assist in their formation by enabling the attenuated atmosphere to take up more aqueous vapour during the lunar day, to be deposited around during the lunar night, and these ranges would, glacier-like, slowly move out to great distances. The crest necessarily highest next the *mare*, and a higher mean temperature at the shore-foot, cause there a more precipitous form. At last these seas would glaciate by zones of irregular outline, and lagoons form here and there large and small. It would be much later than this period that moisture from vents would pile to form cones, and still later—when the outer space was a better vacuum—that aqueous vapour, ejected, would flash into haze, and fall to form the rayed nimbus.

As I understand "F.R.A.S.," the transport of the aqueous vapour would mainly be by diffusion, and not translation, until the last phase of all. I should have been glad if he had more clearly and fully specified the "difficulty" he experiences. I am at a great disadvantage in being so far off and unable to discuss these matters fully here, and apt to overlook other people's difficulties in the case.

The absence of distinct polar caps and similarity of the polar and equatorial surfacing is a negative argument that seems deserving attention, as also the co-relation between inclination of surface and brilliancy (excepting nimbi); the relation of all circular forms, from *mares* to craterlets, to each other and to one cause; the arrangement of clefts, to areas of subsidence; even the dark protruding masses seen by Dr. Klein—all appear to fall into their various places in the general argument, and assist in mutually proving it (as far as such is possible). Instead of endless detail which is unintelligible, it becomes replete with meaning; its past and present history is written there all over it, could we but make it out, as I hope we may.

I may say that lately I wrote out the theory anew, and more carefully and fully illustrated it, sending it to a geological friend, Mr. H. B. Medlicot, F.R.S., F.G S., &c., and he thinks so highly of it that he desires to send the paper to Prof. G. H. Darwin, at Cambridge. Perhaps "F. R. A. S." could get a look at it?

I feel sure that when he sees the subject more clearly as a whole, he will be both surprised and pleased. At the same time, there is, no doubt, much yet to discover and solve. It is unlikely that any theory of this kind should start complete, especially from the hands of an amateur; but, looking at the subject broadly, it seems more likely that the final surfacing is rather a cold than a heated phenomenon. *Absolutely* final it, of course, is not, as I have indicated that (by the theory) we see that gravitation is at work, levelling the most salient features. **S. E. Peal.**

Sibsagar, Asam.

### SUNSPOTS—THE WEATHER.

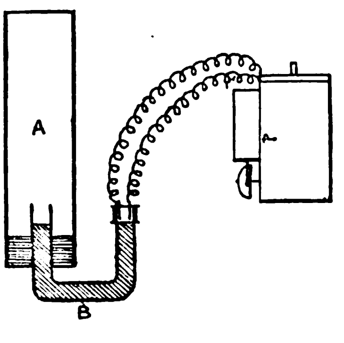
[24419.]—THE large spot mentioned in letter 24314 has again passed the sun's meridian, and has been as conspicuous as before. This time there has been a train of disturbed matter in its rear, which has, in places, broken out into spots; the "train" has been of special interest, and a study in itself. The spot would be about equal in area as previously when it passed the sun's meridian, though quite a different shape, being this time a broad, jagged gash, as it were, with a few brilliant saw-like teeth on its edges. The penumbra was not well defined; the umbra very striking in contrast with a nucleus nearly in the centre of the spot. I also thought I saw two other nuclei, one each at the narrowest part of the spot. Contrast might possibly have misled me in one of these, as there was a bright "bridge" on its edge. On the 21st a rent had been made in the penumbra, opposite to the nucleus, in the centre of the spot.

I thank Mr. Ward for his correction. What is the reason of such cold weather in June? May I be allowed to suggest that the icebergs which we are continually hearing about being in the Atlantic Ocean act as a cooler upon the Gulf Stream, and thus are reducing our temperature by the cool winds which have swept the surface of these icebergs and the Atlantic.

5, Rownsley-street, Leeds. **D. Booth.**

### DETECTION OF EXPLOSIVE GASES IN COAL MINES.

[24420.]—THINKING that some of the readers of the ENGLISH MECHANIC may be interested in the above subject, I will describe a piece of apparatus I once saw for the purpose. Suppose A to be a porous pot, as used in the Bunsen and other batteries. It should be about 8in. high and 1½in. wide, and filled with a tightly-fitting cork, preferably of indiarubber, having a ¼in. hole through the centre. Through this hole is passed one end of a bent piece of glass tube, B. At the other end of the glass tube is a small cork, having two platinum wires passed through, one at each side of the cork, and projecting into the tube about ⅛in.



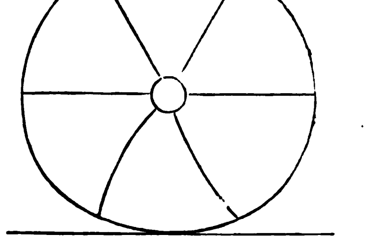
Before putting the glass tube into the cork of the porous pot, the glass tube should be filled with mercury until within a quarter of an inch of the platinum wires. The tube may now be firmly fixed into the cork of the porous-pot, and the wires from a portable electric bell connected to the two platinum wires at the end of the glass tube. On taking this apparatus into an atmosphere of hydrogen gas, the hydrogen gas will diffuse itself through the pores of porous-pot and create a pressure inside sufficient to force the mercury up the tube and make contact with the platinum wires, and so ring the bell and give an alarm.

**Jno. H. Bowman.**

### FLEXIBLE WHEELS.

[24421.]—SOME years ago, Mr. Huxley sent a design for what he called a "paradox wheel" to the "E. M." As some of your readers may remember, it consisted of a spring steel tire and four jointed spokes. The author very ably described the advantages of using such a form of wheel, and as far as I can remember, no one brought any objections against the design.

The inclosed sketch, I believe, represents an improved form of the above for light work. For a bicycle wheel, for which this form has many advantages, I propose making the tire of spring steel ¾in. or 1in. wide, and the six spokes of very thin spring steel about ⅛in. wide, or else round, whichever is found most suitable. When the weight is applied to the hub, the wheel will assume the form shown in sketch, more or less according to weight. The advantages for rough ground are too obvious to need much explanation: springs for the saddle would be quite done away with, and a brick could be ridden over without much inconvenience. If any reader thinks it worth while to make one, I shall be glad to send to his own address details of construction, if he will advertise it in the Sale Column. **S. X. Apprentice.**



### THE CASSEGRAIN.

[24422.]—"A. S. L." (25392) is certainly rather hard on our mathematical friends, and specially so on Dr. Royston Pigott; but I cannot help thinking, from the apparently unfinished state of the Doctor's last letter on the Cassegrain, that there is some cause for this over which he has had no control. There are many reasons we can easily suppose; he may be ill or have illness in his home, so I think we ought to wait patiently. At the same time I do not think the Cassegrain has had fair play either at the hands of our mathematical or practical friends who like the Cassegrain form of the reflector. This, I think, is a pity, for I am sure enough money and labour have been spent on it to have decided before now whether it will compete with the Newtonian form, and with our present mode of testing and working this could be done with certainty. It has its great advantages, and defects too, and when the Doctor has finished his articles on it, I will give a letter or two on what I consider the best and, I think, only way of overcoming some of these defects, and the best modes of practically making the two mirrors. Then the question, being fairly brought to the front, can be discussed by those who like this form of reflector theoretically with those who understand the practical difficulties of making the various parts theoretically perfect. **H. A. Wassell.**

Addenbrook Villa, Love-lane, Stourbridge.

### GAS AND GAS-ENGINES.

[24423.]—I NOTICE in your interesting leading article of last week's issue on "Gas and its Applications," the Dowson, Wilson, and Strong Gas Producers are mentioned as making a gas suitable for working gas-engines.

I cannot see why the well-known Siemens gas producer is omitted, seeing it was the first in the field, and still holds its own in the largest steel and glass works in the kingdom. It has been proved that a combustible gas is made in the Siemens producer which cannot be surpassed in quality by any other gas producer.

It also competes favourably as regards first cost, and cost per 1,000 cubic feet of gas made.

After a considerable practical experience with the Siemens producer as applied to steel-melting purposes on a large scale, I can testify to the gas made (especially that from the later types of the Siemens gas producer, where steam-blast is applied) being in every way suitable for gas-engines.

**E. W. Harvey, A.R.S.M.**

Lllanelly, June 25.

[24424.]—Noticing letter 24412, I think I have done all that can be expected already. I have no drawings of the engine, and I do not think there ever were any beyond a sketch or two to guide the pattern maker. If "Invicta" cannot call or does not like to apply at Bolsover-street, I can only suggest Bath as an alternative, with possibly a less distance to travel.

**J. K. P.**

## THE MICRO-OBJECTIVE—TO "ROB. CRUS."

[24425.]—I am sure many who read the letters of "Rob. Crus." on small lens making would be glad if he gave a few more particulars of his method of grinding and polishing the lenses, more especially the fine grinding. On page 327 we read: "It is in this fine grinding that the Pons Asinorum lies. Get over this, and the remainder of the journey is easy." Exactly so; but how are we to "get over" it? I have tried small lenses many times; but I never could get *all* the surface free from cobweb-like lines when examined with a magnifier, and the more I tried to remove them the more I put in. Should any pressure at all be used in fine grinding?

**Optical.**

## EXAMINATION OF MINERALS BEFORE THE BLOWPIPE.

[24426.]—I possess a cabinet containing 105 boxes of characteristic, and most carefully selected, minerals, which I purchased at Freiberg University in 1867. There is a German list of the boxes, without referring to which I have not the least idea what the minerals are; and I have been examining these (in perfect ignorance of their nature) by my system of pyrological analysis, beginning with box No. 1, with the view of presenting the many students who I know are "constant readers" of the English Mechanic with the methods and results of my examinations in plain English. I shall give copious foot-notes, explaining all details, and my reasons for coming to the conclusions I do, in order that the student may feel himself independent of any previous work of mine, although I presume him to have some elementary knowledge of blowpipe analysis in general, and to possess the following apparatus:—

1. A 3s. Leather Hand-blower, or a foot-blower (£1 10s.), with the necessary elastic tubing and blast-jet, &c.
2. A Pyrological Lamp, whether oil, candle, fat, or gas; if the latter, I would strongly recommend the hot-gas lamp described and figured formerly by me in "E M."
3. Thick Platinum Wire (two 2in. pieces), with the forceps necessary for holding, cleaning, and ringing (that is, making rings upon one end of it).
4. A pair of Agates, one surface of each of which is polished, capable of being placed on the table as "slabs."
5. A piece of Aluminium Plate with holder, and a few lozenges of charcoal, about ½in. square; one large piece can be sawn into these, ready for use (about 3s).
6. A pair of strong but small Crushing Forceps (1s. 6d.)
7. A good Lens (2s.)

### Re-agents.

1. Boric Acid, in white scales (3d. per oz.), in ordinary corked wide-mouthed bottle. Syn. B acid.
2. Phosphoric Acid, glacial, in sticks (6d. per oz.), in stoppered bottle. Syn. P acid.
3. Lime (clean eggshells*).
4. Oxide of Cobalt (an extremely small quantity is sufficient).
5. Potassium Carbonate (ordinary "potash") in stoppered bottle.

N.B.—In instances where I use apparatus or re-agents not mentioned above, I shall put a note of admiration (!). If the student wishes to follow me in those operations also, he must get the necessary apparatus; in my opinion, cheapest and best from J. T. Letcher, Truro, Cornwall.

(Minerals with metallic glance are first treated on aluminium plate: all others, first in boric acid before the blowpipe.)

Box No. 1.—White, Amorphous, Friable Fragments; soft.

| | |
|---|---|
| I. Powder in B acid *a*. (1.) Great effervescence, without smell; green pyrochrome (p.c.) of B acid unaltered. (2.) Amorphous, opaque, white, rounded, fragments (*c*.) (3.) Most fragments dissolve in part to transparent vitreous matter, which flows through the bead. | (1.) Sulphuric Acid: (Carbonic acid turns the green pyrochrome temporarily yellow) (*b*.)<br>(2.) Alumina: May be glucina, or contain a little silica.<br>(3.) Presence of an Alkali, which, as the green p.c. was unaltered, must be potash (confirm by II.). Soda yellows the green p.c. |
| II. Add a trace CoO (cobalt oxide). (1.) A purple suffusion spreading from the black cobalt-borate balls over the whole bead. Balls not all dissolved. | (1.) About 10 per cent. of potash. |
| III. Add equal proportion of lime to original powder, and treat the bead B.B. (1.) The whole bead a milky enamel, opaque (*d*.) | (1.) Large proportion of alumina (can't be glucina). |
| IV. Original powder in P acid, B.B. (1.) Wholly dissolved. | (1.) No silica or zirconia. |

(Time taken by a practised operator for producing the above reactions—quarter of an hour.)

Remarks.—I shall be glad of suggestions from any of your pyrological correspondents (and you have many, as "Ex-Blacksmith," "X.," Enoch Evans, &c., &c.) as to the probable name of this mineral in the subsequent issue of the "E.M."

Box No. 2.—Transparent Colourless Crystalline; but of no shape; hard.

| | |
|---|---|
| I. Powder in B acid. (1.) Transparent ice-like mass (*a*), slowly dissolving B.B. (2.) Faint yellow p.c. at first from powder at bottom of the bead; but green p.c. of B acid unchanged after. | (1.) An alkaline aluminous silicate. (2.) Trace of soda, but greater part of alkali, potash. |
| II. Powder + lime in fresh B acid B.B. (1.) Milky in part, but with lime-borate balls, not decomposed. | (1.) Not much alumina: about 15 per cent. |
| III. Added CoO B.B. (1.) Co borate dissolved as above, or rather more, to purple suffusion over the bead. | (1.) About 10 per cent., or rather more, of potash, with trace of soda. |
| IV. Fresh powder fused on AL plates, boiled, (*b*) dried, and treated in B acid, containing a trace of phosphoric acid. (1.) Undissolved, transparent, crystalline mass. (2.) Two minutes, semi-transparent balls. | (1.) Large proportion of silica. (2.) Trace of lime; here shown as calcium phospho-borate balls. |

What mineral is this?

Box No. 3.—Greyish-white, Compact, Amorphous; soft.

| | |
|---|---|
| I. Powder in B acid. (1.) Roundish, fringed, white, opaque fragments, showing very slight vitreous solution in bead; green p.c. unaltered. | (1.) Probably alumina, with large proportion of silica, and a little potash. |
| II. Added CoO. (1.) Purple suffusion, but only after long treatment before the pyrocone. | (1.) Not much potash. |
| III. Added lime (equal proportion). (1.) Milky, opaque bead, but on vesiculation (*a*) many white irregular fragments observed. | (1.) Large proportions of alumina and (probably) of silica, not glucina. |
| IV. Powder in P acid (*b*). (1.) Large transparent mass undissolved. | (1.) Large proportion of silica. |
| V. Added CoO to bead IV. (1.) Bluish purple. | (1.) Not much alkali. |

What mineral is this?

Box No. 4.—Flesh-white Laminæ; Amorphous, Compact; hardish (*c*).

| | |
|---|---|
| I. Powder in B acid. (1.) Violet p.c. from powder at bottom at first; green p.c. unaltered afterwards. (2.) Quantity of grey opaline matter with calcium-borate balls, and semi-transparent fragments. | (1.) Considerable proportion of potash. (2.) No alumina; much combined water and a good deal of lime; the rest probably silica. |
| II. Added CoO. (1.) Much dissolved to purple suffusion. | (1.) Considerable proportion of potash. |
| III. A fragment in platinum forceps (!), intumesced and frothed up before the blowpipe. | It is impossible not to perceive what mineral this is. |

Box No. 5.—Semi-transparent Fragments; soft.

| | |
|---|---|
| I. Powder in Boric acid. (1.) Great effervescence, with strong choking smell. (2.) Fragments at first, but all rapidly dissolved to a clear bead. (3.) Green p.c. totally yellowed. | (1.) Chlorine or fluorine. (2.) Large proportion of alkali. (3.) Alkali soda. |
| II. Added CoO. (1.) Rapidly dissolved to blue bead. | (1.) 25 per cent. alkali. |
| III. Added lime. (1.) Enamel, milk-white, opaque. | (1.) Large proportion of alumina. |
| IV. Look up orig. powder on B acid bead made on copper wire. (1.) No bluing of the brilliant green pyrochrome. | (1.) No chlorine. |
| V. Crushed bead of IV. with fresh powder, and boiled it in a glass bulb (!). (1.) Neck of the bulb much attacked. | (1.) Considerable proportion of fluorine. |

It is quite evident what mineral this must be.

*Notes.*—*a.* "Vesiculation, or blowing the small bead into a large vesicle or bladder about 70 times the size of the bead, as a glass-blower would (devised by me in 1867), is thus performed. The operator must have a spare mouth-blowpipe, from which the nozzle has been removed, ready at his right hand; the bead, with contents, is taken red-hot from the pyrocone by the left hand, and a moderate but rapid blast sent through the platinum wire ring from the jet before it cools." (In the "Easy Lessons," &c., which appeared in a recent volume, a picture of a "vesicle" is given.)

*b.* To make a bead of phosphoric acid (for which a separate wire should be kept, as the least trace of it very much adulterates boric acid, rendering the bead opalescent), a little of the crystalline powder which collects on the sticks should be laid upon the agate slab, a very small portion taken up on the red-hot ring as before, and held about an inch from the point of the pyrocone, until sufficient has melted on the ring to form the nucleus of a bead, which may then be plunged hot into the powder, and fused at point of the pyrocone without fear of its dropping. This is necessary from the quantity of water contained, which renders the bead very fluid until properly formed. Clean Al. plate should be underneath, and the fluid P acid (which rapidly cools there) taken up again with a clean penknife and replaced upon the ring.

*c.* This "test" is made by scraping the mineral with a penknife, and observing if the powder sounds "gritty" or soft between the agates in grinding. It only requires to be of the roughest description, not as a guide to the analysis, but to the naming the mineral afterwards.

*Remarks.*—*a.* The ringed wire, fixed in the pliers, is held for a moment at the point of the blue pyrocone, where it instantly becomes red hot. The hot ring is then dipped in a little pile of boric acid on one of the (quite clean) agate slabs; a quantity of the flakes of boric acid adhere to the hot ring, and are fused at the point of the pyrocone. This is repeated until a transparent bead, free from air-bubbles, is produced. A small fragment of the mineral is then placed on an agate between the jaws of the forceps (6) and roughly crushed. The coarse powder is then ground to fine dust between the agates, and a *very* small portion taken up at a time, on one side of the hot bead. The result of treatment of this side at the point of the blue pyrocone is then examined through the lens.

*b.* Presence of sulphur confirmed by treating the powder mixed with potash on charcoal before the blowpipe (B.B.), and placing the mass on silver with a drop of water, when a *black stain is left* on the silver. A small proportion of sulphur leaves a *brown* stain.

*c.* If there were any considerable proportion of silica here the fragments would have *fringed edges*, and not be in rounded masses—a formation characteristic of alumina or glucina only. Of these two, alumina decomposes calcium borate (contained transparent balls formed by lime added B.B.), and glucina does not. Silica or zirconia alone, or with a very small proportion of alumina, forms irregular transparent fragments with sharp edges or spikes, unless there is a considerable proportion of alkali present, when these edges are dissolved in proportion to the amount of alkali present. The presence of a large proportion of alumina may be confirmed by putting a drop of cobalt solution (!) on a fragment, and treating it B.B. when it turns blue (a discovery of Gahn); but this test will not answer in the thousands of cases where there is any metallic oxide present.

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* A piece of these, held in platinum (!) or other forceps, is calcined before the blowpipe each time for use. I have examined the lime thus produced for phosphoric acid, from which it is absolutely free.

*d.* This milkiness is easily distinguished (by a lens) from the grey, opalescent, semitransparent bead given by lime balls in presence of silica only in B. acid, B.B., in which latter case the lime balls are *not* broken up.

2*a.* This phenomenon is a certain proof of the conclusion given: Alkali, alumina, and silica shown afterwards separately. *b.* The boiling will require a platinum or aluminium capsule (!) on an iron ring with stand, fixed over the blowpipe pyrocone. By fusing and boiling, you get rid of the alkali, and can then, by treatment in phosphoboric acid as above, get reaction for traces of lime, &c., contained in the mineral. **W. A. Ross.**

## LOGARITHMS.

[24427.]—In working out the product of $(a + b) \times (a - b)$ in numbers, by means of logarithms, I have come upon a curious result.

In eight different cases, instead of coming out $a^2 - b^2$, as one would expect, it has been exactly $a^2$.

Here is one case—

$$\text{let } a = 59{,}000,\ b = 11.$$

$$\text{I } 59{,}011 = 4{\cdot}7709330$$
$$\text{I } 58{,}989 = 4{\cdot}7707710$$

$$\text{Z } 3{,}481{,}000{,}000 = 9{\cdot}5417040$$

This last number being exactly the square of 59,000.

In the other seven cases $a$ was a number of some thousands, $b$ was a number near ten.

In each the logarithm of the product $(a + b)$ $(a - b)$ was the exact logarithm found in the table opposite the number corresponding to $a^2$. The table used had seven places of logarithms. I should like to see this odd coincidence well explained.

Rougham, June 23. **Charles North.**

## AUTOMATIC MUSICAL INSTRUMENTS.

[24428.]—The construction of these instruments is an agreeable and suitable occupation for the leisure time of persons of mechanical tastes, as no elaborate mechanism is required in their construction. But it is to be regretted that amateurs such as Mr. Pugh should not, before they begin, have thoroughly learnt and considered what they have got to do. There seems to be some misapprehension as to the distance required between the notes or air holes in the paper bands when used as a valve.

In the "Orchestrone" of Prof. Galley the holes are ⅛in. asunder and $\frac{1}{10}$in. in diameter; they are all *circular*, and are consequently cut out with a round punch.

As I have stated in my former articles, I prefer the music produced by the key or lever form of instrument best; but of course the construction is more complicated, and in making up a complete instrument the cost is nearly in proportion to the increased number of notes, as each must be made complete with its complement of valves, reeds, and attachments; but when an instrument is made so as to be applied to the existing key-board of a piano, organ, or harmonium, the mere levers and attachments required for striking additional keys do not so materially increase the work of construction. Since my former articles appeared in this journal I have made up another pianoforte player for my own use, and for this reason: The former one included six octaves, or seven keys spaced ⅛in. asunder in paper bands 9in. wide. Now, as the music is copied off just as we read it without any attempt at transposing, in many of the best pieces we had to make a sacrifice by lowering the high octave; therefore I decided to make another machine for the sake of obtaining another half-octave or four notes more. My tune-bands are now 9½in. wide, commencing at the highest G in the treble, and ending at E in the bass. This allows me ample range, as an occasional last note in a heavy chord may very well be dispensed with. As to the music to be set out for these instruments, a score is preferable when obtainable—that is to say, a concert piece including, for example, a violin and flute accompaniment; all these may be ranged in the tune or music band without any extra difficulty or material amount of time occupied in copying.

No air pressure is used in actuating my instrument, which is simple in construction. It is a kind of box about the size of a gun-case that is clamped over the key-board of the piano. Over each key is set a rod or plunger, which is held up clear of the keys by a fine spiral spring, which at the same time tilts the plungers backwards in their sockets. Along the whole length of the keys there is a finger-piece or vibrator kept in continuous oscillation by a crank attachment at its centre, or midway. The front edge of this is buffed by a thick strip of felt, and just clears the tops of the plungers as they lie inclined backwards. The equilibrium of these is so slight that the mere force of the breath is sufficient to drive them under the edge of the moving vibrator by which they are caught, and of course depressed with any degree of force. This action is all that my paper tune-band has to do; that is, select the requisite notes and tilt the corresponding plungers under the vibrator. By a simple lever the force with which each note is struck can be increased or diminished to any desired degree, and every expression is completely under the command of the performer. It might be supposed that this light action would be liable to derangement. Such, however, is not the case: it never goes wrong, and I do not even possess a test-scale to try if every note strikes, as they never miss doing so.

The length of roll or band of 600ft. mentioned by Mr. Pugh is enough to scare one. I have not yet required 100ft. I take up a well-known piece, viz., "*Faust Fantasie* (*Gounod*) *à Leybach*"—the whole of this without any omission occupies only 67ft. of cartridge paper. **F. H. Wenham.**

[24429.]—In a letter on this subject, p. 365, "A. S. L." says that a correspondent has broken his promise to send a sketch of the mechanism of the "organette," which he thinks is "somewhat simpler than that of the organina." I do not know what is to be understood by "mechanism"; but your correspondent "A. S. L." was frequently told in Vol. XXXIX. that the organette is without levers, and depends solely on perforated paper drawn over the mouths of the tubes. In these circumstances, then, I think it will be considered that Mr. Fryer has a very sufficient reason for not sending his promised contribution on the "mechanism" of the organette. If Mr. Pugh likes to take advice which is gratis, and therefore probably worth little, he will abandon his attempt to make an automatic "organ" with harmonium reeds and pressure bellows—though it is not certain whether he is attempting the "blow system" or the "suction principle." **Gray's Inn.**

## THE BREAKING OF CRANK AXLES.

[24430.]—Last week (page 268) I pointed out that there are more iron than steel crank axles in in use; since writing that letter, I have drawn up the following tabulated statement, showing at a glance the numbers on the various railways. From these figures it will at once be seen that the Great Northern, Great Western, Midland, North Eastern, and North British Companies appear to be in favour of iron cranks; the London and North Western being the most important supporter of steel.

Table showing the number of iron and steel crank axles and of straight driving axles in use on the principal lines to 31st December, 1883:—

| Railway. | Iron Crank Axles. | Steel Crank Axles. | Outside Cylinder Engines. |
|---|---|---|---|
| Furness | 6 | 112 | 1 |
| Great Eastern | 37 | 380 | 198 |
| Great Northern | 709 | 19 | 37 |
| Great Western | 1362 | 410 | 38 |
| Lancashire and Yorkshire | 573 | 356 | 8 |
| London and North-Western | — | 2174 | 137 |
| London and South-Western | 6 | 170 | 324 |
| London, Brighton, & S. C. | 90 | 329 | 1 |
| London, Chatham, & Dover | 34 | 134 | — |
| Man., Sheffield, & Lincoln | 215 | 282 | 12 |
| Metropolitan | — | — | 56 |
| Metropolitan District | — | — | 42 |
| Midland | 1453 | 232 | 16 |
| North-Eastern | 1383 | 66 | 13 |
| North London | — | 37 | 50 |
| North Staffordshire | 15 | 99 | 9 |
| South-Eastern | — | 324 | 1 |
| Taff Vale | 132 | 7 | 3 |
| Caledonian | 30 | 3 | 657 |
| Glasgow & South-Western | 13 | 264 | 13 |
| Great North of Scotland | 2 | — | 53 |
| Highland | — | 3 | 69 |
| North British | 581 | 2 | 29 |
| Great Northern, Ireland | 77 | 47 | 5 |
| Great S. and W. Ireland | — | 172 | — |
| Midland G. W. Ireland | 20 | 80 | — |
| Total of 58 minor lines | 250 | 253 | 133 |
| Total | 6988 | 5955 | 1905 |

**Clement E. Stretton, C.E.,**
**Hon. Mem. A.S. Ry. Servants.**
Leicester, June 27.

## CRANK AXLES.

[24431.]—Many thanks to W. Rowland Hart for his letter *re* Saxby's test. He is quite correct, Sir, it can be applied to crank-axles, and has just been tried experimentally. "Wilfred," p. 366, says that statistics fully bear out the truth that axles break in the webs. Will he kindly give us some of those statistics and proofs? It is just some of these facts we want to get hold of. A good many cranks have, I know, "gone" in the bearings or axle-boxes, the driving-wheel thus getting away; but the fatal spot is the web, and generally the outside web.

"Wilfred" hopes practical men will give their opinions; so I express mine most decidedly for best Yorkshire iron cranks; steel is too strong and brittle for the job. **Locomotive.**

## ACCIDENT AT MANCHESTER.

[24432.]—There has been no Board of Trade inquiry *re* the collision with stops at Manchester central. The engine was 1666, the brake the "leak-off." The case hardly wants explanation; it was only Portskewet Pier and Northampton over again —the power leaked off. **Midland.**

## HEBERLEIN BRAKE.

[24433.]—This brake on the Colne Valley is an improvement; it is kept off by a "tight cord," a principle used years ago by Wilkin and Clark, also Park and Webb. We all pretty well know how useless the cord communication is, and I should not like to trust a brake to such a poor contrivance as a cord. Suppose it sticks in a pulley, as the Clark Webb cord does, where are you? It seems this brake is not on the engine, only three coaches.

**Brake.**

## THE NEW TIME.

[24434.]—I may inform our friend "F.R.A.S.," letter 24365 (p. 346), that having observed two or three solar eclipses I am sufficiently acquainted with the phenomenon to know that an eclipse does sometimes begin "before noon" and finish "after it"; and in reply to his query as to how I "propose to surmount" the difficulty of the change of date in this particular instance, I may simply state that I should allow this difficulty (?) to remain. Why? Because a change of date being necessary during the progress of a solar eclipse is a thing that would so seldom occur, that it is really no difficulty whatever. Whereas, in the cases pointed out by me in letter 24355, p. 325, it is a difficulty; therefore, as the change of date has to be made, it becomes a matter of choosing between two evils, and its having to be made occasionally in the midst of a solar eclipse is, I consider, the least of them.

With reference to the new time having been found satisfactory for the administration of the internal work of the Royal Observatory, I may be allowed to point out that though it is the case at that establishment, it may not prove so at other observatories; on that point, however, I may say that, speaking to the Astronomer-Royal on this subject the other evening, I was pleased to learn from him that steps have been taken to ascertain whether the adoption of the new time for astronomical purposes will meet with the approval of astronomers generally.

Though personally not altogether in favour of the astromomical part of the change, I may conclude by saying that I am willing to abide by the verdict of the majority.

Forest Gate, June 23. **B. J. Hopkins.**

## THE TERRESTRIAL TELESCOPE.

[24435.]—The valuable article by Mr. E. M. Nelson on the terrestrial telescope, p. 247, in "E. M." of 22nd May, deserves the thanks of all our readers who use that instrument.

It is impossible not to sympathise with a writer who confesses to loyalty to the single tube to the extent of still carrying a 6-drawer telescope in his pocket as his constant companion.

The perusal of his interesting article made me unearth my own corresponding instrument—a 6-draw, in German silver, by Troughton and Sims —the sight of which recalled times when, some forty years ago, the height of ambition was reached by its identification of the incoming ss. *Eclipse* or *Isle of Thanet* from Ramsgate Harbour; or later on, from Malta Harbour of the *Banshee* and *Caradoc*, the Marseilles mail-boats, which could be seen at a surprising distance in that perfect atmosphere.

But when the writer asks why the public have replaced the single tube by the binocular Galilean glass, and concludes that is "because they like powers of four to eight without, in preference to higher powers with trouble," he is hardly just to the circumstances.

It is not only that the two eyes see more than twice what the single eye sees, for the binocular result is not merely A + A, but $A + A + x$, $x$ being that mysterious charm which perfect double vision possesses beyond the mere duplication of the pictures; but in addition to this advantage the Galilean glass is ready for work all round the twenty-four hours, while the telescope must be closed from dusk till dawn.

The instrument which years ago replaced the 15in. 6-draw telescope (just referred to) as my present constant companion, is the 4-power Galilean glass which fits in the ticket-pocket of all my coats, and although the telescope has a power of 15 against its 4, it is beyond question that I see a great deal more with the 4 than the 15 on account of its greater light and double grasp of the object, and also that I can, and do, use it on many more occasions than a telescope could possibly serve me in, irrespective of its being only 3¾oz., and of the fact that it is taken from its pocket, opened, focussed, shut, and returned by the action of three fingers of one hand only.

Regarding powers, Mr. Nelson finds 30 for ordinary and 40 for extraordinary bright days is as high as can be used (this, I understand, not to be per inch, but to any aperture); "50 always making the presence of the atmosphere unpleasantly conspicuous;" concluding with, "there is imposed by our atmosphere a limit to power no matter how large the aperture of the telescope." Upon this, which is quite true, it is worth remarking that exception may be made at very short distances, when almost any powers may be successfully used.

It is also true that the powers furnished by most English opticians appear to support Mr. Nelson's conclusions. On the other hand, the Paris makers who supply the French Ministry of War, furnish minimum terrestrial powers to the respectively named apertures as follows:—50 to 3in., 55 to 3¼in., 65 to 3¾in., 80 to 4¼in., and 90 to 5¼in. object-glasses. I habitually use 80 and 110 on my double telescope in Paris, and though I often see the atmosphere boil with them, I have never yet used lower power than 60 on its 3⅜ o.g.'s. (I have now, however, ordered a pair of 40's, in consequence of Mr. Nelson's article.) I cannot think that the variation in the English and French powers in use can arise from difference in atmosphere, for the heat is greater in France, and hence the boiling would be most apparent in that country. The French opticians always consider English telescopes under-powered.

Mr. Nelson gives, on page 248, an excellent device for testing the the eyepiece diaphragms; but I would ask if the formula given is not incomplete? "Unscrew e.p. cap, focus and reverse—then seek disc of light seen at e.p., keeping eye some distance from o.g." are the instructions, which should produce—not a disc of light—but a minified counterpart of the magnified picture seen before reversal. Lastly, the same extent of field was found in his 1⅛ 15-power telescope, and in his 2⅛ binocular of power 8. I would ask if 8 is not too high an estimate? I have never yet seen a so-called English made Galilean glass of power 8; and if a 2⅛ aperture has a field of 4° and a focal length of 7½in., it should give a power of 6 only.

Mr. Nelson has satisfied himself that 4¼in. is the maximum aperture for advantageous terrestrial use; but if some owners of larger glasses—which are idle all day—would study and master them as Mr. Nelson has done, we might elicit more of such interesting and useful contributions to this too little known department in optics.

**Montmartre.**

## OPERA-GLASSES OF HIGH POWERS.

[24436.]—Having been twice foiled in my attempt to get a "seven-power" field-glass at the Army and Navy stores, might I ask "Montmartre" the great favour of procuring me one? I shall send cash for glass and expenses to any address he may indicate in the "Sale Column." Should he grant my request, I would ask him to send me, not a 39s. one, but one mentioned by the store people as being "superior" at the price of £2 16s. The distance between my pupils is 2⅜in.

9, India-street, Edinburgh. **G. Dickson.**

[24437.]—What can be fairly called an opera-glass? Surely not a binocular 11in. long, 5in. wide, and 2½in. diameter at largest end. Yet these are the dimensions, when in use, of the glass that "Montmartre" (24893) says he used in the Albert Hall. Where there is one "enthusiast" that would have courage enough to display so formidable an instrument indoors, I venture to think there are 99 who would not value power so highly as to be so heavily handicapped in size and weight. I am told by the optician who has a set of glasses for comparison that, although a great number of gentlemen have been to critically compare them, the general opinion respecting "Montmartre's" recommendation (6 and 10 power glasses) is that they are not satisfactory on account of their very small field and of the great size of the large one.

There is no difficulty in making a high-power glass cheap, and so the comparison of prices is useless if field of view and definition are not taken into account. I feel sure that a binocular with object-glass 1⅝in. diameter, of five diameters magnifying power, such as sold at £2 2s., will be far and away more satisfactory for either indoor or out-door use than the 6-power with small field of view. The question of abnormally high-power opera and field glasses was settled by public opinion years ago, when, after some hundreds had been sold, they were gradually put on one side, or exchanged by the purchasers or owners for others having a larger field, because they were found to be uncomfortable to use. As an instance of how light and field of view are appreciated, and power is confused with definition, I have known persons on being shown a glass of three-diameter power with large field, plenty of light and sharp definition, say it was more powerful than one of six diameters, that they had been looking through a minute before. The explanation is not far to seek, for one produces a pleasant sensation of sight, with a clear and sufficiently enlarged image of the object, while the other is limited in view, and often (unless well-proportioned) very indifferent in definition. Without going so far as to say the high-power glasses recommended by "Montmartre" are without use, I must strongly express the opinion that where they are not to form a portion of a "battery of binoculars" (so that the owner may pick and choose for the particular purpose in hand), they are not the opera and field-glass for every-day requirements. For special out-door work, where only a large glass could be satisfactorily used, the wide-angle binoculars, or a small single telescope (1½ o.g.), of fifteen-diameter power with large field would, in my opinion, be more satisfactory.

**G. R. Baker.**

P.S.—I am informed that "Montmartre's" model glasses can be purchased, as well as compared, at address given in advertisement on front page.

**Discrimination of Butter and its Substitutes.**—Mr. Thomas Taylor, Microscopist of the Department of Agriculture, at a meeting of the Washington Microscopical Society, read a paper on some discoveries he has recently made while experimenting with butters and the various forms of butterine and oleo-margarine. He first boiled a number of samples of pure butter obtained from Maryland, New York, Ohio, and other States, for the purpose of crystallising their fatty acids. After a lapse of twenty-fours, during which time they were laid away in a cool place to crystallise, on placing small portions of each under the microscope, using cotton-seed oil as a mounting medium, he discovered that the crystals of pure butter were sometimes globular and sometimes ellipsoidal in shape, and on turning the polariser so as to cross the analyser there appeared on each a well-defined cross, having equal arms, like that known as the St. Andrew's cross, and that on rotation of the polariser the cross rotated in like manner. He found also that the crystals of butterine and of oleomargarine, beef, and swine fats, are of stellar form, and differ from each other. These do not exhibit the cross spoken of in the case of true butter, and do not follow the rotation of the polariser. In this way butters may be distinguished from olemargarine made of beef or swine fats. Dr. Taylor stated that only in fresh butter has he been able to detect the cross in perfect form, and that in butter which has been kept for some time, or butter of inferior quality, when boiled and viewed under the polariser, the crystals present a rosette form, generally four-lobed, and these rotate on the turning of the polariser as do those in fresh butter—conditions not observed in any other fatty bodies, animal or vegetable.

**Physiological Effects of Compressed Air.**—N. Suchorsky states (*Chem. Centralblatt*) that when compressed air is respired the absolute amount of oxygen inspired and of carbonic anhydride expired is diminished. The rhythm of the respiration remains unchanged. In all cases of mechanical hindrance (bronchitis), restriction of movement of the organs (pleuritis), or reduction of surface (pneumonia), the change of rhythm consists in a gradual disappearance of the pause after expiration, and the times of inspiration and expiration become equal. Compressed air acts on the circulation in a twofold manner—on the one side it compresses all the capillaries of the outer surface and of the respiratory organs, causing a more complete emptying of the veins, and on the other side changes the distribution of blood in the system, causing an accumulation in the abdominal organs. The therapeutic action of compressed air may be referred exclusively to its mechanical action on the organism, and to the increase of partial oxygen pressure. The latter produces no perceptible effect on the oxidation process in the body; on the contrary, in pathological cases where respiration is impeded, it tends to reduce the absolute amount of oxygen taken up and the carbonic anhydride expelled, as the organism obtains the necessary amount of air with less difficulty, and so the muscular work of the respiratory organs is economised. Consequently, the therapeutical application of compressed air cannot be considered as facilitating oxidation and support of the body in sick cases, but as a saving of effort. Nevertheless, it would be erroneous to conclude that compressed air might in these cases be replaced by air rich in oxygen, since the compressed air exerts a series of favourable influences on the sick organism, and especially on the respiratory organs. The pressures employed varied between 1,045 and 1,143mm. of mercury.

# REPLIES TO QUERIES.

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[56257.]—**Telescope Stand.**—Read "convex" instead of "concave," which you will find in letter 56257, p. 351.—D. Booth.

[56314.]—**Strength of Gear Wheels.**—What do you mean by "swinging" 5 cwt.? If this weight is at the end of a lever, what is the *horizontal* distance between a plumb-line dropped through the centre of the weight and another dropped through the centre of the spindle? Is the weight raised suddenly or slowly?—Glatton.

[56538.]—**Ink for Black-Edged Note Paper.**—The usual method, I believe, is as follows:—Mix graphite 11 parts, common ink 22 parts, dissolved gum arabic 1 part. Then with a sponge lay the colour on the edge of the paper, previously placed in the cutting press, rub it with a piece of cloth, and burnish. The edge of the paper must be rendered perfectly smooth before applying the black.—Percy W. Stanley, 119, Manchester-road, Poplar, E.

[56550.]—**Sawing.**—Several replies have been written on wood-working tools, and I believe almost all saws have been mentioned, except pit-saws. Now, I do not wish to set aside the advice given to "Alabama" by "J. M.," but will venture, as well as I possibly can, to make clear the process of sharpening his saw. First, keep the teeth as near as possible like Fig. 1, the hook being about 30°, which will do for most kinds of wood. Fig. 2 is meant to represent the various bevels to be filed on the tops of the teeth; the harder the wood, the less the lead of the teeth, and the softer the wood, the more cant; but do not at any time, let it be more than 80° or 90°, or it tears the fibre of the wood. Most pit sawyers, when sharpening, hold the file something like Fig. 3, and the gullet of the saw is generally a long bevel, and sharp, which is of no earthly use whatever: the result is no two teeth together alike for hook or size. I maintain that a pit-saw requires to be sharpened (much the same as frame-saws, commonly known as vertical-saws), using half-round file, the round part to lower the gullet (straight through), and the flat side to top the teeth with. One of the most essential points is, saw perfectly level on top, and the set to be uniform.—A. Lester.

FIG. 1.

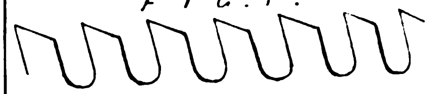


FIG. 2.

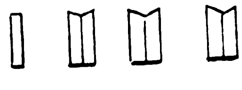
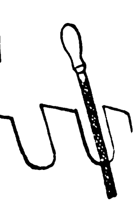


FIG. 3.



[56575.]—**Galvanometer.**—I am sorry I cannot help Mr. Bridge after perusing query 56081. I do not conceive how an astatic needle "entirely concealed from view" can be made to register or indicate its movements.—Nun. Dor.

[56591.]—**Lee-Boards to Boats (U.Q.)**—It is not a common practice to affix lee-boards to boats, and there is no rule for doing so; consequently I fear querist will have to become his own naval architect, and make and affix his lee-boards in the manner that will best attain the object he has in view. If it is to give his boat the stability and lateral resistance necessary to carry a sail, I think the contrivance thrown out as a centre-board would best attain this, and will send a sketch thereof, if querist wishes it.—James McCash Govan.

[56620.]—**Steam Carriages.**—If I understand "Progress No. 2" he must know more about what "Progress" means than I do. I gather from his last that the roads will need to be iron plated, for certainly, you know, *I* am not going to crawl along behind a coal-waggon. He will want four sets of those rails: slow and fast traffic going and returning.—Nun. Dor.

[56620.]—**Steam-Carriages.**—To "Invicta."—It is with great pleasure that I reply to our friend across the "silver streak," and assure him that anything I could possibly do to assist him I would do most freely and frankly. To (1) I would say that so far as I have had experience, the arranging of the engine into a very small space has been in the past one of the fallacies which have blocked the way. For an engine of 1 h.-p. without boiler, fitted also with reversing motion of a simple kind, and, if desired, an expansion gear as well, I should want a space of, say, 4ft. long by 12in. by 12in., or the entire engine and crank can be put into a space like a shoot, 12in. square and 4ft. long. Now the system I advocate is that of a cylinder of small diameter by comparison and long stroke, the abolition of all gearing, and the whole reduced to the utmost simplicity. Now a statement without a reason for it is entirely worthless, and I will give facts for the faith I hold. I have ridden on a steam-carriage which was propelled by a small high-speed engine; something like a space 18in. by 12in. by 12in. would cover the engine; this engine as soon as we started produced a very lively exhaust and a lot of visible steam. But worse still, it produced a vibration and throbbing of the entire carriage and the passengers therein—that to me was very unpleasant. Then the noise of the reducing gear was another objection, and altogether, although it was able to travel all right, still, it did not come up to my ideas of a motor carriage. A mechanical friend who was with me on the occasion of riding on this first motor, decided to make an entirely different one from my designs, and after some delays, due to the want of materials and tools, the machine was tried with a most satisfactory result. The connecting rod taking hold of a crank in the main axle did away with all gearing. The starting was positive, whilst the motion at a speed on a good road was, as "C. B., Zurich," says, like sailing, the speed of the engine being very moderate, there was none of the vibration or jar resultant from a quick-running engine; the exhaust could scarcely be heard or seen, whilst the demand for steam was very small. The high-speed engine mentioned had a large boiler, and was most voracious in its demands for steam, especially at every little rising grade. But, to come to the specific questions again, as point (2) the pressure would be, say, 80lb. to 100lb. on the square in., or, say, seven to eight atmospheres. (3) The piston strokes per minute would be about 110 per minute, or, say, 55 revolutions a minute only, with a speed of, say, eight miles an hour. (4) The steam used would be entirely according to the gradient; and the condition, and consequent resistance due to the surface of the road. (5) The cost of engine alone would, in my opinion, be about £20 to £30. The Parkyns engine is only suitable for a tricycle or carriage for one person, and its power is very limited. The carriage I am thinking of would carry, say, four persons up and down hill, with a weight of, say, 30cwt. Besides this the weight of the passengers would be additional. I am also writing to this gentleman direct, and hopefully anticipate that some practical result may accrue in this direction.—INVICTA.

[56646.]—**Bicycle Painting.**—If you mix the colours with turps and varnish, and they seem to "work stiff," that shows that you have not used enough. It is well to mix a "little and often," as you want them to dry quickly.—ESSAR.

[56656.]—**Planishing Tin Plates.**—You must hammer round the edges now to take out the hollow of the centre; but in future pass the punched plates between flattening rollers, and do not hammer at all.—ESSAR.

[56657.] — **Wireworking.** — It is done by machinery—weaving machines.—J. T.

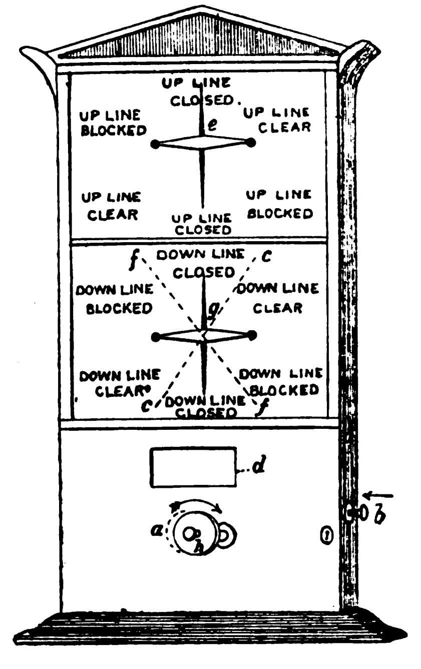
[56672.]—**Tarpaulin.**—Paint it with the required colour pigment mixed in "double boiled" oil, very thin coats, and allow to dry thoroughly between each.—NUN. DOR.

[56676.]—**Free Reeds.**—A so-called reply to this query appeared on pp. 288, 289, which concluded by showing that the writer did not understand the question he had set out to answer; and as in most other instances of the kind, presumption followed ignorance, and the querist was told to "discard the somewhat foolish ideas expressed in the query." The "foolish ideas" are suggestions for making a tuning bellows—an apparatus which Mr. Fryer may now learn is used when filing reeds up to pitch. It has nothing to do with "learning the art of tuning." The least Mr. Fryer can do now is to tell the querist how the bellows is constructed which is used in factories where they make harmonium reeds. The reed filer has a reed of the given pitch fitted on his bellows, and he tries the new ones until he gets them like the standard. I would suggest to the querist that the easiest plan is to use an exhaust bellows having a weight to pull down the feeder, and a treadle and strap to pull it up. Three holes are usually sufficient.—G. L. B.

[56683.]—**Magneto Machine.**—You cannot turn an electro-motor by the current generated in an ordinary form of magneto machine, nor will it ring bells unless a polarised magneto bell is employed, as in the Wheatstone A B C call bell. It would also be impossible to indicate what current an unknown armature could yield simply by the speed to be driven at: the power of the field magnets must be known and the particulars of construction of armature so as to form an idea. The best arrangement of fields is obtained in the De Meritens system, and that form of armature is one of the best and requiring little power to drive, and will ring an ordinary electric bell. There is a special magnet steel now manufactured by a Sheffield firm—cast or shear steel will not suit; good magnet steel should contain a percentage of tungsten, and the bars appear of a dull speckled character. A Belgian mechanic was in England last year who had a method of magnetising steel to a very high degree, and I believe he has formed a company in Paris for this special trade—telephone manufacturers being large users.—AJAX.

[56685.]—**Stiffening Woollen Cloth.**—Use gelatine applied very hot and thin.—T. M.

[56695.]—**Block Instrument.**—I send herewith a sketch with description of the working of the "Tell-tale block instrument" in use on the London and North-Western Railway, at Willesden Junction and other places. The normal position of the needles is as shown. "Line Closed," and no train, engine, &c., may be allowed to proceed so long as the needles stand in this position, in which position they merely show that the signalman is not in a position to accept the "Be Ready" signal for a train. The "Be Ready" for a train having been received, the signalman, if everything is clear, will accept the train by removing the needles to "Line Clear," to do which he must turn the disc A to the right (after he has pressed the plunger B, which unlocks the disc A), and the needles will then stand in direction of dotted line C C; similarly, on the train being given in section, he will press the plunger *b* once more, turn the disc A to the right again, this causing the needles to shift from "Line Clear," to "Line Blocked," as shown by the lines F F. Simultaneously with turning the disc A, the words "Line Closed" in the square *d*, will change with the needle to "Line Clear," or "Blocked," as the case may be. "Line Closed," standing on green ground, clear on white, and blocked on red. The plunger H is used only to ring the bell with, and the needle G corresponds with the needle *e* on the instrument in the box in advance, and *vice versâ*. I have worked these instruments myself, and in my opinion they are the best block instruments yet invented. I may mention they are Tyer's patent. —LEVER.



[56700.]—**Circumference of Wire Rope.**—Circumference = $3\frac{1}{7}$ times the diameter.

$$\therefore \frac{119}{1} \times \frac{3}{32} \times \frac{22}{7} = \frac{7854}{224} = \frac{561}{16} \therefore \text{diameter}$$

of rope = $35\frac{1}{16}$in.—LEVER.

[56703.]—**Algebraical Problem (No. 2.)**—Would W. J. Grey kindly explain the latter part of the equation $\frac{10}{\underline{|r}} : \frac{1}{\underline{|r-1}} :: 5 : 3$. What does he mean by the $30\ \frac{\underline{|r-1}}{r=6} = 5\ \underline{|r}$ signs $\underline{|r}$ and $\underline{|r-1}$? And how does he arrive at $r = 6$? An explanation of the above would oblige several contributors besides—EXCELSIOR.

[56703.] — **Algebraical Problem.** — Having noticed "East Anglian," J. C. Kelly, and "J. C.'s" attempts to answer "Trophy's" algebra question in the last numbers of the ENGLISH MECHANIC, will you please kindly allow me to point out that none of the answers are satisfactory, inasmuch as they do not satisfy the conditions of the problem? "East Anglian" starts with a false premise by assuming that $13\frac{1}{3}$ hours means $3\frac{1}{3}$ hours, and, of course he is out of court. Taking J. C. Kelly's figures, and assuming that $x$ = number of gallons in hold at first, $y$ = number of gallons leak per hour, and $z$ = number of gallons pumped per hour by A. we have time in which A. would pump the whole $= \frac{x}{z - y}$, or 10 hours; then by question, $3\frac{3}{4}z = 3\frac{1}{3}z + 100$, or $600 = 633\frac{1}{3}$, which is absurd. With "J. C.'s" figures we should have, as before, $\frac{x}{z - y} = 10$ hours, and $3\frac{3}{4}z = 3\frac{1}{3}z + 100$, or $90 = 180$, which is also absurd. The true answers, and which satisfy the conditions of the question, seem to be: $x = 1{,}200$ gallons, $y = 120$ gallons, and $z = 240$ gallons; for $\frac{x}{z - y} = \frac{1{,}200}{240 - 120} = 10$ hours, and $3\frac{3}{4} \times 240 = (3\frac{1}{3} + 240) + 100$, or $900 = 900$. —D. R. M.

[56722.]—**Flywheel.**—You may use a wheel 18in. diameter if it be more convenient. At 300 a minute the wheel should weigh from 40lb. to 42lb., instead of 35lb. You can get the extra weight by making the rim nearly $\frac{1}{4}$in. thicker in the major portion. If the wheel was even a little more than the theoretical weight, it would not be a matter of injury even.—INVICTA.

[56733.] — **Problem.** — In reply to "East Anglian," on page 371, I wish to state that the correct answer to problem on page 353 is arrived at as follows:—As A. takes three strokes, while B. takes two, and throws out as much water in five as B. does in four, the quantities pumped out by A. and B. in equal spaces of time are as six to five. Let $x$ = the No. of gallons in hold at first, $y$ = the hourly influx at the leak, $z$ = the time B worked = the time in which A. would clear the hold, $x + yz$ = the quantity which would be pumped out by A in two hours, $\frac{x}{z} + y$ = the quantity A. pumps out per hour, and $\frac{5}{6}\left(\frac{x}{z} + y\right)$ = the quantity B. pumps out per hour. $\frac{5}{6}(x + yz)$ = the quantity pumped out by B. $-\left(x + \frac{40}{3y}\right)$. $\frac{5}{6}(x + yz) = \frac{1}{6}x + \left(\frac{40}{3} - \frac{5}{6}z\right)y$ − the quantity pumped out by A. Also, $z : (x + yz) :: \frac{40}{3} - \frac{40}{3z}\frac{x}{z} : -x + \left(\frac{40}{3}z\right)y$ = the quantity pumped out by A. $\therefore \frac{1}{6}x + \left(\frac{40}{3} - \frac{5}{6}z\right)y = \frac{40x}{3z} - x + \left(\frac{40}{3} - z\right)y$, whence $x = \frac{yz2}{80 - yz}$. If they had both worked together they would have emptied the hold in $\frac{15}{4}$ hours, and the quantity pumped out would have been $x + \frac{15}{4}y$. $11 : 6 :: \left(x + \frac{15}{4}y\right)$ : the quantity A. would have pumped out $= \frac{6}{11}x + \frac{90}{44}y\ \frac{15}{4} : 1 :: \frac{3}{11}x + \frac{90}{44}y : \frac{8}{55}x + \frac{6}{11}y$ = the quantity A. pumps out per hour. $\therefore$ $\frac{8}{55}x + \frac{6}{11}y = \frac{x}{z} + y$; whence $x = \frac{25yz}{8z - 55}$, and $\frac{25yz}{8z - 55} = \frac{yz2}{80 - 72}$. Divide by $yz$, and $\frac{25}{82 - 55} = \frac{2}{80 - 72}$, and $z = 10$, $x = \frac{yz}{80 - yz} = \frac{100y}{10} = 10y$. But if they had worked together, A. would have pumped out 100 gallons more than he did. $\therefore \frac{6}{11}x + \frac{45}{22}y - 100 = \frac{x}{6} + \left(\frac{40}{3}\frac{5}{6}z\right)y$, in which equation put $x = 10y$, and $z = 10$; and we shall have—

$y$ = 120 gals. hourly influx
$x$ = 1200 " the quantity in the hold at first.—TROPHY.

[56744.]—**Water Softening.**—We have an apparatus that has been at work eighteen months, softening 4,000 gallons per hour, costing about $\frac{1}{4}$d. per 1,000 gallons for lime, no chemical knowledge required, and very little attendance, also a simple method of testing the hardness. We reduce the water from 18 to 5 degrees of hardness, and effect a great saving. If "J. T. C." will advertise his address, I shall be pleased to give him particulars and to show him the apparatus and test.—St. Pancras.

[56780.]—**Camping Stoves.**—Thanks for the answers to my query. I have got two large methylated spirit stoves, and am having a thin iron box made for them with holes in the top for kettle, &c., to fit in, with door in front. Would they kindly tell me where they got their drinking water from—whether they got in a supply coming along, or river water filtered? If the latter, which is the best filter to take?—W. P.

[56796.]—**Boiler.**—Surely "Invicta" must be wrong in his statement that the 2oz. weight at the end of $5\frac{3}{4}$in. lever (short end of lever $\frac{3}{4}$in., area of valve $\frac{13}{16}$ths circular in., or rather more than half of a square inch), would give a pressure of 25lb. I fail to see it. Would "Invicta" please be kind enough to show his method of working it out?—J. B.

[56823.]—**Steam.**—Cubical contents of cylinder in cubic inches—

$$\begin{aligned} &= \pi \times (\text{radius})^2 \times \text{length} \\ &= 3{\cdot}1416 \times (16)^2 \times (6 \times 12) \\ &= 3{\cdot}1416 \times 256 \times 72 \\ &= 804{\cdot}2496 \times 72 \times 57905\ 9712. \end{aligned}$$

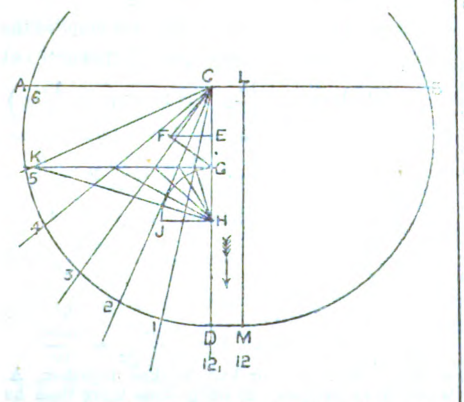
∴ the cubic inches of steam used at every stroke, the cut-off being ·21—

$$= 57905{\cdot}9712 \times {\cdot}21 = 1760 \text{ roughly.}$$

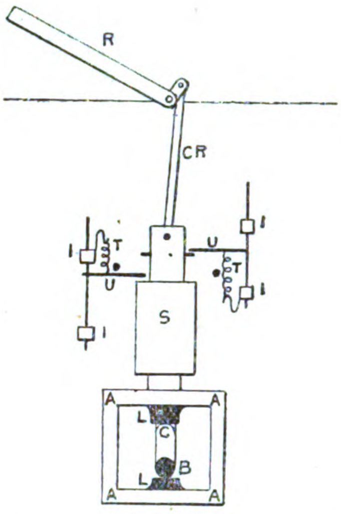
Now, to get the condensing water for this volume of steam, we must know first, as will be shown hereafter, the volume of water evaporated in the boiler to get this quantity of steam. Well, we know that one cubic inch of water evaporates 1,700 cubic inches of steam. ∴ a little more than one cubic inch of water evaporated in the boiler would give the steam in the cylinder. From Watt, we know that 28·9 cubic inches condensed water is required for one cubic inch of water evaporated in the boiler. ∴ we can safely estimate that the quantity of water, in cubic inches, to condense the number of cubic inches of steam in the cylinder will be 30. *Answer.*—A. B. C.

[56834.] — **Sundials.** — Article "Dialling," *Encyclopædia Britannica*; "Mechanick Dialling, or the New Art of Shadows," by Charles Leadbetter, London; "The Art of Dialling," &c., by Thomas Fale; "The Art of Dialling," by John Blagrave; "The Art of Dialling," by Samuel Foster, London; "Four Treatises on Dialling," by John Collins; "Universal Way of Dialling," by King.—G. Dickson.

[56834.]—**Sundials.**—To make a horizontal sundial, draw a line A B, and at right angles to same draw the line C D, and at any point E draw E F perpendicular to C D. Make the angles F C E, E F G, each equal to the latitude of the place in which it is proposed to erect the sundial. Make G H equal to F G. At the centre H, at distance H G, describe the quadrant G J, and divide same into six equal parts, and through the five points draw lines terminating in the line G K, which is parallel to A B; and then through the points in G K, where these lines terminate, draw five other lines from the point C, as shown in diagram. From E describe an arc A D, and number the points of intersection as indicated in diagram, and half the dial is complete. Let C L D M represent the hand to throw the shadow; it will have its point at C L, and the angle of which C L is the apex must be equal to F C E, and must point due south, the arrow in sketch pointing to the north. To complete the dial, measure off places from or corresponding to those on the other side, and commencing at 12 number them 11, 10, 9, 8, 7 till ariving at B, which you number 6, as on the opposite side. If you desire to divide the dial into quarters of an hour, simply divide the parts cut off in G J into four, and proceed as before. You will note that the dial is not a circle, but the second half is described from a point in L M corresponding to E.—Fred. A. Robinson.



[56839.] — **Automatic Steering Gear.**—A cam C, which works on the centre B, is connected by means of a small spindle to wheelwork underneath a brass plate, which is made to revolve once in a minute. This cam works inside a square of brass A A A A, and as it revolves therein it catches the projecting pieces L L and pushes the square up and down. A brass rod, which is connected to the square, slides through the slide S. A smaller rod is connected to this, which is fastened to a lever fixed on the rudder R. In order to bring the rudder into place again, when the cam has left the projections on square, two springs, T, one on each side of the small rod, pull it back by means of the catches V V, which slide through I I I I.—W. E. S.



[56841.]—**Accumulator.** — For practical purposes the pressure due to the height of the water in the accumulator may be neglected in this case: since it is only 1·31b. per sq. inch, it will go to compensate for loss on friction, &c. To find the weight on the column of water, including the weight of ram, of course, multiply the sectional area of ram in square inches by the required pressure per square inch: the result is the load required. The power required to drive the pumps will be equal to the area of the discharge pipe in square inches, multiplied by the velocity of the water through the pipe in feet per minute, multiplied by the pressure per square inch. This will give the power in foot-pounds per minute. The tensile stress on the sides will be equal to the internal diameter in inches multiplied by the pressure in pounds per square inch. Taking the tensile strength of cast iron at 10,500lb. per square inch, and using a safety factor of 5: thus—

$$5\,d\,p = 2\,t \times 10{,}500$$

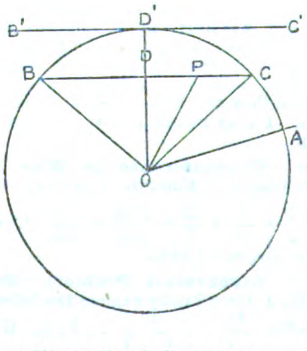
$$\text{or } t = \frac{5\,d\,p}{2 \times 10500}$$

where $d$ = internal diameter, and $p$ = pressure per square inch. This will give for 150lb. pressure—

$$t = \frac{5 \times 18 \times 150}{2 \times 10500} = \tfrac{3}{4}\text{in.}$$

—R. W., Newcastle-on-Tyne.

[56844.]—**Mathematical.**—Take O the centre of the circle, O A the initial line, B C the chord whose equation is to be found, D the centre point of B C, then we have the angle D O C = B, D O A = A, and if $\gamma$, $\theta$ are the polar co-ordinates of any point P in the line B C, $\gamma$ = O D sec. D O P = sec. $(a - \theta)$; but O D = O C cos. B = C cos. B, C being the radius of the circle; thence $\gamma = c$ cos. B sec. $(a - \theta)$. Now, suppose the chord B C to move parallel to itself until it reaches the point D′ on the circumference of the circle; it then becomes a tangent at the point D′ and the angle B O C or B vanishes; then cos. B = 1, and the equation of the tangent becomes $\gamma$ = C sec. $(a - \theta)$, where $c$ and $a$ are the polar co-ordinates of the point of contact.—H. H.



[56844.]—**Mathematical.**—Let AB (Fig. 1) be the chord subtending at the centre O an angle = 2 B. Let C O E = $a$ and radius of circle = $c$. Let P be any point on the chord, O P = $r$, the radius vector, and C O P = $\theta$—

Then O E = A O cos. A O E = $c$ cos. B,
also O E = O P cos. E O P = $r$ cos. $(\theta - a)$

$$\therefore c \cos. \text{B} = r \cos. (\theta - a)$$

$$\text{and } \therefore r = \frac{c \cos. \text{B}}{\cos. (\theta - a)} = c \cos. \text{B} \sec. (\theta - a)$$

Again, to find the polar equation to the tangent at a given point: Let Q P C (Fig. 2) be the tangent at any point P, and Q any other point on the tangent. Let C O P = $a$, and C O Q = $\theta$. Let radius vector, O Q = $r$, and radius of circle = $c$.

FIG. 1.

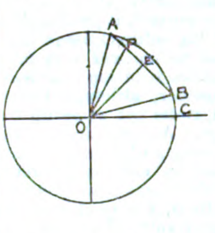
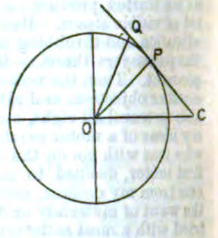


FIG. 2.

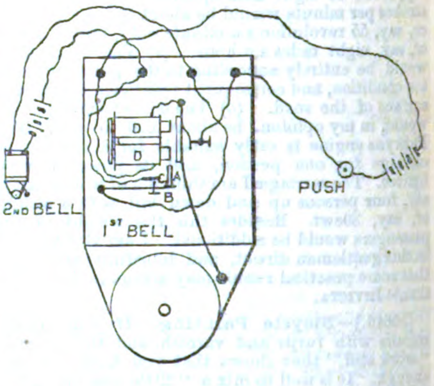


Then $c = r$ cos. Q O P,
or $c = r \cos. (\theta - a)$.

$$\therefore r = \frac{c}{\cos. (\theta - a)}$$

or $r = c \sec. (\theta - a)$, the required equation.
—J. E. Gore.

[56846.] — **Connecting Electric Bells.**—I forward rough sketch of electric bell, which I think will suit "Ignorant." Directly the circuit is completed in the first bell, the armature A is attracted by the magnets D, causing the screw B to press against the upright C; thus completing the circuit through the second bell.—W. E. S.



[56856.]—**Engine Query.**—"Goodeve" must have made a mistake in giving the data of this query; for, as it stands, it gives a gain of over 200,000ft.-lb. per minute.—R. W., Newcastle-on-Tyne.

[56856.]—**Engine Query.** — "Goodeve" must have made some mistake in the wording of his question. For, as it now stands, he can get more work out of his engine than he gives to it. This will be seen from the following calculation. The work in ft.-lb. applied to the piston = 400 × 25 × 15 × 2 × 4 = 1,200,000ft.-lb. per minute; and the work developed per minute $= \frac{400 \times 2240 \times 10}{6}$ = 1,493,333·3ft.-lb., being an excess over the work applied of nearly 500,000ft.-lb., and no power lost in the machinery. Are you right in saying that the number of double strokes made per minute is fifteen?—A. B. C.

[56857.]—**Diminished Power of Engine.**—It moves the reversing link over, bringing the slide-rod motion-block nearer to the centre of the link, thus shortening the travel of the slide-valve, and giving the ports less opening to steam. When the reversing lever is in the central position, the motion block is in the centre of the link, which will oscillate on the block, and give no motion to the slide-rod. Thus we can get any length of travel for the slide-valve up to the full travel, and consequently any degree of wire-drawing of the steam.—R. W., Newcastle-on-Tyne.—

[56858.]—**Horse-Power of Engine.**—If we take the total pressure on the piston at 50lb., then it will travel 100 × 144ft. per minute, and the horse-power will be—

$$\frac{100 \times 144 \times 50}{33,000} = 21\tfrac{8}{11}\text{h.p.}$$—R. W., Newcastle-on-Tyne.

[56858.]—**Horse-Power of Engine.**—H.-P. (horse-power) $= \frac{\text{work in ft.-lb. per min.}}{33,000}$ 1 cub.ft. of steam per minute does $144 r\, p_e$ ft.-lb. of work. Now, $r = 1 + p_e = 50$lb.

$\therefore$ 1 cub. ft. does (144 × 50 =)7,200 ft.-lb.
$\therefore$ 100 „ 720,000 ;

from which required horse-power of engine $= \frac{720}{33}$ = 22. Answer.—A. B. C.

[56862.]—**Scraping Metal Surfaces.**—Shelley's "Workshop Appliances," published by Longmans, will give you the information required; or there is a more elaborate book, of which Prof. Goodeve is the author. The latter is upon the Whitworth measuring machine, but it contains a full description of what you want.—FRED. A. ROBINSON.

[56875.]—**Thymol.**—I thank Mr. Grey for his reply; but I was not aware before that there were two varieties. I have tried the plan he suggests—viz., adding warm water to an alcoholic solution; but when it has gone cold the thymol separates out. I cannot say which variety I have used, by the nomenclature he gives, but it is in the form of a semi-transparent crystal. Caustic soda will dissolve it without separation afterwards; but would this destroy its antiseptic properties?—NOVICE.

[56878.]—**Mineral Water.**—This query is not sufficiently definite. Does "M. W." mean that he employs citric acid in the preparation of the syrups for aërated waters? If so, Goold, author of the "Aërated Waters: How to Make Them," is strongly in favour of acetic as against citric and tartaric acids; and I really do not see what objection can be urged against its use, if pure, that would not tell equally against using vinegar, and the whole tribe of sauces and relishes, at table. If, however, he is alluding to the production of $CO_2$ in bottle, the case would be somewhat different.—PERCY W. STANLEY, 119, Manchester-road, Poplar, E.

[56881.]—**Observatory Dome.**—A dome is a difficult matter to deal with in a manner that is satisfactory every way. Knowing by the experience of friends that zinc is a most unsatisfactory material, I tried my hand at making a dome with sheets of patent sheet tin. This was far better than zinc: it was easier worked, the joints were all soldered, and it was both strong and rigid. The sheets were cut to a template so as to produce the proper curve, and then were hollowed out by a wood mallet, several being worked at a time, the right curve being found by using a wood template, or rather a series on a bar. This dome, which was built some years ago, is still in use, and is in first-class condition. But the labour was too much on it. Subsequently, attempting another one, I tried an entirely different plan, taken from the huts of one of the savage tribes. In the centre was a circular plate of iron dished to the curve of the dome; to this was riveted light frames of T-iron, the lightest I could get, the web being cut away where they were riveted to the circular centre; two circular ring ribs tied these together. Over all was stretched canvas well painted in and out. The gores thus formed by the iron ribs I further reduced by the use of light rods or bars bent to the curves of the roof, the inner ends being brought into a wood centre screwed up to the iron one. The appearance is very good, and there is no nuisance such as a metal dome is sure to cause. Any particulars are freely at your service if you like the plan. The outside looks well: it is rigid, and inside the ribs give it a satisfactory look as well. The revolving top is carried on three points only, and revolves with the greatest ease.—INVICTA.

[56883.]—**Portrait Photography.**—I strongly suspect that you are labouring under a slight delusion with respect to your photos. The negatives are not over-exposed, but under-exposed. Do you get the detail all right? If not, this is certainly the case. Perhaps you don't put enough pyro solution in the developer. Try exposing them much longer and not quicker. If they were fogged you would not get sharp negatives, but there would be a kind of haze over all the objects, and no sharp definition of lights and shades. In this case you would not, very likely, get the white appearance at the back. Put your plates in the oven for a few minutes: sometimes this vastly improves them when they don't work well. Do not over-develop them: this is another mistake which would cause the misfortune you describe.—R. A. R. BENNETT, Vicarage, Frome-Selwood.

[56885.]—**Potato Cleaning.**—A simple plan would be to construct a watertight wood box; in it have a spindle, turned by handle outside. On this spindle have fixed bundles of stiff hair, or fibre, similar to a hard sweeping brush. Supposing the top to be open, put in, say, a lot of potatoes and water. By turning the handle they would be scrubbed and moved briskly about; water should be arranged to flow in and out by an overflow. A flap door with a joint made with a rubber washer and a bar would give a quick way of emptying out the wasted vegetables.—INVICTA.

[56886.]—**Model Boiler.**—Spirits burnt under any condition sufficient to raise steam quickly are certain to make some little smell. The form of lamp I should use for it would be that of a siphon form. I should make it in one of several ways. One would be a small reservoir or wick box, or furnace, 3½in. diameter, 1in. deep. In this I should fit eight wick tubes, each made from ½in. brass tube, five of them in a circle close to the edge of furnace box, the other three as an inner circle. From this box is a tube, say, ¾in. diameter, to a spirit reservoir a few inches away; and with the ¾in. tube arranged to carry a siphon wick, the feed will be steady and constant, and as little smell will result as may be. See that the air admission to the firebox past the lamp is ample, as incomplete combustion is the most fruitful source of smell possible.—INVICTA.

[56891.]—**Shocking Coil.**—If your coil gives no results whatever with a pint Bunsen connected to it, there must be a serious defect somewhere, which the addition of an extra cell would not remedy. It would be difficult to say where the defect really is, as many conditions must be fulfilled in order to produce a successful coil. You do not mention the size of the secondary wire, nor the manner in which the connections have been made. Can last week's replies to 56872 not help you?—BOBADIL.

[56895.]—**Cutting Wards of Keys.**—"Agricultor" should try a circular saw. I succeeded very well with one about 4in. in diameter, it cut through ⅛ of an inch easily.—C. L.

[56899.]—**Boiler.**—To "INVICTA."—Your boiler will drive the 2½in. by 5in. engine; but the heating surface is none too large, so that you must not expect to run at much speed. I am supposing that the boiler is a plain cylinder with egg ends; but do not carry more than 20lb. to the square inch. Much will depend on how it is fixed, as to whether its full power is got out of it. For such a small boiler I should fix it in brickwork; the fire carried as is usual with externally-fired boilers. Then carry a straight flash flue to the chimney. To feed-in the water you may use a pump on the engine, or a modification of the feeder I sent a sketch of to the "E. M." some time since. I would also strongly advise fitting a stay to this boiler—say, ⅜in. diam., with an extra deep nut and washer at each end to draw up with. I will, if you wish, give further instructions as to boiler setting and feeder suitable for your boiler, if you think it needful.—INVICTA.

[56900.]—**Cost of Locomotive.**—Eleven years ago cost of locomotive and tender did average £2,500 to £3,000; but prices have gone down, and we take the average now as £2,200 to £2,700.—MANCHESTER.

[56902.]—**Electric Lighting on Trains.**—The Chingford line trains are still lighted by the method mentioned, and have been for some time. I hear that the company are going to extend its use to the other lines. The extinction of the lamps at the termini would hardly be noticeable, as the wires are coupled to one engine as soon as they are uncoupled from the other.—FABER FABRUM ADJUVET.

[56904.]—**Problem in Algebra.**—In the expansion of $(x + a)\,4^n$, the number of terms will be $4n + 1$, and the middle term will be the $(2n + 1)$ th. Hence the co-efficient of the middle term will be

$$\frac{4n\,(4n-1)\,(4n-2)\ldots\ldots\ldots\ldots 4n-(2n+1)+2}{1\,2\,3\ldots\ldots\ldots\ldots 2n+1-1}$$
$$= \frac{4n\,(4n-1)\,(4n-2)\ldots\ldots\ldots\ldots 2n+1}{1\,2\,3\ldots\ldots\ldots\ldots\ldots\ldots 2n}$$

Multiplying this above and below by $\underline{|2n}$, we have:

$$\frac{4n\,(4n-1)\,(4n-2)\ldots\ldots\ldots\ldots\ldots 2n+1 \quad \underline{|2n}}{1\,2\,3\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2n \quad \underline{|2n}}$$
$$= \frac{1\,2\,3\,4\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4n}{\underline{|2n}\ \underline{|2n}}$$
$$= \frac{(1\,3\,5\,7\ldots\ldots 4n-1)\,(2\,4\,6\,8\ldots\ldots\ldots\ldots 4n)}{\underline{|2n}\ \underline{|2n}}$$
$$= \frac{(1\,3\,5\,7\ldots\ldots 4n-1)\,2^{2n}\,(1\,2\,3\,4\ldots\ldots 2n)}{\underline{|2n}\ \underline{|2n}}$$
$$= \frac{2^{2n}\,(1\,3\,5\,7\ldots\ldots\ldots\ldots\ldots 4n-1)\,.\,\underline{|2n}}{\underline{|2n}\ \underline{|2n}}$$
$$= \frac{2^{2n}\,1\,3\,5\,7\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4n-1}{\underline{|2n}}$$
$$= \frac{2^{2n}\,1\,3\,5\,7\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4n-1}{1\,2\,3\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2n}$$

—J. E. GORE.

[56904.]—**Problem in Algebra.**—I think "Bunsen" will find the following a correct solution of his question:—In expansion of $(x + a)^{4n}$, the middle term is clearly that term which contains $x^{2n}$. Expanding, we see that the coefficient of $x^{4n-r}$ is—

$$\frac{4n\,.\,(4n-1)\ldots\ldots\ldots(4n-r+1)}{\underline{|r}}$$

put $r = 2n$, and we get coefficient of middle term

$$= \frac{4n\,(4n-1)\ldots\ldots\ldots(2n+1)}{\underline{|2n}}$$
$$= \frac{4n\,(4n-1)\ldots(2n+1)\,.\,2n\,.\,(2n-1)\ldots\ldots 3\,2\,1}{[\,\underline{|2n}\,]^2}$$
$$= \frac{(4n-1)\ldots\ldots 5\,3\,1\,.\,2^{2n}\,[2n\,.\,(2n-1)\ldots\ldots 2\,1]}{(\underline{|2n})^2}$$
$$= 2^{2n}\,\frac{1\,3\,5\ldots\ldots\ldots(4n-1)}{1\,2\,3\ldots\ldots\ldots 2n}.$$

—G. F. P.

[56904.]—**Problem in Algebra.**—$(x + a)^{4n} = x^{4n} + 4n\,x^{4n-1}\,a + \frac{4n\,\overline{4n-1|}}{1\,.\,2}\,x^{4n-2}\,a^2$

The coefficient of the middle term is—

$$\frac{4n\ \overline{4n-1|}\ \overline{4n-2|}\ \ldots\ldots\ldots\ \overline{4n-2n+1|}}{1\,2\,3\,4\ \ldots\ldots\ldots\ 2n}$$
$$= \frac{4n\,(4n-1)\ldots\ldots\ldots 3\,2\,1}{(1\,2\,3\,4\ldots\ldots\ldots 2n)^2}$$
$$= 2^{2n}\,\frac{2n\,(4n-1)\,(2n-1)\,(4n-3)\ldots\ldots 2\,3\,1\,1}{(1\,2\,3\,4\ldots\ldots\ldots 2n)^2}$$
$$= 2^{2n}\,\frac{1\,3\,5\ldots\ldots\ldots(4n-1)}{1\,3\,3\,4\ldots\ldots\ldots 2n}$$

—C. P. W.

[56907.]—**Electro-Magnetism.**—How to produce a cheap supply of electricity to feed an electro-magnet lifting from one to two tons, is a problem which has yet to be solved. Electro-magnets of great power can be easily constructed, and a supply of current to work them can also be guaranteed; but the economy of the business is another question. The simplest source of supply would, of course, be the battery; but meaning, as it does, the dissolving of zinc in acid, it would be a most expensive one. Leaving out altogether the cost of the acid, the zinc, which is the very fuel of the battery, costs more than 20 times as much as coal, besides being a far worse fuel.—BOBADIL.

[56908.]—**Caloric Engine.**—I could not help you unless I had far more particulars, and also I should want to see a general sketch to enable me to put you right at once. If you like to advertise your address, I would communicate, and assist you to a successful issue. The loss of power due to the pump may be much or little, just as the arrangement is for feeding it in. Asbestos is not, as a rule, a good packing at all for glands or parts in motion. But I can show "Romeo" how to get over that. Hot-air engines are not so successful as they should be, and, at the best, are not up to a steam-engine, as a rule. The feed, instead of being as, say, 1 to 470, is something like to 1 to 3 only, so that the margin is but small.—INVICTA.

[56910.]—**Flame.**—The reason why the carbon in a luminous flame is not all consumed, but becomes luminous, is that there is not a sufficient supply of oxygen to combine with it. But in the Bunsen, or atmospheric burner, an additional amount is supplied through the air-holes, and the carbon is therefore consumed.—FABER FABRUM ADJUVET.

[56910.]—**Flame.**—The explanation of the Bunsen burner is that the air mixes with the gas as it ascends the tube through the holes at the bottom. As the air contains oxygen, the carbon, which would naturally be in a state of incandescence, is all burnt up instead. The following takes place: the C now having enough O to combine with: $C + O_2 = CO_2$. All luminous flames contain particles of unburnt carbon except that of $CS_2$ in nitric oxide, in which there are no particles, though it is a luminous flame.—R. A. R. BENNETT, Vicarage, Frome.

[56910.]—**Flame.**—The action of an atmospheric gas burner is to burn up the carbon of the gas quicker than in an ordinary burner. In both cases water ($OH_2$) and carbon ($CO_2$) are formed, but in the latter case (i.e., ordinary burner) the carbon, by means of the heat given out by combustion of the hydrogen, is first raised to a white heat and then consumed; whereas, with the Bunsen burner, there being such a great supply of oxygen, the carbon is consumed before it can become incandescent.—A. B. C.

[56911.]—**Writing on Glass.**—Grind lampblack with gumwater and some common salt, draw the design with a pen or hair pencil, or use a crayon made for the purpose.—C. L.

[56911.]—**Writing on Glass.**—You could do it with a strong solution of hydrofluosilicic acid and a quill pen. Mind your fingers.—R. A. R. BENNETT, Vicarage, Frome.

[56917.]—**Plaster Ceiling Centres.**—Plaster centres are run into moulds made of plaster or gelatine (glue), according as the pattern is plain or intricate. If he will advertise his address in the sale column, I can refer him to a firm doing splendid work.—BARIUM.

[56918.]—**Gas Engine.**—The most economical dimensions for a two-man non-compressing engine cylinder would be 5in. bore and 12½in. stroke, assuming that it was run at about the speed of the Bischopp. The flywheel question is more complex, and I should want to know if your proposed engine was to be with the piston below the crankshaft of the horizontal type, or with the cylinder above the crank. I will, on hearing from you, give size and weight suitable.—INVICTA.

[56921.]—**Heat for Workshop.**—Just a problem I have long tried to solve for myself. The nearest approach to it was a plan I tried of a cast-iron tray or stand on feet to hold coke, broken small; at the back was a spirit lamp, the large brush flame from which was directed, with the aid of an air blast, on to the coke. In two or three minutes I had a little fire capable of heating small tools, or drills, &c.; whilst for brazing it was very handy, although it burnt a lot of spirit. I also had a somewhat better plan of using with the same forge arrangement, and using the meth. spirit in the form of spray with the air blast. It certainly was better, and after the coke was incandescent the spirit was shut off and the air blast alone used. Would this suit you?—INVICTA.

[56925.]—**Draught in Chimney.**—I have heard persons say the same; but, in my opinion, the matter is a ridiculous fallacy. The reducing the area of the chimney would, in very rare instances, increase the draught when the chimney was largely in excess of the grate area; but such cases are very rare, and I would advise you to look for and remedy the matter at the point where the cause really is. Now, as I have not seen the boiler, or in default of any other data, my opinion would be that the setting of boiler was in fault, or that part of the flue area was choked up. If your boiler was a tubular one, then the circumstance would be otherwise; but from the grate surface I should presume it was not. Either there is an obstruction in the flues, the flues are badly built, or the products of combustion are cooled so much that the ascensional power is insufficient.—INVICTA.

[56928.]—**Re-silvering Mirrors.**—It is not worth the trouble, nor can you do them as cheaply as you should be able to get them done—I mean making up solutions and other matters that will cost you far more than it is worth. You would need quite a small collection of apparatus as well. A far simpler way, but one equally needing patience, is the silvering with mercury and tinfoil.—INVICTA.

[56931.]—**Bearing Grease.**—I cannot say anything about the "twopence a pound," because obviously the cost of the grease will depend on the prices paid for the raw materials. I give two recipes, because "bearing" grease is not exactly a definite term. Tallow, 8lb.; palm oil, 1 gallon; mineral oil, 1 gallon; plumbago, 1lb. Melt with heat in a vessel in the open air (to avoid fire) and mix thoroughly. A commoner grease is made by dissolving half a pound of soda in a gallon of water, to which add 4lb. of tallow, 6lb. of palm oil, and a gallon of mineral oil. Melt as before and mix thoroughly.—ESSAR.

[56932.]—**To "M. I. C. E."**—Thanks to "A. S. L." for introducing me to a very interesting problem. Geometrical problems, involving the use of the integral calculus give such neat results that it is quite a pleasure to work them. If we draw a circle to represent the section of the sphere through the centre, then draw horizontal and vertical diameters for the axes of $x$ and $y$, and two parallel lines equidistant from the axis of $x$ to represent the boundaries of the hole bored through the sphere, we have our figure complete, the axis of the hole being thus the axis of $x$. Call the radius of the sphere $a$, and the radius of the hole $r$. The hole may be considered a cylinder with flat ends, with segments of the sphere added to each end. The volume of the former will be $2\pi r_2 \sqrt{a^2 - r^2}$; and for the segmental ends We must have recourse to the integral calculus. Suppose the circle to revolve round the axis of $x$, the volume of the solid so generated will be represented by $\int \pi y^2 \cdot dx$ taken within certain limits. Now, the equation to the circle, the origin being at the centre, is $y^2 = a^2 - x^2$. Substitute this value of $y^2$ in the above expression and integrate, and it will then become $\pi\left(a^2 x - \frac{x^3}{3}\right)$. Now, as we only require the segments at the ends of the hole, the limits between which one of these segments lies will be (measuring along the axis of $x$), $\sqrt{a^2 - r^2}$ and the radius of the circle or $a$. Substitute first one and then the other of these limits for $x$ in the last expression, and deduct one from the other, and we will then have an expression for the volume of one of the segments. Multiply this by two, and add to the volume of cylindrical hole given above, and we thus obtain an expression for the volume of the substance bored out. This, by the conditions of the problem, is to be equal to half the contents of the sphere, or $\frac{2\pi a^3}{3}$. The equation is too long to print; but from it we find that—

$$r = \frac{\sqrt{2^{\frac{2}{3}} - 1}}{2^{\frac{1}{3}}} a$$

As $a$ is 6in., $r$ will be found to be 3·648, nearly. Now, as regards the coincidence mentioned. The side of the pentagon will be $2a$ sin. 36°, and the arc will be $\frac{2\pi r}{5}$, add these, and divide by two to get the arithmetical mean; this result should be equal to twice the value of $r$ given above, if it were not a mere coincidence. Let us see whether this equation will hold. Solve it for $\pi$, and we find that $\pi$ will come out = 3·144, instead of, as it ought to be, 3·1416, showing that it is a mere approximation; besides, sin. 36° can be expressed in terms of various roots of certain numbers, so we get $\pi$ equal to an exact expression involving various square and cube roots, whereas $\pi$ is only capable of being expressed by an infinite series, at least, so I believe. The second part of the query contains an interesting statement; I have tested it, and find it quite correct.—M.I.C.E., Bath.

[56933.]—**Mechanical.**—The dioramic change is produced by painting on the back of the front scene with transparent colours. Gas lights are placed so that when those in front are turned down, those behind are turned up. I would, however, wish to strongly advise you not to arrange your scenes to wind up window-blind fashion. I have seen at least one good diorama entirely spoilt by this plan.—INVICTA.

[56933.]—**Mechanical.**—A beautiful theatrical effect I have seen of a winter scene changed instantly into a summer landscape by the appropriate tints being flashed upon it by a powerful magic lantern. To change a day effect into a night scene I would paint on semi-transparent cloth, and illuminate from the front for day and from the back for night. Buildings and solid objects being painted solidly to be opaque to the latter, the moon and coloured lights being arranged behind in the necessary positions, by graduating the opacity of the painting of clouds and distances pretty effects could be introduced.—HAMMER.

**Bengal Lights.**—It is well known that the compositions of the coloured Bengal lights are dangerous on account of their spontaneous inflammability, and it is well therefore to publish here the results of Thoerner's investigations on this subject. According to Thoerner, only perfectly pure chemicals should be employed, especially when potassium chlorate is one of the constituents. Friction, shock, and heating increase the danger. The point of inflammation generally changes by and becomes lower, so that the danger increases with age. The addition of lycopodium does not in any way diminish the danger, as has been stated by some. *White.*—Potassium nitrate 24, washed flowers of sulphur 7, arsenious sulphide 2. II. Potassium nitrate 4, flowers of sulphur 2, antimonious sulphide 1. III. Potassium nitrate 16, sublimed sulphur 8, flour 3. IV. Potassium nitrate 36, sublimed sulphur 7, antimony 12. V. Potassium nitrate 8, antimonious sulphide 1·5, washed flowers of sulphur 2·5. VI. Potassium nitrate 12, washed flowers of sulphur 3, antimony 2. *White* (theatre fire, poured out loose).—I. Potassium nitrate 72, sublimed sulphur 12, antimonious sulphide 12, arsenic disulphide 8, shellac 1. II. Potassium nitrate 32, sublimed sulphur 8, antimonious sulphide 12, red lead 11. *Yellow.*—I. Sodium nitrate 24, arsenious sulphide 2, sulphur 7, antimony (crude) 2. II. Potassium nitrate 16, sulphur 4, flour 16, amber 4, pine resin 3, pitch 4. III. Sodium nitrate 6, sulphur 1, soot 1. *Blue.*—I. Potassium nitrate 16, antimony (crude) 8, zinc 7. II. Ammoniacal copper sulphate 2, potassium chlorate 4, sulphur 1. III. Potassium chlorate 3, mountain blue 1, sulphur 1. *Violet.*—Potassium chlorate 49, sulphur 25, precipitated calcium carbonate 20, black oxide of copper 6. *Red.*—I. Potassium chlorate 5, strontium nitrate 16, arsenious sulphide 1, sulphur 2, soot 1. II. Potassium nitrate 5, sulphur 2, antimony (Regul.) 1. III. Strontium nitrate 20, potassium chlorate 2, sulphur 5, antimony (crude) 0·5, charcoal 2. IV. Strontium nitrate 48, flowers of sulphur (washed) 9, pulverised charcoal 2, potassium chlorate 8. V. Strontium nitrate 5, washed flowers of sulphur 15, charcoal 0·5, potassium chlorate 0·5.

AN experiment was made recently in Birmingham with a new fire-escape, manufactured by the Birmingham Fire Brigade, from the design of the superintendent, Mr. Tozer. The escape is in the form of a canvas "shoot," but, unlike all others, it is inclosed to within 10ft. of the ground. It can be firmly fixed inside the window in a few seconds.

# UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

Since our last, James McCash Govan has replied to 56591.

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56680. Induction Coils—Vertical Plan, 268.
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# QUERIES.

[56935.]—**Choke Damp.**—What is this?—LEVER.

[56936.]—**Patent Law.**—Does the amount for bringing out a patent vary according to the invention, or under the 1884 Act, is it a uniform rate?—LEVER.

[56937.]—**Tons Measurement.**—What is meant by tons measurement of a ship?—LEVER.

[53938.]—**Electro-Magnet.**—Would some kind friend be so good as to throw some light on the following? I am wishing to fix an electro-magnet (1in. core horse-shoe) on to a spindle of brass, ½in. diameter, the leg being parallel to the spindle. Would it affect the hold-power of magnets, if the hole were bored through centre of magnet, or would it be better to make spindle of steel, and make magnet thicker at that point? An answer will greatly oblige.—A SCEPTIC.

[56939.]—**Armature.**—I was thinking of constructing a small model of a Siemens dynamo, but was at a loss about what armature to use. I do not understand a Siemens armature. Could one of our electrical readers tell me if a laminated armature with four sections of wire would suit? An answer would obliged.—ACCUMULATOR.

[56940.]—**Am-meter.**—Could one of our electrical readers give me a sketch and description of a simple but effective am-meter, indicating up to about 10 ampères? An early answer will oblige.—ACCUMULATOR.

[56941.]—**Novel Clock.**—To "GARRISON GUNNER."—I intend making for my own use, one of your novel clocks, from your description (letter 24327); but would like to ask whether I could substitute a brass bowl instead of china? If not, would an ordinary white pudding basin do, with a stand to it, or must it be flat-bottomed?—A. H.

[56942.]—**Electro-Magnet.**—I took a piece of soft iron about 6in. long, and ½in. thick, and heated it in smithy fire, then bent it into magnet shape, and allowed it to cool by itself, afterwards rounding and polishing it, and planing poles with a file. I then took some small pitch-covered wire, the same as is used for telephones inside, and wound it in a right-handed helix, about six times round each leg, having previously covered them with cloth. I also tried it without the cloth, and with cloth and wire naked. I connected the wire to an electrical machine that is used for personal application, by fastening each end, immediately above the handles of the machine. I allowed these to remain, properly isolating them of course. On no occasion could I get as much magnetism as would lift an ordinary sewing needle, even with the machine going at high rate of speed. The machine is in excellent condition. Is the electric bell not rung by a similar machine? What is the matter?—D. W.

[56943.]—**Engineer's Book-Keeping.**—Being prime-cost clerk in a large engineering firm, will someone be good enough to inform me as to whether there is any standard of profit for time, and material for (1) new work, and (2) repair jobs;—class of work, soda-water machinery.—JOHN WHITE.

[56944.]—**Solubility of Carbonic Acid.**—Would some of our chemical readers kindly state the solubility of carbonic acid, in different strengths of hydrochloric acid?—LYNTON.

[56945.]—**Clarionetta, Oboetta, or Bassoonetta.**—Will any musical friend say if the above, in form of an ordinary keyboard, played as harmonium, are as powerful, and exactly the same tone as the instruments they are intended to represent, and where they can be obtained?—CONDUCTOR.

[56946.]—**Clock Springs.**—Can any of our readers inform me what is the strongest spring I can get the same as clock springs?—L. BALDWIN.

[56947.]—**Rotary Hair Brush.**—I am about to make a rotary hair brush. What description (and about what cost) of bristles to be used?—A. J. B.

[56948.]—**Gas Producing Apparatus.**—Will some kind correspondent to the "E. M." inform me how to make a gaseline gas generator, for a small gas engine, or is there any oil-gas apparatus that could be fitted up as cheaply, producing as good or better gas? Any information on the above that will help an amateur, will be thankfully received by—GASEOUS.

[56949.]—**Manufacture of Aluminium.**—Will any of our chemical correspondents, kindly say in a few words, what process is now used for making aluminium? Is sodium still used in the manufacture, and from what compound of aluminium is the metal obtained?—EX-GARRISON GUNNER.

[56950.]—**Hat Lining.**—I have a hat, the leather lining of which stains my forehead a brilliant yellow, especially when I get warm. The hat is of good quality, and cost a good price. Can anyone tell me how I can prevent the stain coming off, by doing something to the leather?—SAFFRON.

[56951.]—**Dynamo.**—To MR. BOTTONE OR "W. H. E." —I have a dynamo, of which the following are particulars:—Upright field-magnets, cores for winding are, each, 8½in. by 4½in. by 1in.; pole pieces are 6½in. by 3in. by 3in.; and each covers ⅓ the circle of armature. The armature is an iron drum, 6in. long, by 2½in. diameter and the metal is ½in. thick. The curve in magnet poles, is 3in. diameter, so there is ½in. space between armature drum and magnets for wire. I purpose winding it similar to Siemens armature, that is longitudinal coils, enveloping the drum, and connected to a number of segments on commutator. Will you please tell me the number of segments, size of wire, or how many fine wires in parallel will best suit the armature for low resistance, as I have decided to make it a shunt machine? Also what size wire for the magnets, of which I think I can get 12lb. on each limb? I should like the E.M.F. to reach 20 volts.—CARNFORTH.

[56952.]—**To "F. R. A. S."**—Will "F. R. A. S." kindly give the variation at the present time, of the magnetic meridian, from true north at a place in East Yorkshire, latitude, 53° 55′ 58″ N.; longitude, 0° 21′ 17″, West? Also the variation at the same place four years ago.—STREETGATE.

[56953.]—**Boracic Acid.**—What would be the best proportion to use to prevent jam fermenting?—LYNTON.

[56954.]—**Boiler Query.**—Will any kind reader inform me what thickness of brass or copper sheet is required for a model steam boiler 12in. long, 6in. diameter, riveted to stand a working pressure of 80lb. per square inch? The boiler to be horizontal, with a fire-box oval, 6in. through by 5in. wide, by 4in. deep; and what thickness of metal for firebox? There will be tubes continued to the end. Is the pressure equal all over the boiler?—A.

[56955.]—**Photography.**—I possess one of the Lancaster's Merveilleux ¼ photo apparatus, and I shall be glad if any kind reader will assist me by answering the following questions? 1st, Can I take negatives from a wet plate with it as well as the dry plate?—if so, please say what are the chemicals used for it, and how they are used? The reason I ask this is, because I find the dry plates take so long to develop and fix, and the negatives do not show up so nice as those the street photographers do, as they get them out in a short time, and can be seen much clearer. I presume good copies can be taken from them.—A.

[56956.]—**Steam**—The pressure of steam in a boiler is 60lb. by the gauge? What will be the sensible temperature and the relative volume? Show how you get the temperature from pressure. A locomotive with coupled driving wheels 5ft. diameter and two cylinders, 17in. diameter by 20in. stroke, is worked at a pressure of 120lb. per square inch; how many tons could be drawn by it on a level road at 25 miles per hour?—FRED A. ROBINSON.

[56957.]—**Ball Bearings.**—A slight accident to my tricycle, occurring a few days since, obliged me to take off and open the bearings, made by one of the leading firms in this country, when I was very much surprised to find one of the balls completely crushed to small bits, and the remainder worn down to half-size. A friend, who is a skilled mechanic, told me that the balls, which had been in use for two years, were not steel as generally supposed, but only good quality iron well case-hardened. We easily filed them upon trial. I write this in the interest of all cyclists, and shall be glad to see a reply from someone who is not a manufacturer. I am simply stating facts when I say that all the builders of bicycles and tricycles say that all balls are best cast steel.—SECUNDUS HAUD ULLI.

[56958.]—**Microscopical.**—I have an eye of a beetle prepared to show multiplied images. What power must I use, and how arrange the microscope and apparatus, to show these multiplied images? At present I can only see the hexagonal facets of any particular—EYE.

[56959.]—**Castings.**—Having had serious trouble with our castings, I should be glad if any of your readers could suggest the cause. Most of our work is light, and has to be turned and shaped all over; consequently, if not clean, has to be thrown away. When the castings leave the trimming shop they show marks like dirt or small coke (mostly in the top of the casting) which, when turned or shaped, go into small holes about the size of peas. If any of your readers could suggest a cause no doubt a cure could be found.—FOUNDRY.

[56960.]—**Riparian Rights.**—I have a boat 12ft. long, which I wish to use on the river Ouse (which is not a navigable river). Owing to disturbances by people who fish, and threats of prosecution for trespass, I wrote to Earl Spencer, who owns land on one bank, and the reply from his secretary was that I might go—he could see no objection; but about a week after, I received another letter to say that as one of the tenants objected to boats on the river, he must say no. Now what I wish to know is, can I be legally stopped from boating, if I keep in the middle of the river, and only land where I have leave so to do? Your kind advice in this matter will greatly oblige—O. J. R.

[56961.]—**Boating.**—In the experience of our readers, has anyone seen any invention or contrivance for propelling a small boat, either by paddle wheels or screw, in a similar manner to the tricycle, either by feet or hands? I have a good deal of travelling along a small river, and it seems strange to me that some mechanical arrangement cannot be contrived and attached to a small boat capable of carrying say one or not more than two persons, and by which they could travel easier and quicker than walking or rowing, and without the bother or waste of time as in a steam yacht. It would, of course, be no use unless one person could manage it, and unless it was much quicker and easier than walking or rowing. Perhaps some of our readers could assist me.—AQUA.

[56962.]—**Legal Telephone Query.**—A person, A., possesses a telephone with transmitters all complete, connected between his works and office, but at the present time out of repair. Can a person, B., a working electrician, supply the man with wire, cells, or anything that may be required to place same in working order without infringing on any patent? When A. had the instruments fixed by a telephone company, he purchased the same, and paid the Royalty, so that they would be his own—he bought straight off. Having done so, he has to repair them at his own cost. An early answer will greatly oblige two old readers of this journal. —TELEPHONE JACK.

[56963.]—**Engine Flywheel.**—To "J. H."—I shall be much obliged if you will give me dimensions of flywheel for a horizontal engine, cylinder 4in., stroke 5in., designed to run about 250 revs. per minute, pressure in boiler 79lb., steam ports 2in. by 5-16in., diameter of crankshaft 1¼in.?—R. N.

[56964.]—**Steam Blowing Engine.**—Will some kind reader of the "E M." favour me with a description of a steam-engine as used for blowing air in the Weldon manganese mud process? Also, what is the advantage of having one which condenses her exhaust steam, as against one whose exhaust escapes, and which is the best book to purchase for information about steam engines, pumps, &c., and oblige a—CHEMIST.

[56965.]—**Blasting Powder.** — Will any correspondent kindly tell me what the explosive force of blasting powder, such as is used in coal and other mines, is equal to? Say what pressure per square inch per ounce (or any given weight of powder), is exerted at the moment of explosion?—ENQUIRER.

[56966.]—**Australia.**—Will someone who has been to Australia by the Cape at this time of year, kindly inform what I had better take in the way of outfit, for the voyage, there and back in a sailing ship? I have been told regatta shirts are the best shirts, what should they be made of? Are duc (canvas) suits worn by passengers? Any advice will be thankfully received. Please mention idea of quantity.—A SICK MECHANIC.

[56967.]—**Deafness.**—Will any medical reader of the "E. M." kindly give me his advice on the following case? A polypus has been in my right ear for ten years, and was extracted about seven years ago, by a local doctor. Since then it has not materially improved, and I cannot hear with it half so well as the other, although I hear a great deal better with it sometimes, when the wax dries a little. There is a slight discharge of humour coming from it now, especially when I catch cold. I have been with two doctors to examine it, and they say there is a small hole in the drum. I have heard of false or artificial drums, will one of these do me any good?—if so, shall be glad to know what they cost, and if it is necessary to undergo an operation to fit it in? I shall be glad if any one using it, will give his experience of it. My age is 26 years. I shall feel deeply obliged to any who will give advice on the query.—IOLO.

[56968.] — **Chlorophyll.** — How is chlorophyll extracted from vegetable substances? What is its chemical composition? Has it ever been produced synthetically? The names of any treatises or books bearing on the subject will much oblige.—BOTANIST.

[56969.]—**Hydraulic Ram.**—I have one of these machines, through which a large quantity of water is supposed to pass, and a small quantity of the same water to be forced to a considerable height. It has two large valves, whose normal position is open. I understand the principle of the action to be, that when a quantity of water from a given head is passed through the machine, the sudden closing of these valves causes a momentary excessive pressure in the machine, due to the momentum of the falling inlet water, and that this is utilized to force a small quantity of the water up a pipe to a considerable height. What I want to know is, why these two large valves do not remain permanently closed after the first rush of water? In the machine I have, there is nothing but the weight of the valve itself that tends to reopen it when once closed, and I cannot see that if the valve be light enough to be overcome by a small head of water, it will not be too light to reopen automatically under a larger head. If any correspondent who is better acquainted with these things than I am, will kindly enlighten me, I shall feel much obliged. I know the general principles of the machine, but want to know if the weight of the valve must vary according to the head of water at which it is required to work.—A MELTING MECHANIC.

[56970.]—**To Mr. Bottone.**—I am making a small dynamo from castings, which I was told by maker were 30 candle-power. It has 5lb of 22 wire on F.M., and ½lb. on laminated armature. Will you tell the required speed to drive it, to obtain its full power? Also would the current be dangerous if it was sent through human body? What is the number of volts it is likely to work at?—P. E. YATES.

[56971.]—**Insects in Telescope.**—Can any one of the numerous readers of the "E. M." recommend a remedy to prevent earwigs and other insects—but especially earwigs—from getting into the clockwork, and other parts of an equatorial refractor, mounted on an iron pillar stand? Felt saturated with crude carbolic acid, and placed round the foot of pedestal, has been recommended, but its staining qualities and odour render it very objectionable. Keating's insect powder has been tried, but it seems to have no effect on earwigs.—L. M.

[56972.]—**Watchwork.**—Seeing in last week's "E. M." that "C. A. W." kindly offers to give information in the way of watch jobbing and finishing, perhaps he would be so good as to help me a little in the matter of steel polishing. Tho' I have been six years in the trade, I have never been able to run against anyone who could do this properly or tell me how. What I want is an exceedingly high polish, such as one sees in the good old work. I am not a very old reader of the "E. M.," but have never seen anything on this subject. If "C. A. W." will kindly step in, he will, I believe, oblige a good number of readers, and certainly—ESCAPEMENT.

[56973.]—**Dynamo.**—To MR. BOTTONE OR "W. H. E." —I have made a dynamo same as described by you in 1007, only in a smaller size. The F.M.s are 16in. high over all, the pole pieces being 8in. high, and the arms 8in. high; the arms are wrought iron 1⅞in. thick, and the pole pieces are of cast iron 8in. high by 3in. wide. The armature is made the same as that described by F. Walker in a back number, being composed of 80 pieces of soft sheet iron and wound with 2¼lb. of number 18cc. wire, in four sections, 10oz. of wire in four layers on each arm, and the fields are wound with 10lb. of 16cc. wire. Will you kindly say what the lighting power will be, and at what speed to drive it at, and what the E.M.F. will be in volts, and its resistance in ohms, and how many ampères of current it will give? How many 20 c.p. lamps it will light well, and what resistance the lamps are to be?—ELECTRIC JOE.

[56974.]—**Boiler.**—To "INVICTA."—I have made a boiler to drive an engine, the cylinder of which is 2in. bore and 3½in. stroke; the boiler is made of ¼in. sheet copper, single riveted, with one 3½in. flue in the centre; the height of it is 3ft. and the diameter is 14in., firebox 1ft. high. Will you kindly say if it is a suitable size, and what is the safe working pressure, and if it will want staying. I want it to drive a dynamo with; the one that I have described in this week's "E.M." Any advice will be thankfully received by—ELECTRIC JOE.

[56975.] — **Mineral Springs in and near London.**—Can any correspondent give me any information respecting these? One reads of Beulah Spa, Norwood, Kensington, Bagnigge Wells, Epsom, &c., and I wish to learn whether they still exist, and if so, where they are still to be found? The character of the water, whether saline, alkaline or chalybeate, could also perhaps be mentioned.—A. S. L.

[56976.]—**Water Meter.**—We have a water meter where I work—it is Kennedy's patent, and when there is no water using the meter knocks about every fifteen minutes, so there must be some leakage in the pipes. Could anyone say how many gallons goes every knock? The meter reads from ten millions to thousands. Also, the best method of finding the leakage, or whether it is worth seeking? I cannot find the size of the meter, but the feed pipe is 4in. outside diameter cast-iron pipe, so that it will be 3in. at least. I hope someone will oblige —ANXIOUS.

[56977.]—**Load on Short Span.**—(1) To carry a load on the centre of a short span, the following three forms of beams are proposed:—1. A bar 4in. deep and 2in. wide. 2. A bar 3·8in. diameter. 3. A bar 3·5in. square. Which is the strongest of these, and what are the relative strengths of the three? Would some reader help me with this question?—A. B.

[56978.]—**Engine Query.**—A slide-valve has to cut off steam at ⅝ of stroke, and its opening for steam is to be 1¼in., the lead of the valve is to be ⅛in. Find the stroke of the valve, and the angular advance of the eccentric? You may neglect the obliquity of the connecting rod, but state in general terms what its effect would be.—A. B.

[56979.]—**Model Locomotive.**—1. Can a boiler of the following dimensions be relied on to drive an engine with a pair of cylinders ⅜in. diameter by 1¼in. stroke? Length of barrel, 6in.; diameter of barrel 2⅞in. Length with firebox 9in.; crown of firebox, 2½in. by 2⅜in., one flue 1in. diameter, heating surface about 45in. 2. I should be much obliged by information as to the proper size of steam ports.—F. M. C.

[56980.]—**Electrical.**—I have made an iron bar upon which is mounted an iron core; upon the core is a bobbin of wire which does not quite touch the base. Upon passing a current of electricity through the bobbin it is pulled right on to the core till it touches the base. Not being acquainted with matters, perhaps some kind reader can explain this and oblige—GLONOINE.

[56981.]—**Preparing and Mounting Small Skeletons.**—I wish to know if any reader of the "E M." could give any information on the above subject? I have seen it stated that ants are very useful in removing the flesh, but living in town I cannot avail myself of their services. If any reader could recommend any preparation to remove the flesh, without injuring the bones, and give any information as to whether they require anything to preserve them, and make them white, and a few hints on mounting them—how the bones are held together, &c.—it would greatly oblige—G. H. CORBETT.

[56982.]—**Ball-Room Floor.**—The opinions of readers are asked as to the best material, and best way of laying a ball-room floor. It is required to be first-rate in every way. Is an oak floor, well waxed, better than a pine floor, grooved and tongued, and planed smooth? Would strips of rubber laid on the joists as a bed for the floorboards be an advantage, if elasticity is considered a desideratum, or would a solid, well-waxed, hard wood floor be better, considering that it is to last? Can any reader give examples of really good floors that can be seen in London?—TERPSICHORE.

**Every Workman** connected with the Building Trades requiring a Situation should advertise in "THE BUILDING NEWS," published every FRIDAY, price Fourpence, at 332, Strand, London, W.C.

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Every Workman should insist on seeing "THE BUILDING NEWS" every week at his Club or Coffee House. He will find more "Lists of Tenders" for new work in it every week than in any similar paper, and can thus judge where work is likely to be had. He is also specially invited to make use of "Intercommunication" if he wants to know anything about his trade; to write to the Editor if he has any suggestions to make, and to advertise in the paper when he wants work.

The charge for Advertisements for Situations is One Shilling for Twenty-four Words, and Sixpence for every Eight Words after.

## ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

### HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

*** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

### BACK NUMBERS.

We receive so many queries asking for directions how to make many instruments and appliances which have been fully described in back volumes that we have compiled a list, which we shall insert in this column at intervals, of those most frequently sent, and as the numbers are still in stock, new subscribers should consult the list before sending their questions.

Batteries: Nos. 741.
Bookbinding: Nos. 613.
Copying processes: Nos. 750, 753.
Electric machines: Nos. 628, 759, 840.
Electro-magnets: Nos. 756, 772.
Lacquers: No. 866.
Pattern Making: Nos, 938, 941, 943, 945, 948, 950, 952, 954, 955, 956, 958, 959, 962, 963, 965, 969, 973, 974, 978, 981, 986, 989, 993, 995, 998, 1,000, 1,001, 1,003 1,004, 1,008, 1,009, 1,010.
Silver-plating: No. 880.
Telephones: Nos. 695, 747, 865.
Varnishes: 478, 619, 675, 691, 723, 775.

The following are the initials, &c., of letters to hand up to Wednesday evening, July 1st, and unacknowledged elsewhere:—

J. Place.—Jabez Francis.—J. B. Brown.—W. I. Chadwick.—J. Devey and Co.—N. G. Wilcocks.—H. Trick.—E. E. Brown.—C. Birchall.—J. Pickles.—G. Crowsley.—J. Hagger.—Clyde.—R. S. Culley.—W. C. Crick.—W. H. P.—J. C. G.—E. C. J.—An F. R. A. S.—Young Firer.—W. S. Franks.—R. F. S.—T. J. Murday.—Bacchus.—Telephone.—J. Myles.—Carbonado.—Libra.—One in the Wilds of Wales.—Experience.—K. J. Tarrant.—S. R. Elson.—F. M. Rogers.

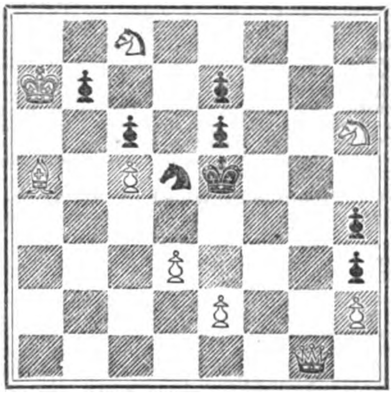
Asterisk. (It is a very useful work, because it is the only book devoted to the subject. 2. There are none which deal with the practical details of the larger machines; but there is "The Dynamo," by S. R. Bottone, which gives full directions for making a small machine. It appeared in Vols. XXXVII.—XXXIX.)—Amateur. (Yes. Try the dealers in hives.)—Novice. (Clean it off with glasspaper, and paint.)—Locomotive. (It has been described many times—so recently even as p. 292.)—Rustic. (Probably to carry a photographic camera. We presume it is a refractor, not "reflector.")—Longworth, Manchester. (You mean the foot-warmers, we presume—metal cases filled with hot water, or, on the L. and N.W., with acetate of soda, which is liquefied by heat, and as it slowly cools and re-crystallises, gives out the heat it has absorbed.)—J. R. (See the indices of many back volumes for references to a variety of flying machines. Make a calculation as to the power required to lift the weight, and then endeavour to ascertain whether a man can exert it; that is where the defect lies.)—Aeronaut. (See previous reply.)—A. B. C. (It would be simply like putting them into a close-fitting swell-box.)—Photo-lithography. (See indices.)—G. M. Callender, New York. (Thanks for the paper.)—Roi ne Puis, Souza je Suis. (Many thanks. You will have seen that we reproduced it in the number for June 19.)—W. Griffiths. (If received, it has been attended to. See Hints No. 5. We really cannot undertake to explain privately why anything is not inserted.)—John Liston. (The arrangement will do, but it is better to drive the wheel direct without the intervention of gear—that is, drive by a belt on the wheel shaft.)—Autograph. (You must employ an engraver to make the woodcut of signature.)—Limp Collar. (See p. 445, Vol. XXV. Use four ounces of common wax to about two pounds of starch, dissolving the wax in boiling water, and adding the starch which has been previously rubbed down in cold water. Starch the linen twice, drying between.)—Musician. (Glue or paste. 2. Glair—that is, white of egg beaten to a froth and allowed to stand.)—B. Jacobs. (See the indices, where you will find references to several diagrams and illustrations showing the connections and the arrangement of the parts.)—G. R. (The secret is in the "out of breath." Take time, and don't get out of breath. See pp. 5, 34, Vol. XXXVII.)—A New Reader. (Hawkins' "Treatise on the Teeth of Wheels" is a useful work.)—H. O. C. (Lac is a resin which exudes from several trees when they are punctured by the lac insect. The "shell" distinguishes it from stick-lac and seed-lac.)—Carino. (We know nothing of the Association, and hardly advise you to trust them with the P.O.O. You might send one payable ten days after date, and stop payment if it turns out wrong.)—Samuel Haigh. (For the present, as you will have seen, we have had enough about the matter. If, after you have made your experiments, you care to embody the results in a letter, we will insert it. We should be glad of the description of the incubator.)—T. C. Clarke. (Both are good at the respective prices—if anything, the first-named is the cheaper.)

## CHESS.

All Communications for this department must be addressed to J. Pierce, Langley House, Dorking.

### PROBLEM DCCCCXLVI.—Ideen.

*Black.*



*White.* [9+8

White to play and mate in three moves.

Solution to 943.

| *White.* | *Black.* |
|---|---|
| 1. Kt-Q 4 | 1. Anything |
| 2. Q-B 3 | 2. Anything |
| 3. B-Q B 3 mate | |

### NOTICES TO CORRESPONDENTS.

Correct solutions to 943 by G. T. Stringfellow, E. Stanley Follwell (most enjoyable), and V. S. Pochin; to 944 by Rev. W. Anderson (Old Romney), and V. S. Pochin, E. Stanley Follwell (delightful), R. A. Bennett, H. Culmer, F. A. Vincent, and A. S. Olver (poor).

To 945 by A. S. Olver (exceedingly clever), H. Culmer, Streetgate (very pretty), E. S, F. A. Vincent, V. S. Pochin, and Rev. W. Anderson.

V. S. P.—The tourney will be concluded in about two months.

## TERMS OF SUBSCRIPTION.

PAYABLE IN ADVANCE.

5s. 6d. for Six Months and 11s. for Twelve months, Post Free to any part of the United Kingdom. For the United States, 13s., or 3 dols. 25c. gold; to France or Belgium, 13s., or 16f. 50c.; to India (via Brindisi), 15s. 2d.; to New Zealand, the Cape, the West Indies, Canada, Nova Scotia, Natal, or any of the Australian Colonies, 13s.

The remittance should be made by Post-office order. Back numbers cannot be sent out of the United Kingdom by the ordinary newspaper post, but must be remitted for at the rate of 4d. each to cover extra postage.

Messrs. JAMES W. QUEEN and Co., of 924, Chestnut-street, Philadelphia, are authorised to receive subscriptions for the United States for the ENGLISH MECHANIC, at the rate of 3 dols. 25c. gold, or Thirteen Shillings per annum, post free. The copies will be forwarded direct by mail from the publishing office in London. All subscriptions will commence with the number first issued after the receipt of the subscription. If back numbers are required to complete volumes, they must be paid for at the rate of 4d. each copy, to cover extra postage.

Vols. IV., VII., XXVI., XXVIII., XXX., XXXII., XXXIII., XXXIV., XXXV., XXXVI., XXXVII., XXXVIII., XXXIX., and XL., bound in cloth, 7s. each. Post free, 7s. 9d.

All the other bound volumes are out of print. Subscribers would do well to order volumes as soon as possible after the conclusion of each half-yearly volume in February and August, as only a limited number are bound up, and these soon run out of print. Most of our back numbers can be had singly, price 2d. each, through any bookseller or newsagent, or 2½d. each, post free from the office (except index numbers, which are 3d. each, or post free, 3½d.)

Indexes for Vols. I., VI., VII., VIII., and IX., 2d. each. Post free 2½d. each. Indexes to Vol. XI. and to subsequent vols., 3d. each, or post free, 3½d. Cases for binding, 1s. 6d. each.

## CHARGES FOR ADVERTISING.

| | s. | d. |
|---|---|---|
| Thirty Words .. .. .. .. .. .. .. | 2 | 6 |
| Every additional eight words .. .. .. .. | 0 | 6 |

Front Page Advertisements Five Shillings for the first 40 words, afterwards 9d. per line. Paragraph advertisements One Shilling per line. No front page or paragraph advertisement inserted for less than Five Shillings. Reduced terms for series of more than 6 insertions may be ascertained on application to the Publisher.

ADVERTISEMENTS in EXCHANGE COLUMN—for

| | s. | d. |
|---|---|---|
| Twenty-four words .. .. .. .. .. .. .. | 0 | 3 |
| For every succeeding Eight Words .. .. .. .. | 0 | 3 |

ADVERTISEMENTS in the SIXPENNY SALE COLUMN.

| | s. | d. |
|---|---|---|
| Sixteen words .. .. .. .. .. .. .. .. | | 6 |
| For every succeeding Eight words .. .. .. .. | 0 | 6 |

*** It must be borne in mind that no Displayed advertisements can appear in the "Sixpenny Sale Column." All advertisements must be prepaid; no reduction is made on repeated insertions; and in cases where the amount sent exceeds One Shilling, the publisher would be grateful if a P.O.O. could be sent, and not stamps. Stamps, however (preferably halfpenny stamps), may be sent where it is inconvenient to obtain P.O.O's.

The address is included as part of the advertisement, and charged for.

Advertisements *must* reach the office by 1 p.m. on Wednesday, to insure insertion in the following Friday's number.

**Holloway's Pills.**—Easy Digestion.—These admirable Pills cannot be too highly appreciated for the wholesome power they exert over all disorders of the stomach, liver, bowels, and kidneys. They instantaneously relieve and steadily work out a thorough cure, and in its course dispel headache, biliousness, flatulence, and depression of spirits.

## NOTICE TO SUBSCRIBERS.

Subscribers receiving their copies direct from the office are requested to observe that the last number of the term for which their subscription is paid will be forwarded to them in a Pink Wrapper, as an intimation that a fresh remittance is necessary, if it is desired to continue the Subscription.

## OUR EXCHANGE COLUMN.

*The charge for Exchange Notices is 3d. for the first 24 words, and 3d. for every succeeding 8 words.*

**Good Value Offered** (cash or instruments) for all kinds of sound or repairable Scientific Appliances.—Caplatzi, Science Depot, Chenies-street, near British Museum. Established 1862.

**Telescope,** 2½in. Reflector, two eyepieces, tripod stand, in oak case, for English made Air Gun, with pump complete.—Jos Blain, Albert-square, Carlisle.

**Polishing Machine,** foot-power, all iron, cost £4 10s.; lot of tricycle and bicycle fittings, bankrupt stock. Seen by appointment. Exchange offers.—W. Smith.

**Youth's Tricycles** (6), part finished. Exchange to £1 each. Seen by appointment only. Particulars one stamp.—Address, W. Smith, Bilston-road, Wolverhampton.

"**Knowledge,**" 1—122, in exchange for good Microscope, Telescope, or Field Glass.—Address, Hugh Crichton, 11, Panmure-street, Arbroath.

Exchange 54 or 56in. **Bicycle,** Carver's hollow spoke, ball bearings, for Lancaster's Instantograph and Accessories, or offers.—Frank Perry, Mountnessing, Brentwood.

Offer wanted. Bench Drilling Machine, iron grooved wheels, chucks, drills, treadle, for model work.—A., 17, Peach-street, Queens's Park Estate, Harrow road.

Twelve **Bunsen Cells** (quarts) offered in exchange for Books on Electricity, or anything useful.—J. W. G., Albert House, Haverfordwest.

**Tricycle,** in perfect order, or 1½ horse-power Gas Engine, or Pentaphone Lantern, perfect. Want immediately, good Engine and Boiler, suitable for steam launch.—T. P. R. Bradshaw, Enniskillen.

What offers for "**English Mechanic,**" Nos. 980 to 988 of Vol. XXXVIII., and Vols. XXXIX. and XL. complete, unbound?—F. Rayner, Sherwood, Nottingham.

Patent **Vulcanite Hydrometer,** by Savigny, St. James'-street, in case complete. Will exchange for good long-range Telescope, or Microscope.—Z., 49, High-street, Dingwall, N.B.

**Organ Bellows,** Windchests, or small Harmonium, 5 octaves, double pedal, complete except keys. Exchange for Tricycle, or 40in. Bicycle.—W. Johnson, 12, Moxley, Wednesbury.

Exchange 14ft. **Rowing Boat** for Launch Engine, about 5in. cylinder, not particular about reversing gear.—Address, Thos. Fryer, 209, York-street, Belfast.

**Horizontal Engine and Boiler,** in good working order, cost £4 10s., new, cylinder, ⅝in. bore; engine bed, 1ft. long. Exchange Hall-marked Podometer or offers.—B. Hewitt, 14, Melson-street, Luton.

**Declination Circle,** 14 inches diameter; also Hour Circle, 12in. diameter; both accurately divided in brass, with vernier for each; the circles are nearly new. What offers?—J. Marriott, Fleckney, Market Harborough.

Quantity of new **Files** and other useful Tools, useful to amateur or mechanic. What offers in exchange to value 30s.?—Yeomans, Waterloo-road, Uxbridge.

What offers for Lancaster's ½-Plate **Instantograph,** complete.—J. T. Smith, 23, Sea Bank-road, Southport.

200 **Stereo Negatives,** for same number mounted Objects for Microscpe, or Jaw Chuck.—M. Walker, Park View, Milnthorpe.

52in. **Bicycle,** "Invicta," new tyres, new lamp, roller bearings, complete, £4; 50 in same pattern, £3; also Bass Drum, complete, £2; pair Smith's Bellows, new, £3. Offers.—J. Olive, Wall, Whitstable.

A Splendid Double-barrel **Gun,** all complete, with machines. To be exchanged for a 4 or 4½ centre Lathe, iron bed preferred.—Address, T. Bullock, 169, John-street, Workington.

Magnificent English Silver Lever, centre seconds, **Chronograph Stop Watch,** full jewelled, gold joints, chronometer balance; exchange £10; offers requested.—R. Pownall, Prescot, Lancs.

**Camera,** by Knight, whole-plate, 3 dark slides (2 double), stand, bath, &c., wet process. No reasonable offer refused.—Apply, first by letter, B., 185a, Earl's-court-road, S.W.

¾-Horse **Vertical Boiler and Engine,** Dynamo, lamps, complete, worth £20. Exchange Gold Albert, Watch, Safety Bicycle, English Concertina.—Charles Walter, Wellington, Somerset.

**Photography.**—Card-size Portrait Lens, and Cabinet-size Landscape Lens, both fit same flange; are in perfect condition; what offers?—A. Smith, Union, Buckie.

Send for **List** of Electrical Articles, &c., for exchange to A. Atkin, 22, Leathwaite-road, Battersea-rise, Clapham-common.

Good sweet toned Old **Violin.** Exchange.—Address, W. Roberts, High-street, Mold.

**Slide-Rests,** Chucks, Twist Drills, Change Wheels, Tool Steel, Headstocks, carriers, &c. Offers.—W. Bundy, 63, Holborn Viaduct, London.

Handsome **Engine and Boiler Model,** of 12 h.p., usual fittings, splendid working order; worth £10. Offers exchange.—R. Douglas, Haslemere, Surrey.

Wanted, Horizontal Slide-Valve **Engine,** 2in. stroke, or parts, cheap; state particulars and prices. Offers various articles.—A., 9, New Broad-street, City.

Splendid toned **Melodeon,** purchased two months ago, cost £4 4s., with two stops and case, complete and perfect. Exchange.—R. Douglas, Haslemere, Surrey.

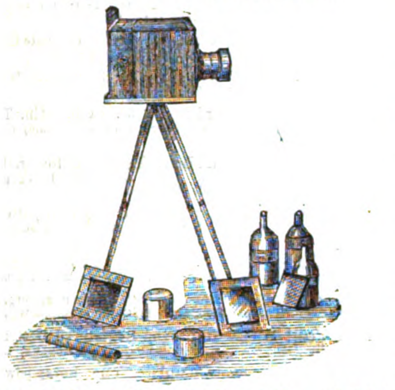
LATHES
AND EVERY DESCRIPTION OF TOOL FOR AMATEUR TURNERS.

LATHES complete, £7 15s., £10, £12, £19 5s. Chucks, and all kinds of apparatus fitted to lathes. Engineers' Files and Tools of every description. AMERICAN TWIST DRILLS and SELF-CENTRING CHUCKS, for holding all-sized drills. AMERICAN SCROLL CHUCKS of ALL SIZES.

JOSEPH BUCK,
56, HOLBORN VIADUCT, E.C., and 164, WATERLOO ROAD, LONDON.

# J. THEOBALD & COMPANY'S SPECIALITIES.

## THE AMATEUR'S PHOTOGRAPHIC CAMERA.
FOR INSTANTANEOUS PHOTOGRAPHY.



As we expected, the one Advertisement inserted by us a fortnight back of this Camera has created quite a sensation, and the large number of Cameras we have sold, and the repeat orders we have received, have fully convinced us that we need have no fear but that they will—in fact, have already—become a decided success.

Many persons have written to us, saying, "I know nothing of photography, are you sure I can take good photographs without a lot of trouble?" Our answer is "Yes. Photography has undergone a complete change the last year or two, and anyone now, by simply following out the full and plain instructions we send, can take perfect photographs equal to a photographer." Others say. "But proper cameras cost £5, £7, and £10; how can you offer one as good for 15s.?" Why, because we buy everything direct from the makers that must be bought, and most of the apparatus we make up ourselves at a very trifling cost. An expensive camera has a lot of unnecessary brass screws, plated fronts, &c., which have nothing to do with the photograph, and simply makes the camera more expensive.

We give everything that is necessary, and rely on an immense sale to pay us for being content with a very small profit.

☞Please note that many cameras now advertised at 30s., 40s., and 60s. are cameras only, and without any apparatus or chemicals whatever. Ours is EVERYTHING COMPLETE.

Photography is a most fascinating art, and is now being largely practised by the gentry and nobility, and many ladies also have become quite professionals at it.

It is not only amusing, but pleasing and useful, to be able at any moment to take photographs of scenery, houses, friends, models, pet animals, seaside views, &c. Why pay a photographer 5s. 6d., 8s. 6d., and 10s. 6d. dozen for photographs, when you can take them equally well at a cost of 1s. 6d. dozen?

The Amateur's Photographic Camera No. 1 measures 6in. square, and consists of a strong well-made camera, wood body, powerful lenses, brass fittings, brass cap, focussing tube, dark shutter and slide, focussing glass, packet of dry plates, packet of sensitised papers, two bottles of developing solution, bottle gold solution, box of fixing crystals, cards for mounting, printing frame, elastic bands, glass roller, and full instructions complete. Carriage free, 15s. This apparatus will really take perfect Photographs, carte-de-visite size, indoors or outdoors.

The Amateur's Camera No. 2 is the same size, but with stronger lenses, and very superior finish throughout; also having larger supply of chemicals. Carriage free, 25s.

The Amateur Camera No. 3 is double size, being made for taking cabinet-size photographs, and consequently has double-size lenses, very superior finish, double shutter, and all other apparatus as given with the Nos. 1 and 2, but double size. Price, carriage free, 30s. This is good enough for any photographer to set up in business with.

Specimen of carte-de-visite portrait taken with the Amateur Camera by an amateur, post free, 6d.; cabinet size, 1s.

Many persons could make a good living with one of these Cameras.

Orders executed immediately, as we have several workmen making these Cameras, and no vexatious delays occur.

All orders should be sent within twenty-eight days (except from abroad), as we do not guarantee to supply them at these prices once we have made them widely known. Carriage abroad 5s. extra. Please mention the name of this Paper.

### VERY SPECIAL NOTICES.

Final Offers.

**Last few weeks of ever being able to get Field-Glasses at these prices.**

It is now nearly five years since we first began advertising our Glasses. The demand for them has been unprecedented, and from every part of the world have been received letters expressing the great satisfaction they have given. We consider now that we have made them thoroughly known to the public. They were started at prices so far below those ordinarily charged that opticians stood aghast, and, in their own interest, declared they could not be good. However, they were a great success from the very first, and now there is no one, however bigoted, who has seen one, but is full of praise. We get repeat orders again and again, and many persons order from mere recommendation. We have decided now to

CEASE ADVERTISING

these Glasses, as they are now so widely known that there is no necessity to continue spending large sums of money weekly in so advertising. Therefore, as this will probably be the last time that this offer will appear, we urge all those who are in want and desire thoroughly good Glasses at nominal prices to send at once.

## THE KENSINGTON AMATEUR

PRINTING APPARATUS.—For cards, notepaper, bill-heads, &c. Strong wooden press, assortment of type, ink, dabber, and instructions complete.

Carriage free, 2s. 9d.

Much larger sizes, 3s. 9d., 5s., 6s. 6d., 8s. 6d., 10s. 6d., 15s., 17s. 6d., 21s., and 25s.

THE RENOWNED AND FAVOURITE

## GEM FIELD-GLASSES,

which have always given such universal satisfaction. These are made in three sizes, and each Glass has six very powerful lenses, and will carry a distance of twenty-five to thirty miles. Each instrument is also fitted with sunshades, gilt mounts, and extra stout case, with strap for slinging across the shoulder, complete. Every one is guaranteed to be of the very best quality; in fact, the years we have been advertising is a sufficient guarantee that no trashy articles are ever sent out. The Glasses will be sent complete and carriage free at the following prices:—No. 1 size, having object-glasses 1⅛in diameter, 18s. 6d.; No. 2, 1⅜in. diameter, 22s.; No. 3, 1⅝in. diameter, 25s. These Glasses are equally suitable for the Theatre as for Field-Glasses, and are really marvels of power and quality throughout. We would also draw special attention to

## THE ACME FIELD-GLASS No. 2,

which is made with twelve very powerful lenses, and has a wonderful power for both long and short distances. Object-glasses are 1⅜in. diameter, and a best soft leather case, with strap complete, is also supplied. Carriage free, 37s.

## THE NEW FIELD-GLASS. — We

specially recommend these Glasses. Don't pass them by. Ever alive to the necessity of advancing on previous efforts, and never resting satisfied with what has been already accomplished, we are glad to be able to announce our manufacture of a new and improved Field-Glass. For the past five years our Optical Instruments have been before the public, and each season it has been our aim to improve on the previous year's product; and up to the present, success has ever been vouchsafed to us. This season we are able to introduce what we are sure will prove a great boon to all tourists and travellers—viz., a glass which, opening to a great length, yet closes into a very small compass. It is a well-known fact that the further away lenses can be placed from each other, the greater power and definition can be obtained; but persons have objected to carrying a cumbersome instrument to effect this purpose. Our New Glass,

## THE "VICTORIA" FIELD-GLASS,

does away with this objection altogether, for it is made with double drawers, so that the length desired is obtained without in any way making the Glass larger when closed than any ordinary single-drawer Field-Glass. When closed the Glass is only 3½ inches high. Is has six lenses of the very best quality, and the object-glasses measure over 1⅜in. diameter. The body is morocco-covered and fitted with sunshades complete, in strong velvet-lined case, with handle and strap. This Glass is extremely powerful and readily carries twenty-five miles. Owing to its small size and special adaptability of its lenses, it would do equally well for the opera as for long distances. Each Glass is engraved "The Victoria," and bears our name, without which none are genuine. We offer them for twenty-eight days, carriage free for 50s. We do not guarantee to supply any after twenty-eight days at this price, as, owing to an immense strike amongst the optical workmen, we can only sell what we have manufactured during the winter at these prices.

## THE "KENSINGTON" FIELD-GLASS,

Precisely the same kind and size Instrument but with twelve lenses, giving an immense increase of power. Carriage free, £3 3s. Carriage to all foreign places 5s. extra.

The leading London and Provincial Press speak in the highest terms of our Glasses.

"Exceedingly cheap."—*Christian World*.

"A thoroughly well made and powerful Glass."—*The Baptist*.

"Gave us every satisfaction. Wonderfully cheap."—*Church Times*.

"Nothing better can be bought for the same money."—*Amateur Work*.

"I can thoroughly recommend them."—*Sylvia's Journal*.

"Carlton Club, Pall Mall.

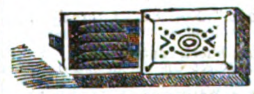
"Gentlemen,—I am much pleased with your Acme Field Glass No. 2. It is marvellous to me how so perfect a glass can be made at such a small price as 37s., possessing such very high powers through its splendid lenses.—Yours obediently,

"R. A. H. HIRST (Major)."

As an inducement to persons to purchase at once, we have arranged a Grand Distribution of Prizes, which will be fairly distributed amongst those persons buying our Glasses within the next twenty-eight days. For these

VALUABLE PRIZES

no charge whatever is made. Every person sending for an Instrument will received a free ticket. The prizes are nearly 300 in number, and are of the value of five guineas, three guineas, and one guinea, &c. For further particulars, see Catalogue. Tickets will be given as follows:—With every Gem, one ticket; No. 2 Acme Field-Glass, two tickets. All persons must mention the name of this Journal, otherwise no ticket will be sent.



## THE MAGIC

CIGAR CASE. Offered to a friend full of Choice Cigars, but directly he attempts to take one they all vanish. Post free, 14 stamps; or real leather cases, 2s. 2d. Large size, 3s. 3d.

## THE KENSINGTON SCREW

STEAMER. Entirely of metal. Propelled through the water by steam for half an hour at each operation. 9½in. long. Painted in two colours, and with boiler, lamp, steam-pipe, fan wheel, screw, and rudder complete. Post free, 1s. 9d. Larger sizes, 5s. 6d., 6s. 6d., 11s., and 13s.

## THE RHINE HARP.—Over 15,000 of

these Harps have been sold in England alone. We had one order from a wholesale house, they would take all we could possibly send them within one week, the demand was so great for them. We offer the remainder of our last consignment from Germany at the low price of 8s. 6d., carriage free. Customers wishing for one should send at once, as, in consequence of the maker altering his prices, we have decided not to order any more.

They are 18in. high and 12in. wide. Each has nineteen strings (2½ octaves) stretched over an iron frame, the woodwork is beautifully polished, and the Instrument finished throughout in the best style. These Instruments can be readily learnt in a few easy lessons by anyone. They are played with the fingers the same as an ordinary harp, giving forth sufficient sound, &c., to fill a large room, or can be played as softly as required. We fee sure that in thousands of English homes the "RHINE" HARP will find a hearty welcome.

We give with each Harp the fullest instructions, and so that a child, in a few minutes, could really play a tune, the music being so arranged by us as to present no obstacle. To give everyone a chance of possessing one, we will send one Harp, with fifty pieces music, tuning-key, and full instructions, carriage free, for 8s. 6d. If two are taken at a time, 1s. each less; if three, 1s. 6d. each less. We will not guarantee to supply any after twenty-eight days at these prices.

## POWERFUL STRONG

BRACE and BITS.—A large consignment to be sold immediately regardless of cost With four Bits free, 1s. 9d.; six bits, 2s. 3d.; twelve Bits 3s. 9d.

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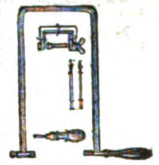

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**Bellaers' Gas Stoves,** 1s. 3d., 2s. 3d., 3s. 3d., for oiling. Breakfast Stoves, 8s., 11s., 14s. 6d. Send for lists.

**London Show Rooms,** 99, Fenchurch-street, may be seen an assortment of Lathes, &c. Several second hand, similar to these, are on sale at Colchester, and will be cleared at moderate prices. All correspondence, Britannia Works, Colchester.

**Notice.**—When you enter the Inventions Exhibition, walk straight down to the extreme end, inquire for Stand 437.—Britannia Co.

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For sale, a fine **Model Locomotive,** 3ft. 6in. long by 13¼in. wide, stands 1ft. 6in. high to top of boiler, all motions from footplate ; it is a powerful and beautifully-made engine, price £75. Photo.—George P. North, 2, Marlborough-place, Brighton.

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**Formulas Worked Out** for winding Dynamos from 10 c.-p. to 500 c.-p., 8 stamps each.—H. Jones.

**Dynamo Castings,** Jones's patent H : 8 c.-p., 5s. ; 16, 5s. 6d. ; 20, 6s. 6d. ; 30, 7s. ; 70, 16s. a set.—H. Jones.

**Dynamos,** finished : 8 c.-p., 30s. ; 16, 36s. ; 20, 40s. ; 30, 50s. ; 70, 100s. each.—H. Jones.

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**Fresh Butter** from the Cream, as above, 2½lb., 3s. 9d.—G. Bull, Manor Farm, Martock, Somerset.

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New ½-horse Horizontal **Engine and Boiler,** with pump and fittings, complete, £2 15s. lot.—Apply, 12, Gt. Union-street, Drypool, Hull. Boiler pressure, 45lb.

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**Oval Chuck,** splendid, in good condition, for sale cheap, suitable for lathes, 5in. upwards.—J. G. Moon.

Two **Cone Plates,** with standard, suitable for 6in. or 7in. lathe, taking from ½in. to 2½in. in diameter.—J. G. Moon.

**Lathe Bed,** nicely planed, with standards, 6ft. long suitable for 6in. centres ; also turned flywheel.—J. G. Moon.

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**Gas-Engine,** 3-man, Barker's Patent Universal, good as new, £28. All my extra fittings.

Also Patent **Band-Saw Machine,** on stand, two saws, hand or power.—10, Darby-road, Folkestone.

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**Water Motors.**—Complete one horse-power, £9. Half, £6 ; Quarter, £4 ; Eighth, £3.—Thomas Wheeler, Preston.

26 Vols. "**English Mechanic,**" 3s. each. 6 Vols. "Popular Educator," 15s ; 4 Vols. "Technical Educator," 10s., clean, well bound.—Walker, 54, Grove-street, Liverpool.

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**Lathe Tool Holders,** 3s. Tools, 4d. each. Much handier and cheaper than ordinary tools.—S. Beeching, Mareham-le-Fen, Boston.

**Engine,** Vertical, 2-horse, £6. Semi-portable Boiler, 3-horse, £9.—79, Dudley-road, West Bromwich.

5¼in. Metal Newtonian **Reflector,** 6ft. focus, 50s Galvanised Iron Tube, 7s. 6d.—Prideaux, Wellington, Somerset.

Plain **Photographic Backgrounds,** in Flatted Oil on rollers, 7s. each.—Samples of H. Southgate, Basingstoke.

100-light **Dynamo,** new ; two 30-light Machines, Several smaller ones, Siemens Armature.—Warne.

25-light original Gramme **Dynamo,** warranted. Particulars, testimonials ; all letters answered.—Warne, 39, St. John-street-road, E.C.

**Serrin Arc Lamp** for sale, cheap, £3, in good order.—R. Huffett, 86, Richmond-villas, Huntingdon-road, Cambridge.

Self-acting **Electric Model** of Steam Hammer, 200 blows per minute, 12s. 6d.—G. Bowron, 97, Crawford-street, W.

**Steam Canoes,** from £30 ; also Engines, Boilers, and propellers for same ; state requirements.—Chinnall, Eastville, Bristol.

For sale, 48in. **Bicycle,** with bent handle, bright, with lamp, bell, keys, oilcan, &c. tyres good as new, £3 3s.—E. Boyce, Flanshaw, near Wakefield.

Self-acting **Organ,** twenty-eight tunes, seven barrels, landscape moving trains, balloons ; sale or exchange.—Davidson, 9, Gladesmore-road, Stamford Hill, N.

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Sale Columns from May 8.—**Stanley's Recipes.** Present terms—one, 7d. ; three, 13d. ; six, 19d. ; twelve, 31d.

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**Electric Indicators, Bells, &c.** Royal Letters Patent. Cheapest in market.—Halbert Works, 27, Penton-place, Pentonville-hill.

**Lathes.**—New designs, best workmanship, unequalled finish ; own make. Note Prices.—W. Bundy, 62, Holborn-viaduct, London.

4½in. centre, 4ft. bed, **Screw-Cutting,** chain treadle, hollow spindle, double geared, 22 wheels, face plate, &c. ; weight 6 cwt. ; £17.—Bundy.

5in. centre, 5ft. bed, **Screw-Cutting,** double-geared, improved slide-rest to turn any angle and indexed, 22 wheels, tool board, anti-friction treadle, 4 speeds, £.2

6in. centre, 6ft. bed, same as above for treadle, weight 13 cwt., £27 ; surfacing £3 10s. extra.—Bundy.

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Double-geared **Foot Lathes,** straight beds, with eccentric rests and chain treadle (slide rests extra), as below. 5in. centre 5ft. bed, 9 cwt., £14 ; 6in. centre, 6ft. bed., £16 10s.—Bundy.

**Makers** of all other sizes and descriptions of Lathes and Machine Tools.

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Note Name.—**W. Bundy and Co.,** 62, Holborn Viaduct, London.

Beautiful rare **Orchises,** in bloom. Bee Orchis, 1s. each ; Butterfly Orchis, 9d. each ; Fly Orchis, 8d. each, carriage free.—John Burns, Fellside, Kendal, Westmoreland.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
*FRIDAY, JULY* 10, 1885.

## TOOLS AND CUTTER-BARS.

(*Concluded from page* 358.)

INSIDE WORK.—For this the bars and cutters hitherto described are unsuitable, and their place is occupied by variously-arranged side tools, either themselves bent or placed in holders, which will present them to the work at the proper angle. One such bar, by Taylor, of Birmingham, is shown at Fig. 48, and the tool to fit it is given at the side at B to a reduced scale. Here the smith has to bend up the end of a round steel bar, which is then filed to the desired cutting angle with sufficient clearance for the work in hand. The tool is prevented from revolving in the bar by a flat filed on its upper side, against which the end of a clamping screw presses; but this does not prevent the cutter from being drawn out or thrust in to a limited extent, according to the depth of the hole to be cut. Another bar is shown in Fig. 49, as made by Hines, of Norwich, to hold small, straight bits of steel requiring no forging or bending and no clamping screw. A small and slightly conical mortice is drilled and filed near the end of the bar, and at right angles to it, and a very small bit of steel is filed up to fit it accurately, and to project very slightly. This is also shaped for clearance, and made more or less keen, according to the metal on which it is to be used. To prevent the necessity for so long an end beyond the squared part, which is an element of weakness, and only needed for a deep hole, the shank is now often made as a separate piece, drilled and sawn to receive the round bar like that of W. S. Brown, already illustrated. This is a great improvement, because only so much of the round bar need project as is actually necessary for the particular hole to be bored, doing away with all unnecessary springiness. To enable the cut to be taken quite to the bottom of a hole which does not go through the work, the cutters are sometimes put in at an angle, such as to cause their projection beyond the end of the bar. This, called a Cawdron bar by Mr. Hines, is a still further improvement, and top rake can be given by filing the little mortise at a suitable angle. The very small cutters are a little difficult to fit, but need no clamping-screw to hold them—a very great advantage. The bars are in sets of three, and are very useful. It is plain that the only choice before us is between such tools as Fig. 48—i.e., bent ones, or straight tools held so as to project on the side of a suitable bar, the latter for very heavy cuts usually needing the security of a clamping-screw. The theory of cutting tools is the same whether for inside or solid work. There will be the surface of the work and the shoulder; but the former is, of course, concave instead of convex. The leading edge in this case will be the one that has to deal with the shoulder, and which has to take the big share of work, yet here the amateur is generally at fault, as the end of the tool frequently has absolutely no clearance, and very little cutting power. At A, Fig. 48, the tool is made quite sharp, but at B it is quite blunt, and the consequence is that it needs great force to push it forward, and the work done is rough and uneven. Whether round or not, consider it a double-edged tool, and the proper way to sharpen it will appear at once, whether it is a solid tool or a short cutter held in a bar. Suppose the tool held in a Haydon bar as before (Fig. 50), and travelling forward in the direction of the arrow; *a* would be its leading, and *b* its following edge. Bend it instead, as shown, remembering that the shank of the tool or the bar merely acts as a handle, and the principle of the cutting edges will be at once apparent; rounding off the point will bring it to the usual form of an inside tool (Fig. 50 B). It may be as well here to add a word in relation to the actual work of hollowing out a casting, as, for instance, a cup chuck. The skin is intensely hard, and if a nicely sharpened tool is placed to cut it without previous preparation, away goes its edge forthwith. To prevent this very undesirable consummation, take an old file and so hold it while the work is revolving as to clear a bevel and expose the bright metal. Then place the tool so that its edges only meet this clean metal, and they get under the hard skin, which then comes away on the first shaving, unless the chilled part of the metal penetrates deeply, or the cut is very light. This will depend a good deal upon the founder. I have had iron so hard that I could do nothing with it, while other castings, specially intended for the lathe, often prove of excellent quality, scarcely blunting at all a well-hardened tool. In boring small holes the chief difficulty will probably arise from the rubbing of the tool below the edge, as the setting of the tool is a little more difficult than for work of large size. In this case, therefore, it is usual to give rather more clearance, or to set the tool very slightly above the centre. In adding to the clearance, it is better to round off the tool below the cutting edge to nearly the intended curve of the inside of the work. But, in practice, small work, which does not readily admit a well-shaped tool, is drilled, and not bored, especially as the twist-drills now used make such beautiful and true work. And these same drills show pretty fairly what should be the test of a well-ground and correctly placed tool—viz., a clean shaving. When new, and employed upon metal of good quality, two equal shavings, often of considerable length, will emerge as the drill descends into its hole. A cutter, right in edge and position, will bring away a clean shaving, bright and

FIG. 48

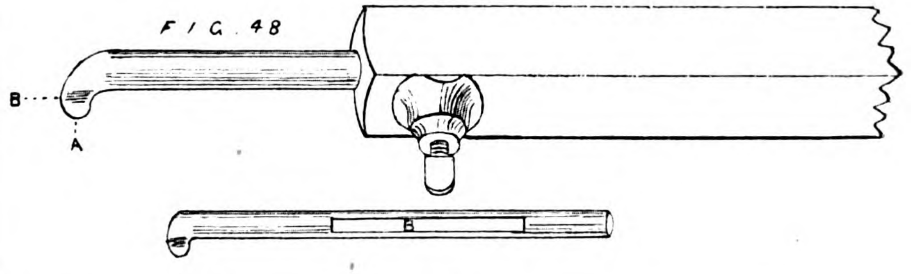


FIG. 49

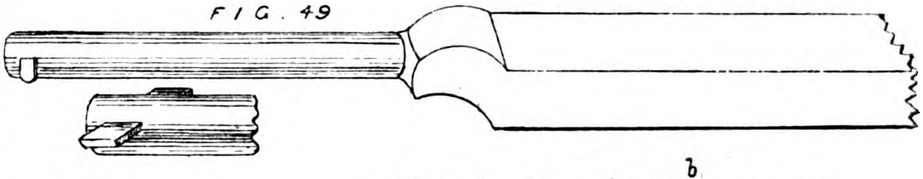


FIG. 50

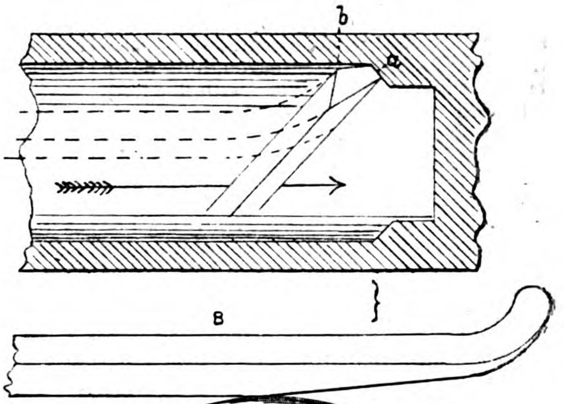
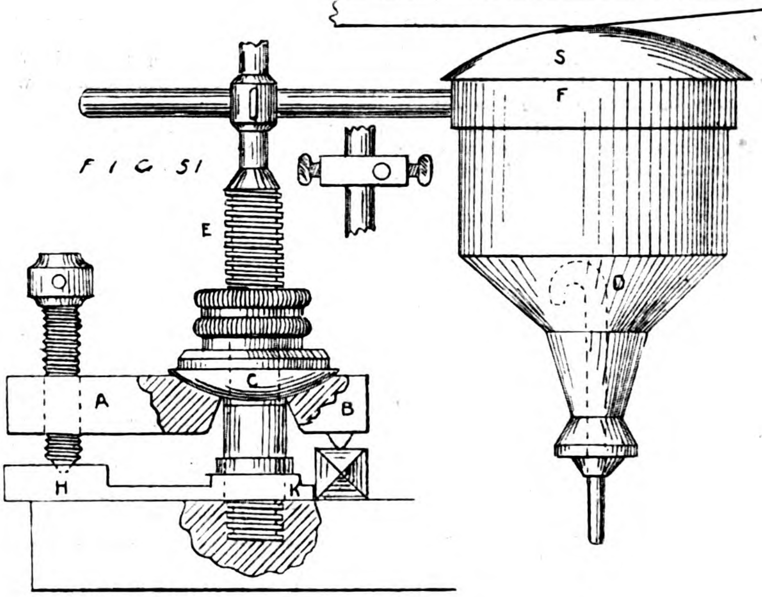


FIG. 51



polished on the outer side, if a lubricant is used. That side having been fairly cut, the inside is, of course, crushed across, as it has curled up, and is, consequently, quite rough.

If, instead of such a shaving, the metal comes off in chips, the tool cannot be considered satisfactory. At the same time, a perfect shaving equidistant between the coils is not to be expected, unless the feed is automatic, as it is in reality what may be termed an unwound screw, whose threads would not be evenly cut by hand-feed with the slide-rest. It is, however, difficult to state, with certainty, to what particular defect of form or position of edge any unequal or broken-up shaving may point. As regards the finish of the surface left by the tool, Mr. Haydon's own remark is that it should be so brilliant that the slightest touch of the finest emery-cloth would spoil it. In most cases there will be first a coarse or roughing down cut, and then a finishing one with fine feed, although Mr. Haydon's theory was in favour of leaving a perfect surface from the first cut; in fact, that such surface was the natural result of an efficient tool even with a coarse feed and deep cut. Certainly a great deal of work can be sufficiently finished at one cut because the following edge always leaves it smooth and bright, but when it is an object to get as perfect a surface as possible, the tool edges should first have a final touch on the oilstone, and then a finishing cut should be taken with a fine feed, using soap-and-water as a lubricant, and this should flow freely from a drip-can, travelling with the tool slide. Means must be taken, of course, to catch the surplus water, which may be returned to the can after having the dirt and chips strained out of it. Mr. Haydon's sketch of drip-can set up on a steel support screwed into the pillar of the tool post I copy bodily, as no plan can answer better. The Willis tool holder is also shown made correctly, which is not always the case. The conical, or rather hemispherical, washer C is often omitted, as well as the lower triangular plate H but both are of real use, as the washer allows the plate A a certain amount of adjustment, while it nevertheless conveys the pressure of the screw and nut above it to the plate and tool. The lower plate forms an abutment for the side of the tool shank or bar at K, assisting in placing it rapidly in position. The screw passing through A enters a recess in H, and the whole turns as one piece with A. The most important detail, however, is that which is often wholly overlooked—viz., that the end A of the triangular clamp should be twice as long as B measured from the centre of the pillar. I have bought rests in which the two were equal. I have casually glanced at some details of this excellent tool-holder because it chances to be introduced with the drip-can; but I have not considered it necessary to give plan drawings, as the apparatus is pretty generally known. The drip-can itself exemplifies very well indeed the peculiar knack which Mr. Haydon has of adapting to his purpose the odds and ends so readily obtainable. I believe I am right in saying that the component parts in this case were a preserved-milk tin, part of a funnel, and a gas tap, to the latter of which was soldered the siphon-shaped bit of brass tubing shown by the dotted lines, which is intended to prevent dirt from being carried to the orifice of the tap. The tap itself is omitted, probably by accident, as it is very convenient; but the original of this drawing, copied by a "graph," is now very faint indeed, and I think I can detect a shadow or ghost of a tap handle. I have little doubt that it was once visible. The supporting pillar of the sliding block, which supports the rod and ring, is screwed into the pillar which forms the centre of the Willis holder—a very capital place for it. When not in use, the can may be swung back out of the way, or the can itself and its rod and ring can be instantly removed, leaving the pillar standing. Mr. Haydon used the drip-can much more than I do myself, because I have a great dislike to the "mush" and "mess" which I should call inseparable from it, were it not that in his hands no such disagreeables were ever in existence, as he was the cleanest workman I ever saw. Still, a great deal of work can be done without lubricants, except in the final cut which is to leave the surface in a state of perfect finish.

It does not appear to me that there is much more to be said upon the present subject, the object of these remarks being chiefly to call the attention of recent subscribers to the matter, which is one of great interest and importance. Every aspirant to the metal-turner's craft finds himself at sea as soon as he attempts to work with fixed tools in the slide-rest, and when some of us were young the battle had to be fought on very unequal terms, except with those who, living in London, were blessed with the advantages of King's College school and workshop. Now it is, at any rate, possible to learn why and how a certain form of tool answers better than another, and, when the principles are grasped, practice will soon follow with every prospect of success. If a tool is ground and also placed theoretically correct, it will assuredly do its intended work; if it fail, a closer examination will prove that some error existed which was overlooked. In the case of a tolerably coarse cut a tool may work satisfactorily, which, if drawn back and then reset for a very fine cut may not act as well. In this case I have generally found that it has been badly placed—a shade too high, causing it to rub slightly or a little below the level of centres, or the second edge may not be set sufficiently parallel to the work. No one who has not practised metal-turning would believe how slight a cause will affect the action of a tool. To quote my old friend once more, by way of conclusion, "A hair's breadth in the setting of the tool will make all the difference between a finished surface, so perfect that the least touch of emery would ruin it, and a hitch-in of the following edge, accompanied by the usual results of a spoilt surface to the work, and probably a fracture of the point of your carefully-ground tool." O. J. L.

## THE INTERNATIONAL INVENTIONS EXHIBITION.—X.

### Gas and other Illuminants—Fuel, Furnaces, &c.

ALTHOUGH gas and other illuminants, and fuel, furnaces, &c., are the subjects of two distinct groups, the number of exhibitors is so small in the one section that we will take the two groups together. No very great improvements in the manufacture of gas have been made within the last quarter of a century, but in almost every detail, and especially in connection with the utilisation of the by-products and the methods of consuming the gas, the changes have been considerable—in the case of the by-products amounting to a revolution. The great discovery of the methods of manufacturing aniline dyes from benzol was made in 1856, and the artificial production of alizarine from anthracene, a solid product of the distillation of coal, dates from 1869. Some of the more useful improvements in burners are comparatively old, but the application of the "regenerative" principle is practically new, though it is perhaps senior to the application of the same principle for heating retorts. The exhibits which are connected with the manufacture of gas are not of much interest to the general public, who are concerned rather with its economical consumption than with its production; still there is much to attract the attention of the student even in connection with the drawing and charging of retorts, the working of the hydraulic dip, and certainly in the scheme for withdrawing gas from mines and utilising it for generating steam, &c. That is the Morgan and Shippey process exhibited in large diagrams by the Universal Electric Light and Engineering Co., of King-street, E C., and if the inventors could successfully withdraw the gas from mines, and so prevent explosions, they would undoubtedly achieve an important step in advance, for it seems clear that there is no safety-lamp which will prevent explosions. G. Waller and Co., of Holland-street, S.E., show their patent compensating governor, which is made to act direct on the throttle-valve of the steam-engine and regulate its speed according to the varying flow of gas. A bell works up and down in a vessel holding water; the lower part has a loose float, and a self-compensating water-chamber imparts great steadiness to the governor, which connects to the engine by a rack on the rod projecting from the bell actuating a toothed quadrant connected direct to the throttle-valve. Great steadiness is thus given to the up and down movement of the bell, and there is practically no "hunting" as the gas supply varies. The same firm also exhibit the "absolute" retort valve, which is fixed on the hydraulic main like the ordinary dip pipe—in fact it may be said to be a dip-pipe with a separate valve for the passage of the gas. The dip pipe is so placed that all the tar passes directly down to the hydraulic main, the gas going through the valve; but if the latter has not been opened, it goes through the dip pipe too. The valve is opened by a lever attached to a rod with a hook at its lower end to fasten under a bar by the retort lids, and on releasing that the valve closes at once. These valves are said never to choke with thick tar. Mr. Somerville, of Bankside, S.E., exhibits his patent dip reducer, which removes undue pressure on the retorts, and prevents the entry of furnace gases, as the liquor in the reducer resumes its normal level before the charge is withdrawn, and thus automatically seals the end of the dip pipe. He also shows his patented mouthpieces and self-sealing lids, in which the mouthpiece is cast with its front edge slightly splayed to form an internal conical seating faced up to receive the lid, which is made with a rim in the form of a shallow plug turned on the outside to correspond with its seating. The lid is swung on a hinged cross-bar, to which it is held by a central steel bolt capable of turning freely in a hole in the crossbar, so that the lid can be turned round in the event of dirt impeding its direct action, which is however rare, as the form of the rim clears the seat. Caink's patent automatic pressure-changing gas governor is an apparatus for increasing or diminishing the pressure in the mains according to the supply of gas demanded; it is believed to be the only one which meets the requirements of a district gas governor, and the inventors, Messrs. T. & H. A. Caink, of Sampson-road, Birmingham, claim that it is constructed on the only true principle, as to obtain uniformity of pressure at the point of combustion it is necessary to have a variable pressure at the source of supply. Messrs. A. Wright and Co., of Millbank-street, S.W., show a variety of apparatus, including calorimeters, analytical and testing instruments, Hartley's and other photometers; while Sugg & Co., of Westminster, S.W., have a large collection of their specialities in the shape of burners, and a number of instruments which will attract the attention of gas men. Thus they exhibit an improved Evans's photometer, which does not require a dark room, a patent travelling photometer, the radial photometer designed by Mr. Dibdin, chemist to the Metropolitan Board of Works, which is being employed by the jury for testing the lights at the Exhibition; Sugg's improved jet photometer, in which the pressure required to give a flame of a certain length is an index of the illuminating power. Sugg's patent illuminating power meter is an interesting apparatus, for it is constructed to show the illuminating power by the observation of an index for one minute. The meter being in order, gas is passed through to clear the drum; the burner is then lit, and the flame adjusted to the proper height. When the pointer marks 16 (the nominal value of the gas), the lever is shifted and the gas sent direct to the burner. The clock is now started, and just as the minute hand reaches a division the gas is again sent through the meter for one minute, when it is cut off and the illuminating power read off on the dial. Amongst the exhibits at this stand is Sugg's patent "Cromartie" gas lamp, which is one of the "regenerative" type, in which the gas passes in a nearly horizontal direction from a small hollow-headed burner inverted. The air supply to the upper side of the flame passes between tubes which it serves to keep cool, and the supply to the lower side goes directly to the burner, descending by its own gravity down the sides of the glass. It is stated that the burners consuming 5ft. per hour give a light of 25 candles. These regenerative burners are undoubtedly the chief attraction to the public in this group, and the report of the jury will be awaited with much interest. The Wenham patent gas lamp has been brought out by its inventor a little later in the day than some of the others. Unlike the Siemens lamp, the Wenham is inverted, but is based on the same principle of heating the gas and air by utilising the heat generated by the combustion of the gas. Lamps of several sizes are shown, one burning 18ft. per hour and giving a light tested in the vertical direction of 300 candles, or at an angle of 45°, 200 candles. The maximum illuminating power of the lamp burning 11½ cubic feet is put down at 180 candles; one burning nine cubic feet at 120 candles; and the six cubic feet lamp at 75 candles. These figures, it will be seen, are extraordinary, and there is no reason to doubt them, for it is plainly stated that the No. 1, which burns six cubic feet per hour, has an illuminating power of only 50 candles at an angle of 45°. Still that is very noticeable, and puts the Wenham lamp in the front rank. The lamps can be seen in action all day long at the stand of the Wenham Patent Gas Lamp Co., of 12, Rathbone-place, W., and the advantage of the new lamp can be appreciated by comparison with an ordinary burner consuming six cubic feet per hour. Another lamp of this class is shown by Kirkham, Hersey, and Clark, of Great George-street, S.W., in the shape of F. W. Clark's patent recuperative shadowless ventilating lamp, a title which suggests the remark that the majority of these lamps lend themselves very readily to schemes for ventilation, the heat generated by the combustion of the gas being used as the motive power for extracting foul air from a room. Those who based their recommendation of the electric incandescent lamp on the belief that it was much cooler than gas forgot that the modern gas lamps can also be made to act as ventilating engines, and so compensate for the extra heat they give out. According to a certificate by Mr. F. W. Hartley, the Clark lamp consuming 11·4 cubic feet per hour has an illuminating power equal to 60·33 times that of a standard candle. The Bower "Duplex-regenerative Gas Lamp," exhibited by Mr. Bower, of St. Neot's, Huntingdon, is a combination of the good points in the designs of Messrs. Grimston, Thorp, and Bower, but differs from other lamps of the class in having a lower air tube projecting below the glass cover. This contains an arrangement for varying the air supply so as to adapt it to different qualities of gas. According to Dr. Wallace, of Glasgow, a No. 2 Bower lamp, consuming 12·16 cubic feet per hour, yields an illuminating power of 109·62 candles when tested horizontally, elevation of course increasing the amount of light, a remark which suggests the advisability of taking all statements as to the illuminating power of any given lamp with caution, for no proper comparison can be made unless they are all tested in exactly the same manner. Next to the gas lamps the public will be mainly interested in those constructed to burn mineral oils; but before referring to them we must mention that the Albo-Carbon Light Company, of Horseferry-road, S.W., have an excellent exhibit of their appliances for enriching gas with a hydrocarbon. Kynoch and Co., of 199, Piccadilly, W., exhibit Martin's lamp, which has two semicircular wicks combining to give an annular ring of light, while Browne and Co., of 186, Paccadilly, exhibit the "Mitrailleuse" lamp, which has 16 small round wicks all raised or lowered by the one key. It is, in fact, a sort of Argand burner with wicks, the centre portion being used to distribute the air direct to the small flames, thus insuring perfect combustion and the maximum amount of light. The lamp is said to need trimming only once a week. Messrs. Defries, of Houndsditch, exhibit their safety lamp (Sepulchre's patent), which has received the high commendation of Mr. Boverton Redwood, and is so constructed that neither ignition of the vapour nor overflow of the oil in the event of an upset can occur. It is said that this lamp cannot possibly explode, and that, in the event of being accidentally overturned, it is automatically extinguished, while it will burn such perfectly safe oils as those having a firing-test of 300° Fahr. Mr. Daniell, of Linslade, Bedfordshire, exhibits his patent oil lamp chandelier, in which the wicks are laid in the tubular arms, and Flatau and Turner, of Mincing-lane, E.C., show their railway-roof lamp in action. This lamp burns mineral oil without the assistance of wicks. Jones and Willis, 43, Great Russell-street, exhibit a collection of ornamental designs for lamps, and their well-known triple-wick lamps. Amongst the other illuminants, attention must be drawn to Webb's wickless, non-guttering candle, exhibited by Gray and Son, 115, Leadenhall-street. This is an ingenious device, in which a disc of gauze, carrying a little wick of asbestos, is placed on the top of a cylinder (or candle) of wax, &c., and held in position by a sleeve, which slides down the candle as the substance is consumed. The sleeve prevents the disc slipping off the top, and the "wick," with the sleeve, sinks down as the candle is consumed. As there is no "pool" of liquid hydrocarbon near the "wick," guttering or spilling of the melted wax or tallow is prevented. Messrs. Garratt and Fowler, of Leipsic-road, S.E., exhibit their plumbers', gas-fitters', and painters' lamps, which contain a supply of cotton, on to which the spirit is poured, and the vapour of which rises as it is required. The air is supplied by a mouth blowpipe, and by means of a little tap the outlet of the air can be shifted so as to give a small jet or a broad flare. These lamps can be used in any position, and will enable the plumber to wipe a large joint in all sorts of out-of-the-way places. As there is no reservoir of spirit, they are perfectly safe. The same exhibitors also have an improved union which can be screwed up tight without running a risk of twisting the pipes. It is in reality an octagon fitting, which is made tight by screwing up a sleeve nut. In connection with gas meters we notice several attempts to design a "readable" index. Mr. Grey, Whitehead's-grove, Chelsea, adopts the form of a ring on the index finger, which shows the figure that is to be read; but the best of all the designs is, we think, the clock dial of Messrs. Foxall, Llewellin, Jones, and Co., of Newport, Mon. In this the index resembles a clock dial, with the usual two hands, but only 10 figures. The long hand reads thousands, and the short hand tens of thousands of cubic feet—an arrangement which can scarcely puzzle anyone. Their testing index is also an improvement, for, instead of a little hand liable to fall, they use a disc which revolves behind a vertical wire, and which, being equally balanced, indicates to any required degree of accuracy. The same firm also exhibit improvements in dry and wet meters. The dry meter, for instance, has the bellows supported both vertically and horizontally, so that it must always retain its full capacity, and must expand and close symmetrically. The wet meter has an improved valve, which is proof against any pressure, and can close the outlet only when the water is too low. Amongst pressure governors for use by consumers, Stott's (174, Fleet-street) is shown in various forms, some of them being entirely new devices for use with the regenerative burners, to which they have been applied in some cases in the Exhibition. It consists of a dome, or ring, of iron working in a trough containing mercury, and weighted to a certain pressure. As the pressure of the gas increases the dome lifts, and closes, or rather decreases the area of, the orifice forming the inlet of the gas by means of a conical valve.

Tice's gas regulator is shown by its patentee, W. Tice, Thornilee, Sutton, the special feature being the absence of any liquid, a flexible diaphragm causing a conical valve to be drawn into the inlet orifice as the pressure increases. Carter and Lees, Oldham, exhibit a pressure regulator with the dome and the mercury trough; but having patent equilibrium valves, and an arrangement by which the weight on the valve is increased automatically as more lights are brought into use. That is accomplished by means of a weight pivoted at one end, and pressing on the valve spindle by means of an arm. In the upright position the weight has little or no effect on the valves; but tends to force them wider open as the pressure decreases. Bromhead's dry gas regulators, which have been used for some time at St. Paul's Cathedral, and at several noted houses and clubs, are shown by Bromhead and Co., of 28, Paternoster-row. There are one or two self-lighting arrangements for gas burners, which, however, depend on the keeping of a small jet constantly burning, and in draughty places that is liable to be blown out. Kinnear's patent, 91, Finsbury-pavement, is a self-lighting burner with automatic governor, which is said to save 25 per cent of gas. J. Freeston and G. Kyle, of Geddington, Kettering, exhibit an ingenious self-acting regulating machine for extinguishing and re-lighting gas lamps in the streets. The motive power is derived from the air entering the lamp, which drives a small fan. The fan by gearing works a wheel carrying a number of pins, which, set according to the season of the year, turn the tap of the gas burner off and on, the gas being lit by a small jet constantly burning. The gearing requires setting about three times in the year, but as lamps must of necessity be cleaned occasionally, there is no extra labour involved. Messrs. Kirkham, Hersey, and Clark also exhibit Clark's gas-making apparatus, which is found very useful in country places. The mineral oil or hydrocarbon liquid flows into a copper retort as it is required, and is there subjected to a destructive distillation. The products being mixed with warm air, a permanent gas of high illuminating power and of uniform quality is formed. The apparatus is self-contained, the heat requisite being generated by the machine itself. Amongst the exhibits in this group we must not omit to mention Mr. Newman's art metalwork in connection with gas fittings, and his wrought-iron candlesticks of coiled rod, by means of which the candle can be raised as it burns down.

In the Fuel and Furnace Group Mr. F. Siemens shows a large-size model of the improved forms of regenerative furnace and gas producer, and also a few samples of his tempered glass bottles, millstones, and sleepers especially adapted for electrical railways. Mr. Fletcher, of Warrington, has a large collection of his famous cooking and heating apparatus in which gas is utilised, including laboratory furnaces and his coffee roaster, which is worth notice by those who like to have coffee in perfection. Mr. C. Kingsford, of the Lea Chemical Works, Hackney-wick, shows a large model of his system of combining a steam-boiler plant with coke ovens, so as to utilise the waste heat of the latter in firing the boilers. Captain A. S. Tomkins, of the Victoria Rifles, shows his field or camp stoves for cooking, which will be found very useful and suggestive to all who desire to camp out. Several of the exhibits of ranges, kitcheners, &c., are apparently remanets from the Health Exhibition; but are sure to attract the attention of ladies, especially the self-fitting stoves, like the "Gem" shown by Brown and Green, of Finsbury-pavement. The patent safety gas-stove, constructed on Somerville and Webber's patent, by the Patent Gas-stove Company, Hatcham-park-road, S.E., will also interest many, as it depends on radiant heat from illuminating burners, instead of Bunsens, and is, therefore, quite free from any tendency to alarm to the cook by flying back. The oven lining is of tinned copper, and can be removed for cleaning, while the waste or escaping heat is used for warming water. This stove has, we believe, never before been exhibited, and it certainly merits careful attention. We have, however, said sufficient to prove that the groups devoted to gas, &c., are not the least interesting portions of the Exhibition.

## ON SOME MATTERS IN THE THEORY OF MIRRORS.—II.

By W. BRADBURY.

§ 4. TO apply the rule to a Cassegrain telescope.

In this case parallel rays falling on the great mirror are converged by it on a small convex mirror, which brings them to a focus at or behind the vertex of the great mirror. Let Fig. 3 represent this arrangement, A being the final focus, B the vertex of the great speculum, and C its focal point, D the vertex of the small mirror, and E its focal point. Thus, in this case the rays fall on the small reflector before completing their convergence, whereas in the Gregorian they encounter it after passing the focus. Let $AB = a$, $BC = F$, $DE = f$, $AD = v$, $DC = u$. Therefore $BD = F - u$, and $AD = v = a + F - u$. This being a case of the reflection of con-

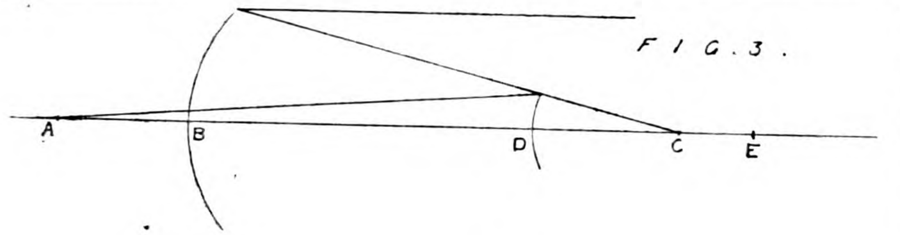


FIG. 3.

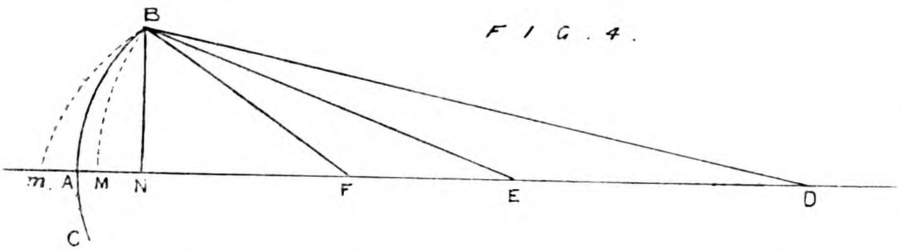


FIG. 4.

verging rays, falls under eqn. (8), which may be put in the form—

$$\frac{1}{u} - \frac{1}{v} = \frac{1}{u} - \frac{1}{a + F - u} = \frac{1}{f} \quad \ldots\ldots\ldots(16)$$

Or, as a quadratic eqn.—

$$u^2 - u\,(F + a + 2f) = -f\,(a + F) \quad \ldots\ldots(17)$$

As before, assume for brevity that $(F + a) = m$, then—

$$u^2 - u\,(m + 2f) = -mf.$$

The solution of which gives—

$$u = \frac{m + 2f \pm \sqrt{m^2 + 4f^2}}{2}$$

Now $m = F + a$ and $BD = F - u$, which substitutions give

$$BD = F - f + \tfrac{1}{2}\left\{\sqrt{(F+a)^2 + 4f^2} - (F + a)\right\} \ldots(18)$$

Also CE, the difference between the principal foci of the mirrors, is

$$CE = f - u = \tfrac{1}{2}\left\{\sqrt{(F + a)^2 + 4f^2} - (F + a)\right\} (19)$$

Hence it will be seen that the distance apart of the mirrors is somewhat greater than the difference of their foci.

As a particular case, assume that $a = 0$, then we have

$$BD = (F - f) + \tfrac{1}{2}\left\{\sqrt{F^2 + 4f^2} - F\right\}$$

$$CE = \tfrac{1}{2}\left\{\sqrt{F^2 + 4f^2} - F\right\}$$

and if the focal ratio $f/F$ be represented by $r$, these become

$$BD = F\left\{1 + r + \tfrac{1}{2}\left(\sqrt{1 + 4r^2} - 1\right)\right\} \ldots.(20)$$

$$CE = \frac{F}{2}\left(\sqrt{1 + 4r^2} - 1\right) \quad \ldots\ldots\ldots\ (21)$$

When the quantity under the vinculum is developed in a series, and the first three terms used, we find—

$$BD = F\,(1 - r + r^2 - r^4) \ldots\ldots\ldots\ldots\ldots(22)$$
$$CE = F\,(r^2 - r^4) = Fr^2\,(1 - r^2) \ldots\ldots\ldots(23)$$

To show the amount of error given by the last pair of equations, let us calculate several values for different ratios by both pairs of equations.

$$\begin{array}{lll} & \text{By (20) and (21).} & \text{By (22 and 23).} \\ r = \frac{1}{3} \ldots & BD = F \times \cdot 7675 \ldots & F \times \cdot 7654 \\ & CE = F \times \cdot 1008 \ldots & F \times \cdot 0987 \\ r = \frac{1}{4} \ldots & BD = F \times \cdot 809 \ldots & F \times \cdot 808 \\ & CE = F \times \cdot 059 \ldots & F \times \cdot 058 \\ r = \frac{1}{5} \ldots & BD = F \times \cdot 8385 \ldots & F \times \cdot 8384 \\ & CE = F \times \cdot 0385 \ldots & F \times \cdot 0385 \end{array}$$

A geometrical relation amongst the focal distances may be found as follows, though it is not of much practical utility. In equation (19) let CE be represented by $x$, then we find—

$$x\,(F + a + x) = f^2$$

Substituting from Fig. 3 the geometrical for the algebraical quantities in this equation, it gives (since $CE = x$, $AE = F + a + x$, $DE = f$).

$$CE \times AE = DE^2$$

Or, as a proportion—

$$AE : DE :: DE : CE.$$

This holds true for any position of the point A, so that when A and B fall together—

$$BE : DE :: DE : CE.$$

The above geometrical relation is applicable to the Gregorian as well as the Cassegrain form.

Having now given the chief formulas which show the relations among the foci, it is necessary to proceed to the more complex problem of finding the aberration of a spherical reflector. In this question we shall follow entirely the analytical method of Coddington.

§ 5. To compute the spheric aberration of a mirror.

First, for a concave mirror.

In § 1 we had the eqn. D.

$$\frac{FB}{FE} = \frac{DB}{DE}.$$

and it was shown that when A and B are so near together that distances measured from either are practically alike, we obtained rules which furnished the means of finding the positions of the focal points for the so-called central rays; but obviously the higher the point B rises on the curve away from A, the greater is the difference in the length of lines measured from A and B; and consequently the greater is the error in the formula. Hence it becomes necessary to use, not the central values of FB and DB, but others which take into account the distance of A from B. In Fig. 4 the various points correspond to those in Fig. 1: from B, drop the line BN square apon AD. BN is called the semi-aperture of the mirror, and is generally represented by $y$. Next, from D as centre with BD as radius, draw the arc BM; and from F, with radius BF, draw B $m$. Then, of course, DM and F$m$ are the exact lengths of DB and FB, and AM and A$m$ show their difference from the corresponding central lines AD and AF. But $AF = v$, $AE = r$, $AD = u$, and the equation (1), when inverted, may be put—

$$\frac{r - v}{v + Am} = \frac{u - r}{u - AM} \ldots\ldots\ldots\ldots\ldots\ (24)$$

and the next step is to find the values A$m$, AM.

By the property of the circle $y^2 = 2rx - x^2$, where $y = BN$, $r = AE$ and $x = AN$. But since $x$ is very small compared with $r$, we may neglect its square, and say that AN or $x = y^2 \div 2r$. And for the circular arc, struck from D, we may put $MN = y^2 \div 2u$; and for that from F, $mN = y^2 \div 2v$. From these values we readily find A$m$, AM, and eventually

$$v + Am = v + \left(\frac{1}{v} - \frac{1}{r}\right)\frac{y^2}{2}$$

$$u - AM = u - \left(\frac{1}{r} - \frac{1}{u}\right)\frac{y^2}{2}$$

The second quantity is very small compared with the first, and the reciprocals may be put in a serial form, rejecting all terms after the second. This gives—

$$\frac{1}{v + Am} = \frac{1}{v}\left\{1 - \frac{1}{v}\left(\frac{1}{v} - \frac{1}{r}\right)\frac{y^2}{2}\right\}.$$

$$\frac{1}{u - AM} = \frac{1}{u}\left\{1 + \frac{1}{u}\left(\frac{1}{r} - \frac{1}{u}\right)\frac{y^2}{2}\right\}.$$

By these values being substituted in (24) and the equation then divided by $r$, we have—

$$\frac{1}{v} - \frac{1}{r} - \frac{1}{2v}\left(\frac{1}{v} - \frac{1}{r}\right)^2 . y^2 = \frac{1}{r} - \frac{1}{u} + \frac{1}{2u}\left(\frac{1}{r} - \frac{1}{u}\right)^2 y^2 \ldots\ldots\ldots (25)$$

Now, the first part of each side is in reality our first approximate focal formula, so that the coefficient of $y^2$ embodies equal terms; and if we write $\frac{2}{r}$ for $\left(\frac{1}{u} + \frac{1}{v}\right)$ we get

$$\frac{1}{v} = \frac{2}{r} - \frac{1}{u} + \frac{1}{r}\left(\frac{1}{r} - \frac{1}{u}\right)^2 y^2.$$

or, if $f$ is the principal focal length—

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} + \frac{1}{2f}\left(\frac{1}{2f} - \frac{1}{u}\right)^2 y^2 \ldots\ldots (26)$$

---

# THE AMATEUR WORKSHOP.—IX.

## Planing Machines—Vertical Slides.

THERE is not much variation in the types upon which these are constructed. In the larger machines the castings are hollow throughout, on the boxed principle, as in the illustration (Fig. 2) on p. 444 of the last volume, and the elevating screws are inclosed in the hollows of the castings. These frames are all made roughly triangular in outline, in order to resist the reaction of the cutting tool. In the larger machines they rest directly upon the ground foundation as in the Fig. 2 referred to above, and the bolts which connect them to the bed sides simply retain the parts in place, while in machines of medium and of small size they are sustained either directly against the bed or upon brackets cast with it as in our own particular case. In some instances the bearing faces are prolonged downwards to carry an extra tool box by the side of the table, and additional gear is provided for moving it. The bearing faces require to be planed accurately to receive the cross slide, and they are kept rigid laterally by the bed below, and by a cross bar near the top.

The slide here figured is a plain plated casting, stiffened with flanges round the edges. It would involve slightly less work if the back, instead of being curved, were made straight, though the curve has a better appearance. In the Figs. 88, 89, 90, the lug A carries the end of the elevating screw, which is therefore placed without the frame, and the plate B is brought to one side of the centre, both to give flange room at the bottom for the holding-down bolts, and to allow sufficient width for the heads of the tightening bolts to slide freely—the bolts passing from the cross slide, through the slots C, to the back of the $2\frac{1}{16}$in. thickness. A T-headed recess for the bolt heads (Fig. 91) would answer equally well, but the inner bearing faces of the recess should be planed in that case, and this would be more troublesome than the filing of a clear slot. The facing D is for the end of the cross bar, and the narrow strip E is for the purpose of affording additional guidance to the cross slide, besides that provided by the screws and nuts.

In the pattern, the plate will be framed together in a similar fashion to the standard (p. 468 of the last volume), four pieces, *a*, *b*, *c*, *d*, being required, and corner pieces for the hollow radii being glued in. An ⅛in. allowance will be made upon the face for fitting; but it is not necessary to carry this right down to the bottom flange, but only so far as the lower lugs of the cross slide will come when at their lowest position. Hence the bottom flange will be 1ft. 1in. long in the pattern; but 3in. above the foot the front face will be increased an ⅛in. in thickness, and carried thus right to the top.

Upon the plate when cut to shape and cleaned off will be screwed the remaining work. The bottom flange F will measure 1ft. 1in. by 2¼in. by ¾in., and its bottom face will be square with the plate, a trifle of taper being put upon its inner face only. The front or slide portion G will be made up by one piece measuring 2ft. 0⅜in. by 2¼in. by 2⅜in., and fastened to the plate. On the back or inner side of this strip a thin facing 2ft. 0⅜in. by 1⅜in. by ⅜in. should be tacked, to afford a narrow and true bearing surface for the heads of the tightening bolts, and thus prevent the frequent hitch or diagonal bite which occurs against an uneven surface.

The plate will be strengthened and stiffened with ribs, *e*, *e*, *e*, 1¾in. deep, and cut to their respective curves from a piece of stuff planed to that thickness. The ribs around the inner curves will be jointed as shown by the dotted lines, Fig. 88, in order to avoid shortness of grain. Glue must not be used in any except the half-joints of the plate itself, because all the parts will have to be reversed, for right and left-handed castings respectively.

The print for carrying the slot core C will be prepared to 1ft. 10in. by 1¼in. by ¾in. (it is made thus wide purposely to afford sufficient

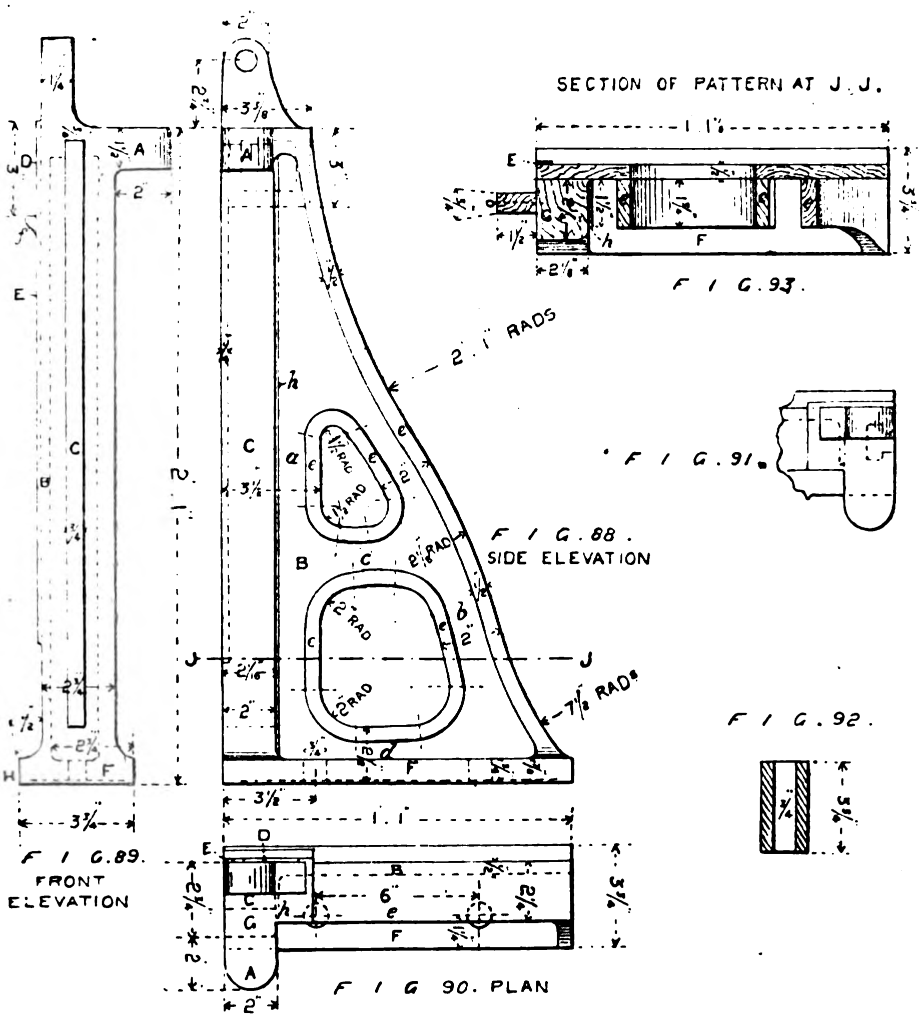


FIG. 89. FRONT ELEVATION

FIG. 88. SIDE ELEVATION

FIG. 93.

FIG. 91.

FIG. 92.

FIG. 90. PLAN

support to the core without other assistance), and a couple of shavings off each side will give enough taper in this case. If much taper were given, and the moulder did not file the corresponding taper in the core symmetrically, the slot would be out of parallel in the casting. The print is skewered on, and a core box of the plain section (Fig. 92) is made, equal in depth to that of the print and casting combined, and 1ft. 10in. long. The lug A, which sustains the bevel wheel and the elevating screw, made to the size and shape of Figs. 89 and 90, and 1½in. thick, will be fastened on. The facing, D, on the back will consist of four chipping strips of ½in. by ⅜in. section, and fastened on in rectangular form 3in. square—one side of the rectangle being flush with the top; another, ⅜in., from the front edge. A joggle *f*, Figs. 88 and 90, 3in. long, will be fastened on 3in. below the top to form a steady bearing for the cross bar. On the back of the plate a strip, H, will be wanted, 1ft. 1in. by ¾in. by ⅜in. to complete the width of the foot; and on the same side of the plate, and running up its inner edge, the facing strip, E, 1ft. 10in. by ⅝in. by ⅛in. will be fastened. A chipping strip of a ¾in. by ¼in. section will be put around the foot, the lower strip only being skewered on. Bolt holes should not be cast, but drilled in. Fig. 93 shows a section of the pattern cut through J J, to enable the reader to understand clearly the descriptions here given.

In reference to the provision for carrying the wheels for the elevating screws, there are two or three methods open to our choice, the adoption of either of which would involve modifications in our patterns. In Fig. 1, on p. 444 of the last volume, I illustrated the very common method of carrying the wheels by means of hood-shaped bearings resting upon the top of the horizontal wheels, and kept in place on the spindle by a small check pin. But a simpler method would be that shown in Figs. 88, 89, 90, where a couple of lugs cast upon the vertical slides take the bearing of the cross spindle, and as this gives rather less trouble in the making than the independent wrought-iron bearings of Fig. 1, and is very commonly employed in small machines, I have drawn that attached to the pattern of the slide, and should advise its adoption. In large machines bearings of either kind are employed. Where the cast bearings are used, they are frequently cast in a piece with the stretcher or cross-bar. Or the bearings of each wheel in the pair are taken on a single curved bracket, which is bolted to the top of the vertical slide. Of these methods the attachment shown in Fig. 88 is most suitable for our machine, and in that case we simply have to make a lug, as drawn, and fasten it on. If the independent bearings are chosen, the pattern is already complete without the lug.

Two castings are required, one right, the other left-handed; so after the pattern has been moulded for the first, the pattern will be reversed by transferring all the parts from each side of the plate to the sides opposite. The two castings will weigh 136lb., and should cost about 12s. per cwt.

The fitting of these slides will be a comparatively easy affair after the table and bed, the most important part being the front face. The instructions given on pp. 468 and 554 of Vol. XL., relative to chipping and filing, need not be repeated again, since they will apply equally well in this instance. The faces should be filed first, at exact right angles, with the edges of the feet; and true lineally, and the chipping strips on the feet will be filed afterwards perfectly square with the bearing faces in front, and with the plate at the sides. The necessity for this carefulness will be apparent when we come to try the slides in their places on the bracketings of the bed, and to test them relatively to each other and to the bed with straightedge, checked across their faces, and with square or level in relation to the faces of the bed. Both slides, when stood in place, should show faces perfectly parallel with one another, and the bed being adjusted with spirit level, the slide faces should, when tried with the same instrument, show perpendicular. Some little adjustment will sure to be necessary before these results are attained, and this can be done easily on the chipping strips. Lastly, the holes will be marked off from the brackets in Fig. 38, p. 554 of the Vol. XL., and drilled to ¾in. in diameter.

The facings for the stretcher bar, and the guide strips for the cross-slide, have yet to be filed, and the holes have to be drilled for the spindle and the screw. At this stage, therefore, we had better let this work remain until after the cross-slide and stretcher, with the wheels and their spindles, are made, the preparation and fitting up of which will furnish the subject-matter of our next article.

## MAKING LANTERN SLIDES.*

I REGARD the successful development of lantern slides as one of the most difficult and delicate things that I have as yet met with. Many subjects which make excellent silver prints fail to make good lantern slides. The formula which I use is slightly modified from that recommended by Mr. Carbutt, and I prefer to use his slow gelantino-albumen plates.

No. 1.

| | |
|---|---|
| Water | 32 ounces |
| Sulphate of iron | 8 ounces |
| After filtering, add | |
| Sulphuric acid | 40 minims |

No. 2.

| | |
|---|---|
| Water | 32 ounces |
| Citric acid | 60 grains |
| After dissolving above, add | |
| Neutral oxalate potash | 8 ounces |

If the solution does not turn blue litmus paper faintly red, a trifle more citric acid is added, and when this is dissolved, add

| | |
|---|---|
| Citric acid | 300 grains |

Mr. Carbutt advises the following proportions for the developer:

| | |
|---|---|
| Oxalate of potash solution | 5 ounces |
| Iron solution | 1 ounce |
| Bromide of potassium | 6 grains. |

In respect to the use of the bromide, I am governed altogether by the negative from which the slide is being made. If the negative has strong contrasts of light and shade I should not employ any bromide, as its retarding action in this case would unduly check the development of the high lights, and by the time they did appear, the shadows of the transparency would be so dense as to be almost opaque. As a general precaution, however, I find it desirable to use a little bromide as the development is under better control, and any slight over exposure may be easily corrected.

It will be noticed that the developer contains about all the iron it will retain without precipitation, hence, if by reason of under exposure the image fails to develop fully, nothing can be done to force the development, for if more iron is added a precipitate will be formed. On the other hand, if a long exposure is given and the developer containing a bromide is poured upon the plate, there is some chance of saving the transparency in case the bromide checks the development too much, by pouring it off and flowing with a fresh developer containing no bromide. When the developer is used full strength as given, it is of vital importance to have the exposure exactly right, and this is very easily done when the copying camera is in the same place and a uniform light employed, either from the sun or a northern sky. I find in reducing a 5 × 8 negative to 3¼ × 4, having the copying camera containing the negative placed within 6in. of the window, and the latter protected by a piece of ground glass or white tissue paper, the sun's rays shining direct, or nearly so, upon it, an exposure of from five to seven seconds is sufficient for negatives of ordinary density. For a very thin negative, I have reduced the time to cap on and off. I prefer this latter exposure for negatives of such subjects as rocks, white stone buildings, steamboats, sailing vessels, and rough water and marine views. In such cases I use the developer at its full strength, as I notice it yields what are called "black and white" tones, but which are actually more black and blue or black and very dark purple, such as is often seen in an ordinary silver print. For such objects as landscapes containing considerable foliage and grass, brown stone buildings, or those composed of the yellowish brick much used at the present time, I prefer a dilute developer, as I think it yields tones more in accordance with the subject. The exposure should be trebled, and the strength of the developer reduced one-half, putting in one grain of bromide to two ounces of solution, and picking out the plate when the development has proceeded far enough.

By commencing the development with a weak solution there is little need of ever losing a plate. My plan of proceeding is as follows: Suppose we have two ounces of developer just half the normal strength in the tray, and in a graduate near by an ounce of the same full strength, now this latter solution can be added, a little at a time, if necessary, to bring out the picture without danger of causing

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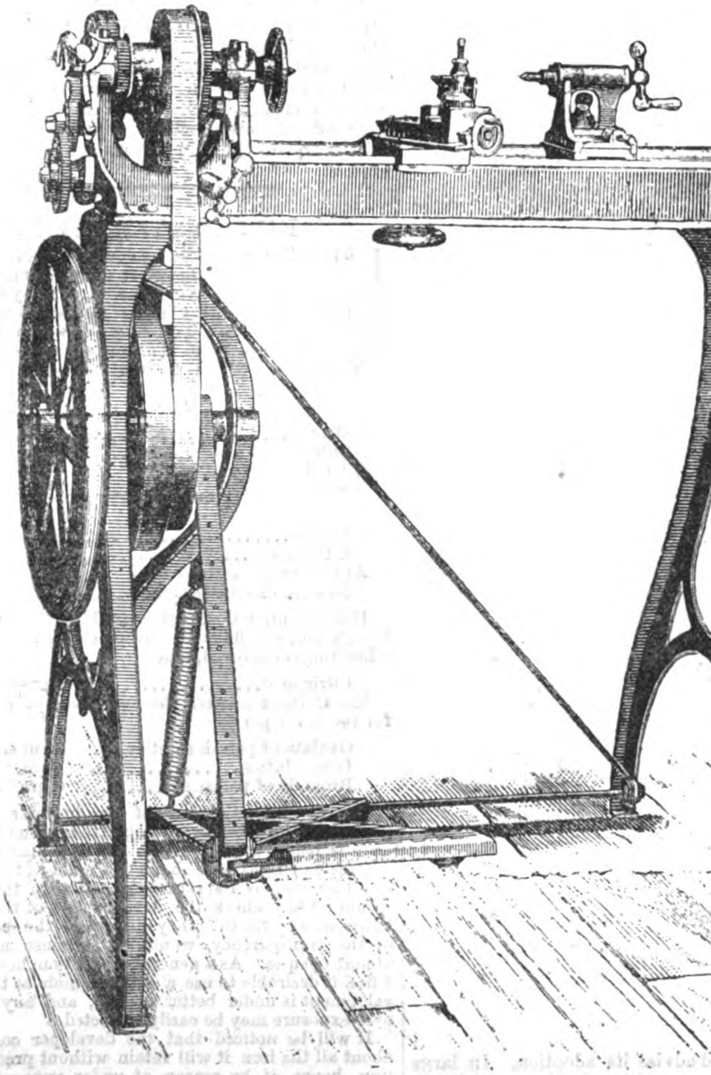
* By A. B. Benjamin. A paper read before the Societ of Amateur Photographers of New York.



any immediate chemical change in the developer. I do not advocate using a developer that has been mixed over thirty minutes, as beyond that time the yellow precipitate begins to form, and though the developer appears to remain clear, there is a sprinkling of golden sand deposited on the surface of the plates, which, while it can be easily removed by a constant and rather violent agitation of the tray, is a movement that is really needless so long as the plate is well covered. When a negative to be reduced is thick on one end and thin on the other, the thin portion can often be shaded with success. I have even thrown a handkerchief over the thin end, and thereby obtained a more even illumination. Until some better light is provided, it will be necessary to make a double set of slides for home exhibitions, one suited for oil and the other for the limelight. I have some subjects that I cannot develop thin enough for oil, and retain any pluck, yet if the development is continued, the transparency becomes practically worthless. I employ two cameras facing each other, in one the negative to be reduced is placed in a kit in the space occupied by the plate-holder, and the lens front is removed. The lens of the copying is inserted in this aperture, and the space between the two cameras covered by a black cloth; this plan I find works very successfully, and avoids the necessity of using a copying camera. In focussing I employ a magnifying glass. The making of lantern slides is to me extremely fascinating, and if I have imparted any information which can be utilised by others, I shall feel that my experience has not been in vain.

## THE PROVIDENCE SCREW-CUTTING LATHE.

THIS lathe possesses several important features of construction, some of which are represented by detail views. It is designed for use on electrical work, sewing machines, or other light work, and is a very convenient tool for amateurs. It will turn 18in. long, 4½in. diameter, and swing 8in. over the bed. The gearing furnished enables screws to be cut from five to the inch up to very fine pitches. It has a hollow steel spindle to take rods up to $\frac{5}{16}$in. diameter. The spindle bearings are straight, with adjustment for wear. The centres are fitted to Morse taper. The tailstock has set-over for turning tapers, and the slide rest swivels on the carriage.

Fig. 1 represents some of the features of this lathe. The gear teeth are represented by heavy black lines. A is the spindle gear, shown disconnected from the right and left gears, B and C. It will be observed that if the back gear is disconnected there will be no gears running in connection with the spindle, so it can be run at high speed without noise. The lever, E, connects either the right gear, B, or the left gear, C, with the spindle gear, thus driving the screw, S, right or left, as desired; F is the fixed stud, and G is the intermediate stud. On coarser threads the gears on the stud, G, may act as intermediate; on fine threads it may be compounded, as shown; this gives a very wide range of threads. An index plate accompanying each lathe gives 29 threads, but many others may be obtained, or gears may be made for special threads. This system of gearing is very direct and simple. The screw-cutting train of gears are all 20 diametral pitch, and the back gears 16 pitch. By means of a novel motion the spindle may be instantly reversed at any point and run backwards without stopping the lathe. This is entirely separate from the ordinary right and left motion, and completely reverses the spindle and screw-cutting gearing, running the carriage back while the lathe is going at full speed forward. This is accomplished by means of an addition to the usual back gearing. On the same shaft with the usual large back gear, H, is the gear, I, of the same diameter; these gears are connected by means of the gears, J and K, thus the motion of the gear, I, is exactly the reverse of the gear, H. Now, as these gears (H and I) are on the back gear shaft, and revolving loosely in opposite directions, and as the spindles are driven through these gears, it only remains to connect the back gear shaft with either the regular back gear, H, or the oppositely running gear, I, to produce a forward or backward motion of the spindle. This is done by means of a clutch operated by the lever, L. Then, if, while the belt, M, and pulley, N, are running forward, the lever, L, is pressed towards the pulley, N, the gear, I, will be connected with the shaft, and the spindle will run backward, carrying with it the screw-cutting gearing, and running back the carriage to start another cut. It will be noticed that the train of gearing from the spindle to the screw remains unbroken, hence the operation of the reverse gearing is precisely the same as that of a countershaft with straight and cross belt.

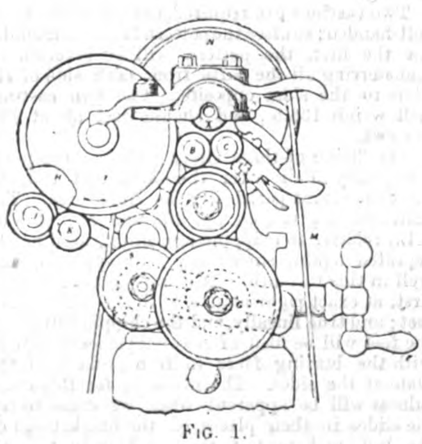


FIG. 1.

Fig. 2 is a view of the carriage and section of one of these foot lathes, showing the bed in section.

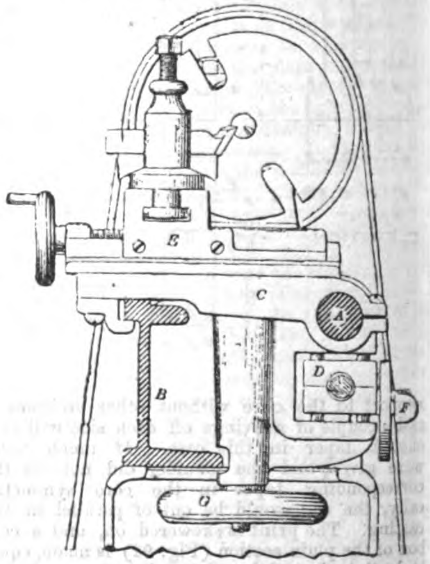


FIG. 2.

The front side of the bed consists of a single casting 3⅜in. deep, as shown at B. In place of planed V's to guide the carriage, C, a compressed steel bar, A, is used at the back, as shown; the front being gibbed to the bed, B. The bed is deep, and being directly under the tool-post, receives all the pressure from the same, the bar acting only as a guide. The bar and bed being placed well apart, form a broad and firm support for the carriage. The screw, D, is placed close to the guide bar, A, thus avoiding any cramping of the carriage. By means of the cam, F, the half nut may be separated and the carriage detached from the screw, and moved by hand to any part of the bed. The slide-rest, E, is secured to the carriage by a bolt, which is tightened by the wheel, G. It may be set at any angle for turning or boring tapers, or instantly removed and a T-rest holder, or other device, substituted. The slide-rest and carriage are milled true on their edges, so that the slide-rest may be easily set square with the guide bar. The top part of the slide-rest extends back so as to cover the wearing parts and protect them from chips and dirt; it also acts as a support for the tool. The point of the tool may be raised or lowered by means of the convex washer and concave shoe. The slide is gibbed, to provide for any adjustment it may need.

The foot power is shown in Fig. 3. On the lever pulley shaft is a clutch, C, which, when the treadle, D, is pressed, engages with and gives motion to the pulley. On the stopping or returning of the treadle, the pulley continues its rotation, so the strokes may be long or short, quick or slow, at the will of the operator. The spring, E, raises and balances the treadle. The cone, B, has two steps, 2⅛in. and 5in. diameter. The lower cone pulley has steps, 12in and 9¾in. diameter. An additional balance wheel, F, is provided. This foot power is all ready to start from any position, and no power is wasted on it. With back gears a speed of 25 revolutions may be kept up; without back gears the speed may be varied from 120 to 3,000 revolutions. It always starts in the right direction. The

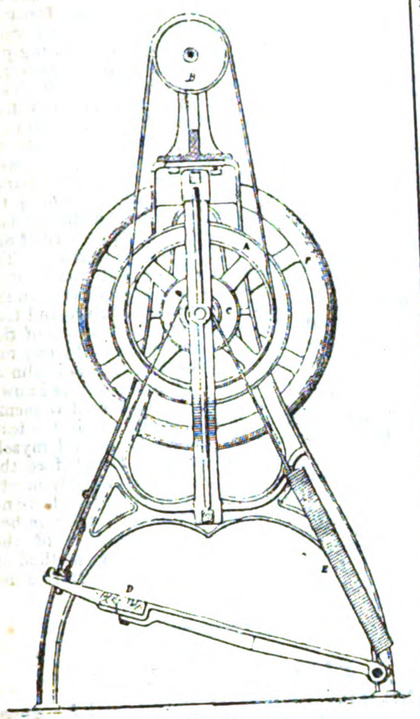


FIG. 3.

foot can remain at rest on the treadle while the machine continues to run, thus avoiding the motion necessary to crank motions, even when power is not needed. This last feature is one that will be appreciated in delicate operations. The lathe is made by the Narragansett Machine Company, Providence, R.I.—*American Machinist.*

## THE CAMPHOR BAROMETER OR "STORM GLASS."*

IT was discovered by our ancestors that the height of the undissolved camphor in a camphor bottle was different in different states of the weather; and it became quite customary to keep a camphor bottle in sight, in order to anticipate the change in the weather, it being thought that an increase in the height of the camphor indicated approaching rain or wind. The inventive genius of our age could not allow the instrument to remain in this crude form.† The camphor‡ and alcohol were put into long glass tubes hermetically sealed at the top, and adjusted in a frame with a thermometer attached. The side of the frame next the tube was divided into three divisions. On the bottom one was marked the word "Fair," on the middle one "Change," and on the top one "Storm." A note accompanying the instrument stated that the weather was indicated by the word in the division with which the top of the chemical substance corresponded. It also stated that the direction of the wind was shown by the substance being a little higher on the opposite side from which the wind came. These were manufactured and sold all over our country under the name of "Storm Glasses," or "Chemical Barometers." One firm, I suppose in order to increase the sales, adopted the name of "Signal Service Barometer;" and I have met a number of people in possession of these instruments who really thought they had one of the genuine barometers which the Signal Service used in its predictions.

The fact that the manufacturers have hermetically sealed the top of the tubes fortunately assists in an investigation of the cause of the instrument's action, for it is evident at once that the contents of an impermeable, air-tight vessel of glass can neither be affected by variations in the atmospheric pressure nor moisture. That light is not the cause of its action can be easily shown, for the chemical substance varies in height in the dark just as it does in the light. Neither can its changes be due to the action of the electricity of the air, for the changes of the tube take place the same in a protected shelter as they do in the open air, and the electric potential inside of a shelter is always zero.* We turn to changes of temperature for the cause of its variations, and find a most satisfactory explanation of its action. If it is winter, one can easily convince himself of this by taking the instrument into a warm room. If now the instrument be hung out of doors, the precipitate will in a little while increase greatly in quantity, and if the difference of temperature is considerable, the alcohol in the tube will be filled from top to bottom. I have a tube on which I have divided the length from the top of the alcohol down to the bottom into ten parts, and these again into ten parts, so that I can read the height of the precipitate at any time in hundredths of the greatest height to which it is possible for it to extend. March 24, I found the instrument hanging in my room read 21 on the scale, temperature inside of room 73°, outside 27°. I placed the instrument outside, and in two minutes little stars began to form at the side and to move down toward the bottom and up to the top again in the centre of the tube. These continued to increase in size, and in five minutes the alcohol was about one-quarter full of them. As these increased and the circulation of the liquid became slower, they began to accumulate at the bottom and somewhat at the top, until in twenty minutes the alcohol was full from top to bottom. I brought it inside the house, and in a few minutes the precipitate began to take on a more attenuated appearance and to slowly decrease in height. In forty minutes it read 21 again. Readings of the height of the precipitate taken every ten minutes were as follows: 4.55 p.m., 100; 5.5 p.m., 93; 5.15 p.m., 80; 5.25 p.m., 50; 5.35 p.m., 21. Another instrument with the scale arranged in exactly the same manner had been hanging outside for a month or two, and read 50 during the whole experiment. The instrument in my room was next put into warm water, and I found that at a temperature of about 100° every particle of the precipitate would disappear.†

If allowed to remain in the water while it cooled, little stars or flakes would begin to appear in the alcohol, and when it had fallen to a temperature of 70° or 75°, the alcohol would be entirely filled with the precipate. If, then, the indications of the instrument are to be relied on, it is easy to get up a storm on short notice.

Suppose, when an instrument has been carried out of a warm room and the precipitate fills the alcohol from top to bottom, and it is left outside, as was done on the 1st of January, with the instrument hanging outside referred to above;—in such a case, after the instrument has been out some time, the column or precipitate will begin to shorten, even though the temperature remains the same; and it will be noticed that the bottom presents a more compact appearance. After about a week or ten days, the precipitate will have entirely lost its feathery appearance, except, perhaps, a little at the top, and will present a compact granulated mass filling about half the tube, if it is winter, and about one-quarter, if it is summer. If while the column of precipitate was shortening there was any considerable change in temperature, there might be some minor oscillations in the length of the column, but the whole tendency would be downward. When this state is attained, the precipitate dissolves very slowly in the alcohol, and the instrument is capable of going through considerable changes in temperature without much change in the height of the precipitate. Thus, suppose in the morning the temperature was 40°, and by noon had risen to 50°, the height of the column may show no perceptible decrease, because the dense crystals dissolve slowly, and the alcohol lacks considerable of containing as much as it could dissolve at the latter temperature; but when towards night the temperature again falls to about 40°, the liquid is nearly saturated; and, if by the next morning the temperature has fallen to say 32°, the liquid will be filled to a considerable height with light, feathery crystals which readily dissolve on a rise of temperature, or if the temperature remains stationary, settle to the bottom changed into the more compact granular crystals. To illustrate from observation—on January 13, the temperature in the room for about a week had been ranging from about 60° to 70°, and the height of the precipitate in the instrument had been almost steady at 23 on the scale, when the temperature in the room on the evening of the 13th fell to 52°, and light flakes of precipitate began to form. I knew the liquid was now super-saturated, and any further decrease in temperature would cause a decided precipitation. On the morning of the 14th, the temperature had fallen to 43°, and the height of the column of precipitate was 32 on the scale. I observed the instrument inside the house and the one outside, three times a day during January and February, and it was always found that the height of the two columns varied in opposite directions whenever the temperature changes inside and outside were in opposite directions.

I observed the instrument three times a day during the whole summer and autumn of 1881, and there was never an increase in the height of the precipitate without a corresponding fall of temperature, or a decrease without a corresponding rise of temperature. It will thus be seen that the instrument is not a "storm glass" or a "chemical barometer," but a chemical thermometer, and a very poor thermometer at that.

Do its indications bear any relation to weather changes? Yes; because temperature changes are closely related to other weather changes. In the summer, under an extended but moderately high pressure area, or anti-cyclone, there usually exists beautiful, fair, warm, settled weather, and the top of the precipitate will be even with the division marked "Fair." When showers come on, the air turns cool, and the precipitate rises to the division marked "Change." Whenever an area of decided low pressure passes over the country, the air is warm in front of it; and as the centre passes over, there is usually a sudden fall of temperature. This causes the precipitate to rise up to the division marked "Storm," and the wind in such cyclonic systems is always high, especially in their rear. In the winter the top of the precipitate is nearly always up in the division marked "Change," and as the weather is eternally changing, I suppose it may be considered about right. On the contrary, a decided anti-cyclone may in summer bring cool weather; and the precipitate will rise up into the division marked "Storm," accompanied by the clearest skies and delightful breezes. It is also common for rains to pass over without any material changes in temperature. In such cases the height of the precipitate will remain unchanged. The indications of the instrument are then sometimes right, sometimes wrong, like the negro's dumb watch, which was always right twice a day, but, as it gave no indications of the time when it was right, it was not worth much as a practical instrument.

## MIND.

THE Rev. S. J. Jerram delivered an able and interesting lecture at Ealing a week ago on "Mind," in which an approximately accurate view of the relations of mind with brain function was lucidly expounded. It is satisfactory to note the advance of a theologian towards science. We do not affirm that Mr. Jerram has shaken himself entirely free from the trammels of his professional habit of thought on these subjects, but his position is one which holds out an excellent promise of further progress. He is not prepared to say that "the mind *is* the brain," nor is any scientist prepared to make such an assertion; but he recognises the fact that physiological, as distinguished from purely metaphysical, inquiries are likely to play the most important part in elucidating the mystery of mental phenomena, and he has arrived at the perception that "no state of mind and no change in a state takes place without an act of cerebration;" at the same time making the necessary allowance for the possibility that the consciousness may hereafter be found to be located in the periphery as well as the centre of the nervous system, or diffused through the body as a whole. It is not necessary to point out to the scientific reader that these formulations of thought show a deeper insight into the subject than is common among those who study it from the ouside standpoint. The weakest part of Mr. Jerram's argument is that in which he strives to harmonise Locke's hypothesis that the mind at birth is as a blank sheet of paper, upon which anything may be written, with the doctrine of heredity; and in which, of course, he is compelled to assume the undemonstrable proposition, and, as we believe, the untenable position, that ideas are something else than the products of ideation, and that in some unexplained way *intuition* bridges over the chasm between primal agnosticism and consciousness. The logical process to which Mr. Jerram commits himself obviously necessitates that he should regard the physical organ of the mind as comparable with the cylinder of a phonograph upon which certain marks are impressed; in fact, as an organic or organised record of ideational impressions which forms part of its constitution, and is as much part of the inheritance as the matter itself. When any species of organised matter reproduces its kind, the form in which it is cast is as much part of the inheritance as the matter itself, and it is on this form character and quality depend. An educated cell brings forth as its progeny educated cells; and the education thus reproduced —"in its likeness," or "in his kind"—is something more than mere capacity for function: it is the recorded *result* of function. In this way an evil tree brings forth evil seed. Vice, or, as Mr.

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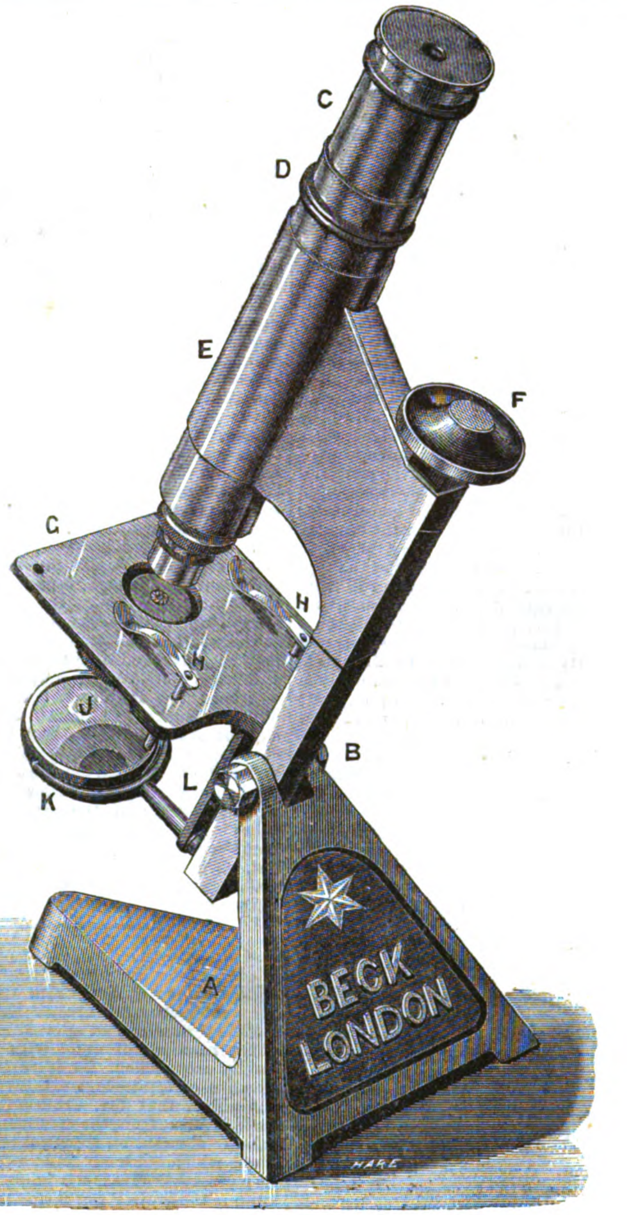
[*] By H. HELM CLAYTON, in the *American Meteorological Journal.*

[†] The first improvement was, I believe, made by Admiral Fitzroy.

[‡] Other ingredients besides camphor, I believe, are now included. I find it stated that two parts camphor, one part nitrate of potash, and one part salammoniac are put into the alcohol, and a little water added.

[*] I exposed an instrument for fifteen minutes to an electrical machine charged to high potential, and no change whatever took place in the height of the column in the tube.

[†] In order to make it dissolve rapidly, it is well to shake it up before putting it in water.



Jerram would say, *sinfulness*, is actually transmitted; not merely the possibility or probability of sinning, though these are implied. Mr. Jerram has gone so far that he must needs go somewhat further. Meantime we heartily endorse his conclusion: that which "metaphysics" represents, albeit the term has no precise significance, "the philosophy of mind as distinguished from that of matter......eventually comes to facts, the nature of which has not hitherto been solved, as all sciences of observation must do; but so long as it does not dogmatise, no danger is to be feared; and when it has reached the point beyond which it cannot go, that for the time is the true system of psychology, and we must patiently wait till further inquiries open out a more extensive field of knowledge.—*Lancet.*

## BECK'S "STAR" MICROSCOPE.*

IN the construction of this microscope Messrs. Beck appear to have reduced the cost of an efficient instrument to its very lowest limits, £3 3s. only being charged for it, including a 1in. and ¼in. objective, which, it is claimed, "are accurately worked, purely achromatic, and thoroughly suited for scientific research."

The microscope is nickel-plated throughout, with the exception of the case, which is solid in design, and contrived so that the instrument is steady in every position. It is made in two forms, with a sliding or a rack-and-pinion coarse adjustment.

The foundation of the stand is a solid cast-iron base, A, having at its top a hinge joint, B, which allows the instrument to be inclined at any angle, and is sufficiently firm to permit of its being placed horizontal for use with Wollaston's camera lucida. The body, D, has a draw-tube, C, with coarse and fine adjustments at N and F. The stage G has two springs, H H, the pins attached to which may be inserted in any of the four holes on the stage, and by their pressure (which can be varied by pushing them more or less down) will hold the object under them or allow it to be moved about with the greatest accuracy. The mirror J, besides swinging in the rotating semicircle K, is attached to a bar, L, with a joint at each end allowing a lateral movement, so as to throw oblique light on the object. An iris diaphragm, M, in which the size of the aperture is varied by revolving it in its fitting, screws into the under surface of the stage, and can be removed when other substage apparatus is required.

## PURE BUTTER.

IN Messrs. J. W. Queen and Co.'s *Microscopical Bulletin* for June, we find a brief account of some experiments with Dr. T. Taylor's method of discriminating between butter and its substitutes, made by Mr. J. B. Betts, of Philadelphia. We gave some notes in connection with this matter on p. 392, and Mr. Betts says:—

Some months ago the *Microscopical Bulletin* noticed the publication of a pamphlet by the Department of Agriculture, entitled "Analysis of Butter and Fats, by Thos. Taylor, M.D., Microscopist." Thinking it might be of interest, I sent for it at once, and must return thanks to the *Bulletin* for having put me on the track of this interesting matter. Having secured the information from the pamphlet of how to detect the presence of adulterations in butter, the next thing was to prove the work to my own satisfaction. To find the characteristic result promised for pure butter, I vainly tried samples of "Pure Creamery Butter" from the first-class groceries of our city, but somehow I could not get the result promised—even, strange to say, they all showed the unmistakable mark of admixture. It may be well here to quote the words of Mr. Taylor: "The test is a very simple one. If a few drops of sulphuric acid be combined with a small quantity of pure butter, the butter will assume first an opaque whitish-yellow colour, and after the lapse of about ten minutes it will change to a brick red. Oleomargarine made of beef fat, when treated in the same manner changes at first to a clear amber, and after a lapse of about twenty minutes, to a deep crimson."

In order to satisfy myself, I was fortunate enough to secure some butter made under my own eye, by the old-fashioned method of beating pure cream in a bowl. With this as a prime prover, I obtained the promised result, both when fresh and after several days. (In fact, the rancidity from age did not in any way affect the test.) But, to my amazement, all the samples afterwards showed clearly that some other fat was present; some were part butter, in which case the two fats separate themselves in the dish, the butter forming the centre, and the other fats forming a ring of dark crimson surrounding it, with a greenish cast if any preparation of lard enters in the mixture. The action of cotton-seed oil I am not able to state certainly, but believe it to have a peculiar granulation, which I intend to prove by mixture and test. There is a difficulty arises in examinations of this character which must be borne in mind by any one inclined to test his table butter, that it is almost impossible to buy butter after it becomes known that the test is being made, the buttersellers seeming to have a great lack of confidence in the test. It is the intention of Mr. De La Cour and myself to give a public exhibition of the tests before the Microscopical Society of Camden at an early meeting and *invite samples* from dealers, but we have no fear of our powers being overtaxed by the number presented. The peculiar crystallisation of the various fats in cooling is another easy method of detection, but a description thereof would be too lengthy for the time at my disposal.

## PAPER NEGATIVES.*

ONE of the questions at present, and for some time past, exercising the photographic mind is that of a substitute for glass for landscape work—a substitute which, while giving all the good qualities and offering all the conveniences of glass, shall be free from the serious objections of weight, bulk, and fragility of that substance. Despite many years of patient search in that direction, we seem now as far off the goal—a *perfect* substitute—as ever; and photographers have recently shown a tendency to accept the sort of compromise which paper as a support offers them. Numerous have been the processes, some patented, devised for the purpose of rendering paper translucent or transparent, and depriving it of its "grain"; many also have been the attempts to introduce a flexible and transparent film-substitute, composed of collodion, celluloid, guttapercha, and other materials, but no great success has attended such efforts, owing mainly to the great expense of the material and the trouble involved in its use. Paper, however, even of good quality, is a comparatively cheap material, and if it can be utilised with advantage, so far as quality of result and facility of manipulation are concerned, many a tourist will rest content to put up with such minor inconveniences as the longer time required in printing.

Notwithstanding the vast amount of attention that has been given to the subject of paper for negative purposes from the very earliest days of photography, it is probably the case that many modern experimenters have entirely failed to grasp fully the requirements of the paper negative process of to-day. In the days of Calotype and waxed-paper processes, the sensitive silver salts were formed in the body of the paper; hence, in order to obtain an image as free as possible from "grain" caused by the texture of the paper, it was absolutely necessary that the latter be perfectly homogeneous in its internal character, as well as smoothed and polished on its exterior surface. It was in the combination of these qualities that the old "Causon" and "Turner" papers excelled all others, and gained such a reputation for the special purposes referred to.

In order to explain the action of a coarse-grained paper in giving granularity to the image, we will digress for a moment. Suppose, for instance, a (theoretically) perfectly homogeneous paper is saturated with, say, potassium bromide, and afterwards floated on silver nitrate. Silver bromide will be formed in the body of the paper in a state of uniform division—that is to say, will be evenly intermixed in the minutest particles with the almost grainless pulp of the paper support. Consequent upon development a correspondingly grainless image will be the result.

If, on the other hand, a coarse-grained paper be used, or one which shows the "mesh" distinctly, we shall have the potassium bromide unevenly absorbed, the "pores" or interstices of the paper holding more than the coarse particles of solid pulp. Consequently we have the silver bromide formed in a coarser or less uniform state of division. From this it may be seen that it is not the grain of the paper *directly* which causes the granularity so often found in the image, but really the uneven distribution of the sensitive salt which the granularity of the paper causes. In fact, a structureless negative (on glass), printed through a sheet of paper of moderately even texture, will show far less granularity than would a paper negative made upon the same kind of paper.

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* *Journal* Royal Microscopical Society.

* From the *British Journal of Photography.*

Arguing from this, it would appear that when an emulsion is applied to the surface of the paper only that the difficulty of securing freedom from granularity is overcome, and such, no doubt in the abstract, really is the case. But it is just here where experimentalists, and perhaps manufacturers, fail to recognise what is required. Thus, given a paper of fine and even structure and smooth surface nothing would appear easier than to apply a layer of structureless collodion or gelatine emulsion, and, as a result, to secure a grainless and perfect image on development. But practically, and in the absence of precautions, the matter is not so easy. The pulp from which the paper is made may be of the finest, and structurally the paper itself may be beyond reproach. Fine, however, as may be the internal composition of the paper, its surface, when first made, is, as most of our readers are aware, decidedly rough, this roughness being subsequently removed by "calendering," or by the combined application of heat and pressure, which produces a surface of almost any degree of fineness and even gloss.

This artificial surface disappears, more or less, under the influence of moisture; consequently it can easily be seen how, upon the application of a warm gelatine emulsion to such a paper, the surface swells and partially resumes its original rough character, and, practically, a *cast* is formed in gelatine emulsion, of which the uneven paper surface is the matrix. Here it is quite possible that the paper itself, when dry, may be so entirely free from apparent structure as to show not the slightest grain when printed through, and yet the negative image, if stripped and printed, will give most emphatic evidence of a paper grain. For positive work this matter is not of such high importance as in the case of negative paper, because a comparatively thin image is viewed by reflection; whereas the value of a negative depends upon its varying power of arresting and transmitting light, and each difference in the thickness of the film produces an effect identical with that of an increased deposition of silver by the developer.

What is really wanted is a careful preparation of the surface of paper intended for negative work with an isolating medium, which shall prevent the fibres of the paper from swelling under the warm emulsion. After that, the production of a homogeneous deposit of silver follows as a matter of course, and the tendency to granularity arising directly from the structure of the paper remains the only trouble to be combated.

We have made these remarks in consequence of having recently seen many negatives taken upon unsuitable paper—unsuitable, that is to say, for negative work, though quite adapted to positive printing—while we are aware that it is quite possible to produce prints from paper negatives, which will defy the keenest scrutiny to distinguish them from prints from glass negatives. It is, we believe, but a question of a very short time before we shall find paper negatives firmly established amongst us for many purposes; a few prejudices have to be overcome, and a few mechanical and manipulatory details arranged, and then glass for landscape work will find a powerful rival in the field.

## A FAST STEAM-YACHT.

THE *Mechanical Engineer* describes the *Stiletto*, a steam yacht built by the Herreshoff Company, and claims that this craft is the fastest afloat. She is 95ft. long over all, by 11ft. beam, and 7ft. 9in. depth of hold. Her model is peculiar, and all that we can say about it is what the Herreshoff Company wish to make public; her bow lines are nearly straight, and she is sharp at both ends, with a round bottom; proportion of beam to length $8\frac{6}{11}$ths. The engine is of the Herreshoff pattern with 12in. and 21in. cylinders by 12in. stroke, driving a 4ft. screw with 6ft. 6in. pitch. The engines can drive this 450 revolutions per minute, if required. The boilers are of the Herreshoff pattern, and to those unacquainted with them need a brief description. They are "pipe boilers" so called, and are made in sections like steam radiators. These sections are disposed over and around the furnace, and any one of them can be quickly detached, in case of need, for repairs. The water is fed in at the top and is converted into steam in its passage down, and emerges into a stand-pipe or separator at one side of the sections; from this it goes to the engines. The advantages of this system are great lightness and efficiency. The whole boiler is heating surface, and being without a shell is capable of carrying very high pressure. The *Stiletto* works under 150lb., that being sufficient to attain great speed, but we presume the boilers would stand 200lb. just as well. Our readers at a distance may be interested in knowing that Mr. John B. Herreshoff, the principal of the Herreshoff Company, is totally blind, and has modelled all his vessels by the sense of touch alone; he has literally felt the lines out. The fastest vessel that swims to-day, irrespective of size, is doubtless the steam yacht *Stiletto*. She recently ran from this city to Sing Sing on the Hudson, 30 miles by the chart, in 77min. from the start. This is an average of 23·7 miles per hour, but is not an expression of her highest velocity, for she was not put to speed from the start, but ran some miles under easy steam. The *Stiletto* outran on this occasion the *Mary Powell*, hitherto the fastest boat on the river, beating her with ease. The *Mary Powell* was fully alive to the occasion, and did her best, but that was not enough. The *Stiletto* has achieved by this adventure a wide notoriety. In closing, we may give the secret—if it may be so called—of the *Stiletto*'s great speed. This results from her lightness, great engine-power, and fine lines; but the first two qualities are paramount. She weighs only 28 tons and develops 450-h.p., having 16-h.p. per ton of displacement. This, as all engineers and constructors know, is simply tremendous in its possibilities. The *Stirling Castle*, the fastest merchant vessel afloat, has only 3 to $3\frac{1}{2}$-h.p., per ton of displacement, while ocean steamers generally have only from 1 to 2-h.p. per ton of displacement.

# SCIENTIFIC SOCIETIES.

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## ROYAL MICROSCOPICAL SOCIETY.

MEETING of June 10th, 1885, at King's College, Strand, W.C., the President (the Rev. Dr. Dallinger, F.R.S.) in the chair.

Mr. Suffolk exhibited a collecting bottle with flat sides, which had been ground and polished. Everyone must have found the inconvenience of the ordinary round bottles, through which it was impossible to see anything clearly, and therefore would welcome one which had flat sides worked to a true surface, through which an ordinary objective could be focussed and would give perfect definition. The bottles were made by Mr. Stanley.

Prof. Bell said that flat bottles had been made for some time, but they were not to be had except from foreign makers. He believed that some had been used at the College of Surgeons; but the glass was very bad, and their use had in consequence been discontinued. Round bottles were very inconvenient, and he hoped that as an English maker had taken up the matter, they might be able to get flat ones of different sizes.

Prof. Stewart said they had almost ceased to use these bottles at the College of Surgeons, because the sides were so rough and the tops so far from flat as to be of very little value. The first samples were very much better, but the later ones were so bad as to be practically useless.

Prof. Stewart called attention to a specimen he exhibited under the microscope, showing the special eyes of chitonidæ described by Prof. Moseley. He also showed a model of the species of *Chiton*; but having found at the College of Surgeons a better specimen than the one from which Prof. Moseley's model had been made, he had brought it to the meeting. A section showed that the shell was raised into numerous corneal elevations, beneath which it was tunnelled out in a very distinct manner. Behind the elevation was a substance like a lens, and below this a space caverned out, at the lower end of which was a series of rods, from which a number of filaments proceeded, together with some pigmented matter forming a sort of choroid coat, a part of which projected forwards, forming an iris. The optic nerves proceeded directly upwards, so that there was no turning over as in the eyes of the pectens. In addition to the specimens exhibited, Prof. Stewart illustrated his remarks by drawings on the black board.

Prof. Bell said that he thought the Society should know something of the kind of work which was being done by Mr. Hill, who had been assisting Prof. Moseley, and had made the model exhibited. Whatever the general opinion of models might be, those who had any experience could speak as to their great use for purposes of illustration in class instruction.

Mr. Wright's letter with reference to Dr. Anthony's criticism on his note on the structure of the tongue of the blow-fly was read as follows:—The February number of the *Journal* of the Royal Microscopical Society is only just to hand. At page 174 I note Dr. Anthony's letter read at the January meeting of the Society as to my observation on the structure of the tongue of the blow-fly. I have looked up his paper on "The Suctorial Organs of the Blow-fly" in the June number of the *Monthly Microscopical Journal* for 1874, and I at once disclaim any previous knowledge of it. I can only now regret that it was unknown to me, as I should have certainly given all the credit to Dr. Anthony for the discovery of the "suctorial organs," which he so well earned by the long and arduous work he bestowed on this subject during the whole of a blow-fly "season." After speaking of his numerous dissections, he says: "Many a hundred coaxings were necessary to get the parts into definite positions ere I could satisfy myself of the arrangement of what I will venture to call the 'suckers' attached to the pseudo-tracheæ of diptera." These suckers he likens to "earlike appendages," "mouse ears," or "bats ears." Before I sent the slide of the proboscis in September last, I consulted all the most recent standard works on the microscope, as well as Mr. B. T. Lownes's "Anatomy and Physiology of the Blow-fly," and I could not glean any information that the details of structure described in my letter had been observed. This description was only such as would suggest itself to anyone conversant with anatomy. I hope I may be permitted to make this explanation, so as to show that Dr. Anthony's charge that I have plagiarised, although not wilfully, must fall to the ground, and that it was, in fact, as he suggests, a "re-discovery." I wish to call attention to the fact that the proboscis of the blow-fly, as prepared and mounted by Mr. Sharp, requires no dissections or coaxings to display the leaf-like processes or "suckers" *in situ*. Under a sufficiently high power they, at the first glance, arrest the observer's attention—their visibility being entirely due to the mode of preparation, and to the highly-refractive fluid in which the object is mounted. I find with a $\frac{2}{3}$ Tolles of 65°, or a $\frac{1}{4}$in. of 90° (made 25 years ago by the late Andrew Ross), the "suckers" can be distinctly seen, although not with equal brilliancy to the performance of my Tolles's $\frac{1}{10}$ immersion lens. When viewed with the latter, each of the "suckers" appears as an actual protrusion of the lining membrane of the pseudo-trachea through a corresponding forked opening of the chitinous ring, and its expansion forms the leaf-like process or "sucker"; each of these has a longitudinal slit or fissure extending from the base to the apex. In some of the suckers the slit is seen with the margins in close contact, in others it is more or less widely open, and they all, on each pseudo-trachea, communicate with a central undulating channel running its whole length. The elasticity of the chitinous rings does not satisfactorily explain the way the suckers act. The opening and closing of the slit is most likely effected by some inherent contractile power in the sucker itself, which probably is under the control of the insect's will. In the imbibition of fluids, capillary attraction must also play a very important part; and it seems possible that the so-called "suckers" may maintain a regulating action in this respect, and thus prevent what would be an injurious or even fatal absorption. I think if Dr. Anthony will examine a proboscis mounted by Mr. Sharp's method, he will candidly admit that his illustrations need something more than "small alterations and corrections" to bring them "up to date." As no allusion to his paper was made by any of the members present at the November meeting of the Society, the inference is that, with the exception of those to whom Dr. Anthony has personally shown his preparations and dissections, the "suctorial organs" up to that time were generally unknown. I used the term "endoderm" in the same way Mr. B. T. Lownes has done in his work on the "Anatomy and Physiology of the Blow-fly," to indicate "the innermost cuticular layer of the integument." It is likely that the "suckers" consist of the three layers of the integument; certainly they have an outer layer of the protoderm, which Mr. Lownes thus describes ("Anatomy and Physiology of the Blow-fly," p. 9) as "transparent and continuous over the whole surface of the insect, investing all the appendages and processes of the skin, even the hairs, and covering the surface of the eyes. It appears to be continuous with the lining membrane of the tracheal system, and to extend throughout the digestive cavity, even although it is somewhat modified in the latter." I beg to send a slide of the Blow-fly proboscis (mounted by Mr. Sharp) showing the "suctorial organs," as a donation to the Society's cabinet. Mr. Sharp also sends for publication his method of preparation and mounting in the biniodide of mercury solution.

The president said Mr. Wright's communication placed the matter in a somewhat different light, and gave them additional information.

Mr. Suffolk said he had examined Mr. Wright's first specimen, and he had also made a similar specimen of his own; but the conclusion he came to was that the appearances described were due to some sort of diffractive effect, and that they were, in fact, out-of-focus appearances.

Mr. J. Mayall, jun., called attention to the fact that a Nobert 19-band test-plate had been successfully mounted in Prof. Hamilton Smith's medium, having a refractive index of 2·4, the result being to render the lines very much more visible than had been the case before. The preparation was made by Dr. Van Heurck, and was attended with considerable difficulty. He now thought it possible to improve upon the photo-micrographs of the 19-band test-plate made by the late Dr. Woodward, of Washington, for the lines being mounted in the highly refractive medium could be illuminated by immersion means, so that an objective of higher aperture than any employed by Dr. Woodward could be used to resolve them. He hoped to try some experiments in photographing this test-plate by means of Powell and Lealand's new homogeneous immersion of $\frac{1}{12}$th of 1·5 N.A.

Mr. Crisp said that they had received from Prof. W. A. Rogers, of Cambridge, U.S.A., a collection of upwards of 60 slides, showing the action of a diamond in ruling lines upon glass. The series was accompanied by a descriptive paper which, when printed in the *Journal*, would enable the Fellows to compare it with the slides.

The president said that Prof. Rogers had expressed the hope that someone might feel sufficiently interested in the subject to make a careful study of the slides. They had not yet had any opportunity either of examining the slides or reading the paper, but their best thanks were due to Prof. Rogers for his valuable donation.

A vote of thanks to Prof. Rogers was carried by acclamation.

Mr. Crisp, in exhibiting Theiler's "Universal Pocket Microscope," read some of the press notices of it, and commented on the extravagant manner in which it had been referred to in some journals.

Dr. Maddox said that since the last meeting he had continued his experiments on the feeding of insects with bacilli, and had fed both the wasp and the blow-fly, formerly alluded to, with the Anthrax bacillus. They had lived on through the month until that very hot day when the thermometer rose to 136° in the sun, when they succumbed to what he believed was heat asphyxia, so that he was unable to attribute their deaths to any effect of the bacilli.

Mr. Waters read his paper on "The Use of the Avicularian Mandible in Classification," the subject being illustrated by drawings.

Mr. Cheshire described a method of mounting, which he had found of great advantage with the particular class of preparations with which he had lately been engaged, and he proposed to give some account of it as likely to be of interest to others similarly working. All present were, no doubt, aware, of the great value of glycerine as a mounting medium for delicate structures, Canada balsam being destructive to soft tissues and cells. Glycerine also possessed a marvellous immunity from freezing. The great difficulty about its use for mounting purposes generally arose from the fact that when once the surface of glass had been contaminated with glycerine it was very troublesome to get rid of. The reason of this was that the surface of glass, however well polished, was not mathematically true, the most highly-polished surface having its surface covered with very fine lines, and these not all running in the same direction. In fact, if marks were made upon a piece of glass with glycerine or turpentine, the traces of them could be distinctly seen after the glass had been well rubbed. The first thing, therefore, to do was to get a perfectly clean slip, and having put it upon the turntable, to make a ring of Canada Balsam dissolved in benzole. The next thing was to get a perfectly clean cover-glass, and in order to hold this conveniently he had found it an excellent plan to mould a small piece of bees'-wax into a semicircular form, having about the diameter of the cover, which, if slightly pressed upon the upper side of the cover, adhered to it sufficiently to form a kind of handle by which it could be lifted; and if it were turned upside down, it would stand upon the corner of the table until it was wanted for use. A ring of the balsam was then put upon the under side of the cover glass of the same size as that upon the glass slip. The next step was to select the object, and he had found that the most convenient things in which to keep stained objects were the small china saucers, which were to be bought at the artists' colour shops. They were much better than watch glasses. He then took up a small drop of glycerine, and put it in the ring of balsam which had been made on the slide (and for this purpose he had found nothing better than the ivory handle of a small dissecting knife), and then the object was placed on the slide. In doing this he had found nothing so useful as a watchmaker's eyeglass, and to save the inconvenience of having to take it up every time it was wanted he had it fastened round his head with a piece of elastic web, and when not in use it was pushed up upon the forehead. Having placed the object on the slide in proper position, it was well to remove all superfluous glycerine, and the best way to do this was with a small sable brush, sucking off the fluid when the brush was full. Another drop of glycerine was then put upon the under side of the cover glass, which was then placed in position on slide, the two rings of balsam were slightly pressed together, they adhered immediately, and the thing was done. A small amount of practice would enable anyone to judge exactly how much glycerine was required to fill the space; but if it happened that too much had been used it would force a small channel for itself and squeeze out through the balsam, which would afterwards close together again quite tightly. The only thing remaining to be done was to put on a coating of Hollis's glue to prevent the balsam from setting, and by adopting this system it would be found that the cover could be pressed down just as much as was required. The usual process was to mess the glass with glycerin first and then, of course, the cement would not adhere properly, and the result was leakage. Mr. Cheshire further illustrated his meaning by drawings upon the black-board, and by the exhibition of specimens, which were handed round for inspection.

Mr. J. W. Groves said that Mr. Cheshire's first statement was that delicate structures and cells could not be seen in balsam-mounted specimens; this, however, he was prepared to deny, knowing from experience that there was no difficulty in the matter. With regard to Mr. Cheshire's suggestion of sticking the clean cover on a piece of wax and letting it remain with the under side upwards until wanted, he could only say that if a cover was left like that in his laboratory for even two or three minutes, it would get so coated with dust as to need cleaning again before it could be used. The plan of cleaning up the excess of glycerine by means of a brush was the one he usually adopted. With regard to putting two rings of balsam, there were, he thought, other things which would do better, and he should suggest Miller's cement instead, if there was no glycerine upon the slide; and instead of putting glycerine on the under side of the cover, a better plan was simply to breathe on the cover—it answered quite as well, and was much less trouble. In using a watchmaker's eyeglass, a far more convenient way was to have it mounted upon a piece of light spring wire fixed in a heavy block as a stand; it was then very easy to bend it over the object, and apply the eye when required, and the moment the head was moved away it sprang on one side, without any attention being required by the worker.

Mr. Cheshire said that notwithstanding the remarks of the last speaker, he must still persist in stating that there were some structures which were absolutely destroyed by mounting in Canada balsam. For instance, there was a certain part of the dorsal vessel which contained cells which could not possibly be mounted in balsam without destruction. Certainly if any one could so mount them without, he should be very glad to see them.

Mr. Groves said he would willingly accept the challenge, the results to be shown in that room.

Mr. Cheshire said that the proposal to breathe upon the cover-glass was just undoing the thing he had been advocating, and as regarded the difficulty of keeping the cover-glass clean, if mounting was done in such dusty places the cover might be placed with the underside downwards if necessary.

The President said they were very much obliged to Mr. Cheshire for his remarks. There were doubtless some amongst them who would derive useful hints from the communication. They would also be much interested in seeing the results of the mounting in balsam, concerning which the challenge had been accepted.

Prof. M. N Dutt's letter was read, accompanying some unknown powdery substance found near Delhi.

"My method of mounting the proboscis of blowfly in solution of bin. mercury is as follows:—Apparatus necessary, two pieces cut from a glass slip, 1in. long by ¼in. wide, a weak spring clip, and a wide-mouthed bottle containing methylated spirit. Kill the fly by dropping it into boiling-water, cut off the head, place it on one of the bits of glass, squeeze with finger till tongue protrudes and lobes expand; then gently nip with the other bit of glass and put on weak clip to hold in position; place the whole in the methylated spirit, and leave there for an hour or more. On releasing the proboscis from the glasses, the lobes will remain expanded: cut off the proboscis and place in spirit till all the air is removed. Then place in water for half-an-hour, then in weak solution of biniod. mercury (half water and half saturated solution) for two or three hours, then in the full strength solution for twelve hours. When the proboscis is put in the weak mercury solution, it will most likely curl up (the lobes), to prevent which, I place it on a slide when taken from the water, and put on a cover with a weak clip to hold it in position, and then run the weak solution of mercury under the cover, and do the same when transferring from the weak solution to the full strength solution. Mount in shellac cell, and use shellac for securing the cover. I find it safer to use for the final mounting, a solution of the biniod. mercury slightly weaker than saturation, as if full strength, crystals will develop in very cold weather."

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**Benzol Magnesia.**—German journals allude to the efficacy of "benzol magnesia" as a grease eradicator. It is prepared by saturating calcined magnesia with benzol. A little of this powder rubbed on a greasy stain on paper, or any fabric, will remove it; but old stains may require a repetition of the process. The mixture is said to be excellent for cleaning windows.

## SCIENTIFIC NEWS.

THE *Building News* directs especial attention to a valuable report on a new economical and fireproof cement by Mr. G. H. Hunt (Verity and Hunt), which it publishes in its last issue. The cement is made by Messrs. Joseph Robinson and Co., of Knothill, near Carlisle, and is equal in every respect to Keene's, Parian, and other high-class cements, used in the best work, while its cost will admit of its employment instead of the ordinary lime, sand, and hair plaster, which at present has to be put up with where expense is an object to be avoided. The new cement is fireproof, very hard and strong; it takes paint well at once, and can be used at any time of the year, or in any weather; and can, if desired, be brought up to a splendid polish. Capt. Shaw, the chief of the London Fire Brigade, believes "it would be more effectual in preventing the spread of fire than any other of the common plasters or cements generally used," and his opinion is not lightly formed. The cement has found favour wherever used, and seems likely to create considerable stir in the building trade.

Although he had reached the seventy-eighth year of his age, many will hear with regret of the death of James Kitson, of Leeds, an English mechanic of the first rank. Commencing life as a student of the Mechanics' Institute, in Leeds, he rapidly rose in his profession, and soon made a name for himself as a builder of locomotives when railways came into vogue—a reputation which has clung to the firm ever since. Mr. Kitson, when he ceased to be a pupil of the Mechanics' Institute, filled several of its offices in turn, and ultimately became its president. Mr. James Kitson was, in fact, a scientific mechanic, and a commercial and public man, whose influence in Leeds was deservedly very great. Many will hear with regret that his long and useful life has ended.

M. G. Witz, of Rouen, died recently at the early age of forty-eight. He was a conspicuous member of the Industrial Society of his native town, and was a notable contributor to the progress of chemistry. We mentioned in this column recently his observations on the presence of ozone in the atmosphere of Paris during the cholera epidemic, but his most important work is probably that in connection with the chemistry of cellulose.

The death is also announced of the venerable and distinguished Swedish physicist, Prof. A. W. Eklund, at the age of ninety years.

Small planets are now becoming so numerous that the announcement of the discovery of a new one is wisely delayed until its novelty can be verified. It appears that Dr. G. Palisa, of Vienna, discovered No. 248 early last month, which increases his list to forty-seven.

M. F. Folie, of the University of Liège, has been appointed director of the Royal Observatory, Brussels.

Mr. Bosworth Smith has been appointed mineralogist for the Madras Presidency, and has been specially requested to compile a complete index to the mineral wealth of the presidency, and to commence, in consultation with other officers, a mineralogical survey.

At a recent meeting of the North of England Institute of Mining and Mechanical Engineers in Newcastle-on-Tyne, Mr. T. W. Bunning read a report on experiments made at Saarbrücken on the influence of coal-dust in explosions. Mr. Galloway, who was present at some of these experiments, stated that if the coal-dust were removed from the vicinity of the shot-holes, or kept watered for a space of six yards, the risk of explosion was removed.

The 53rd annual exhibition of the Royal Cornwall Polytechnic Society will be opened on Tuesday, Sept. 22nd. Medals and prizes are offered in mechanics, naval architecture, chemistry, and electricity, fine arts, photography, and natural history, and there are competitions with prizes in maps and essays (Lander competition), art needlework, and British lace. Full particulars can be obtained from Mr. E. Kitto, F.R.Met.Soc., Secretary, Polytechnic Hall, Falmouth.

The first section of the Barrow-in-Furness tramways was inspected by the representative of the Board of Trade last week, and will shortly be in full work. The line runs from a point near Furness Abbey to Roose, and has a total length of about four miles. The gauge is 4ft.; the rails were manufactured by the Barrow Steel Co., and weigh 84lb. to the yard. The locomotives are being made by Messrs. Kitson, Leeds. The line is a single one, with passing-places three chains long at intervals of a quarter of a mile.

At the beginning of the next college year, in the autumn of 1885, Professor Thurston, formerly of the Stevens Institute of Technology, will assume the position of "Director" or presiding officer of Sibley College, Cornell University, Ithaca, New York State, and will undertake the duties assigned him by the trustees of the University, of recommending a revised course of instruction in mechanical engineering and of tuition in the mechanical arts. Sibley College was erected by the Hon. Hiram Sibley, of Rochester, New York, and will be devoted to this department of instruction. Its recent additions, in the form of enlarged buildings, added tools, and new collections of apparatus, make it an exceedingly well-equipped school; and it is stated that the trustees have declared an intention of doing all in their power to make it the equal of any such school now existing, and to give it every really desirable facility for its work. With the enormous wealth of Cornell University under their control, that will probably be easily within their power.

The Darwin Medal for 1885—founded by the Midland Union of Scientific Societies—has been awarded to Mr. W. J. Harrison, F.G.S., Science Demonstrator for the Birmingham School Board, for his original researches in connection with the geology of the Midlands.

On Sunday, June 28, an important portion of new railway was opened at Market Harborough. The whole of the Midland main line traffic has ever since 1857 passed over about a mile of the London and North-Western Railway, and great delays have been caused to important traffic. On the above date two new lines were opened, perfectly distinct, and the Harborough and Great Bowden junctions removed.

At the meeting of the San Francisco Microscopical Society on June 10, a living book-worm, taken from an old Bible in Hebrew, belonging to the Sutro collection, was shown under the microscope and referred to Mr. Wickson for identification. The consideration of the subject announced for the evening "Pathogenic Bacilli," having to be deferred until the following meeting, Mr. Banks gave an interesting demonstration of the electric light in its relation to microscopy. He first showed a miniature incandescent loop lamp, actuated by a sulphuric acid and sulphate of mercury battery. For purposes of microscopical illumination, the incandescent electric light possesses the great advantages of extreme whiteness and intensity. With regard to the batteries actuating these lamps, there are still some difficulties to be overcome, but there can be scarcely a doubt that it is a question of only a short time when, with increased steadiness, duration of action, and cheapness of battery power, the electric light will be superior to all other methods of artificial illumination for microscopical and microphotographic purposes. Mr. Banks also showed, under the society's largest microscope, the electric spark in its passage between the terminals of a ¼in. spark induction coil, attached to a Grenet bichromate solution battery. Two vulcanite slides had been prepared, on which were fastened adjustable platinum strips connected with the battery wires, and terminating in brushes of platinum wire of extreme tenuity. The electric fluid, in its passage from one terminal to the other, formed a very attractive object under the microscope. One of the slides was used to show the effect on the electric spark, of interposing films of soot of different thicknesses. In its passage through these the current was deflected into meandering lines, around which scintillated showers of sparks. The particles of soot could be seen arranging themselves in symmetrical groupings around the terminals. In conclusion, Mr. Banks announced that he had sent for, and would soon be able to exhibit the Stokes-Watson apparatus for showing under the microscope the combustion of various metals in the electric arc. Their characteristic spectra can also thus be shown by the micro-spectroscope.

Mr. J. A. Youl says that there is now no doubt that the true *Salmo salar* has been successfully introduced to Tasmania, his last shipment of ova having arrived in excellent condition. An Australian paper says: "Out of 200,000 salmon ova, arived per *Yeoman*, 40,000 are now ascertained to be alive. Three hundred have already been hatched. A preserved specimen from which the ova was taken, and which has been sent out, and is now in the museum, indicates that the same fish which have been caught here are genuine salmon, after all."

At Nuremberg, on the 15th inst., an exhibition of machinery for the production of motive power will be opened, and continued until the 30th of Septemper. The chief object of this exhibition is to introduce labour-saving machines for small workshops.

On the authority of Sir Henry James, the late Attorney-General, we learn that misconception has arisen as to the inclusion of more than one invention in the same patent. The late Solicitor-General and himself have issued regulations, the effect of which is that the rules as to the inclusion of more than one invention remain as they were before the new Act was passed.

An abstract of the results of the experiments by Dr. Tidy and Prof. J. Dewar, carried out at Aylesbury with the A B C process of treating sewage, shows (1) That the A B C process produces a clear effluent free from suspended matter and devoid of smell; (2) that the effluent is uniform, notwithstanding the very varied nature and concentration of the sewage; (3) that as the strength of the sewage increases, the precipitation is more complete; (4) that the process removes over 80 per cent. of the total oxidisable organic matter; (5) that it precipitates 60 per cent. of the organic matter in solution, and of the residue left in the effluent at least two-thirds is non-albuminous, and therefore of a nature less liable to putrefactive and other changes; (6) that the process is carried on without nuisance, the sewage being immediately and completely deodorised, and the entire works free from any objectionable smell; and (7) that it produces a manure containing an average of 3·8 per cent. of ammonia calculated on the perfectly dry manure, or if with 20 per cent. of water 3 per cent. of available ammonia, and also 5 per cent. of phosphates reckoned as tricalcic phosphate of lime.

It will be remembered that the proceeds of the lectures delivered by Prof. Tyndall in the United States during 1872 were handed to trustees, with the view that the money should be devoted to the sustentation of science fellowships; but a difficulty arose, and the money having been invested, now amounts to about £6,500. At the suggestion of the trustees, Prof. Tyndall has directed that the fund shall be equally divided between Columbia, Harvard, and Pennsylvania universities.

**The Institution of Permanent-way Inspectors.**—At the general summer meeting held on Saturday week, the following persons were elected:—As members: Messrs. S. W. Jones, East Indian, Bengal, India; J. Richards, L. and S.W., Basingstoke; J. Pilling, Cheshire lines, Baguley; W. C. Summerfield, L. and N.W., Coventry; J. Jobbins, L. and N.W., Smethwick; F. Giles, G.N., London; Alfred Ivins, G.W., Dorchester; Clarke White, Midland, Hellifield; George Rodgers, Midland, Chesterfield; Wm. Genders, jun., M.S. and L., Sheffield; Samuel Genders, M.S. and L., Retford; Wm. Steel, N. and S.W. Junction, Acton. As Associates: Messrs. W. H. Elliott, Chief Signal Inspector, G.S. and W. of Ireland, Thurles, Ireland; C. Cornes, Signal Inspector, Midland, Luton; Thos. Henry Knight, New Works Inspector, Midland, London; Chas. Bindley, Foreman Carpenter, Midland, London; Thos. Winfield, Foreman Platelayer, Midland, Nottingham; Henry Barlow, Foreman Platelayer, Midland, Nottingham. As students: Messrs. J. F. Hewitt, Somerset and Dorset R., Glastonbury; Wm. Smith, Midland, Ambergate.

**Varnish for Ferrotype.**—The solvent should be highly rectified benzole; and the resinous body most suitable is gum dammar. Crush the gum, and having placed it in a tall bottle, pour in the benzole and shake up at repeated intervals until dissolved. Allow to stand until quite clear above the sediment, then decant carefully into a clean bottle, and dilute with benzole until of the consistency desired. Good varnish can be made by dissolving Canada balsam in benzole.

# LETTERS TO THE EDITOR.

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*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

*All Cheques and Post-office Orders to be made payable to* J. PASSMORE EDWARDS.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

> **"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original."**
> —*Montaigne's Essays.*

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## RED STARS—16 CYGNI, 53 OPHIUCHI, &c.—ORBIT OF 61 CYGNI, AND STARS SEEN BY DAYLIGHT.

[24438.]—THE red star B.Add 27 Geminorum mentioned by Mr. Franks in letter 24367 appears to be identical with 12 Geminorum; at least Se. identifies it with B.A.C. 2029, which is certainly 12 Gem. 10, 11, and 12 Gem. are close together. I examined these three stars and all prominent ones near them some years ago, when I was endeavouring to identify the triple star H. V. 55; but I have no note of any red star here. However, I have some reason to believe that my eyes are not so sensitive to red as to some other hues—at least, I well remember, when observing one evening some six or seven years ago at Hardwick, with my deeply-lamented friend the Rev. T. W. Webb, being especially struck with the fact that his sight seemed far more sensible to impressions of red or orange in the colours of some red stars we observed than my own was. B. 607, to which Mr. Gore refers in letter 24391, page 367, is *m* Lacertæ (1 Hevel, Piazzi xxii. 36). It is 5·0 mag. in Piazzi, and was entered by Sir J. Herschel as No. 1746 of his 4th catalogue of double stars, having two companions of the 12th and 13th magnitudes at estimated distances of 20″ and 60″ in the direction of 180·0° and 185·5°. A.B. was measured at Cincinnati, 178·5° : 27·2″; mags. 6·0, 11·0, 1879·522; colour of A not noted. It is curious that Sir J. Herschel did not note the colour if the star was at all red when he observed it, as he has frequently called stars *red* in which other observers have seen no indications of such a hue. He calls A 6 mag.; it is 5 mag. in Houzeau. Some of Mr. Burton's magnitudes seem very low.

The magnitudes of 16 Cygni, about which Mr. Gemmill inquires in lettter 24391, were taken by Smyth from Piazzi. This is invariably the case in the "Cycle," where Piazzi gives both components of the stars observed by Smyth, and Smyth always assumes the magnitude of the bright star from Piazzi in the cases where the companion was too faint to be seen at Palermo. I suspect that the small "$^{s}$" of $\alpha^2$ Cancri was accidentally omitted by either Mr. Franks or myself when reading the proofs of the last edition of "Celestial Objects." By the way, Mr. Gemmill should write B. 212, and not β 212, &c. B. is the conventional term for Birmingham, and β for Burnham. I am afraid I can tell Mr. Gemmill nothing at present about de Zach's magnitude of α Draconis. Baron de Zach did little or no observing after leaving Genoa in 1826, and he died of cholera in September, 1832, while the date of Smyth's "measure" of his *comes* to α Draconis is 1834·41. His magnitude is, of course, assumed from Piazzi. I fear that my language would be, too frequently, the language of imprecation before I succeeded in unearthing de Zach's observation of the magnitude of Thuban from the forty odd volumes of the "Monatliche Correspondenz," and the "Correspondance Astronomique," to say nothing of his other works.

The statement about 16 Comæ being the "lucida" of that constellation is taken from Smyth's Cycle II. p. 267. Smyth says of 53 Ophiuchi: "It is followed by the two 8th magnitude stars mentioned in Piazzi's Note 150." He does not show these stars in his diagram, but he undoubtedly referred to C and D, although D, strictly speaking, is about 10″ or 12″ *preceding* 53. Argelander rates C 8·2 mag. and D 9 3 mag., the *comes* of 53 being 8·5 magnitude. These are the two stars observed by myself in 1872 and 1875, and in company with Mr. Read in 1881. On turning to Piazzi's note in the Palermo Catalogue of 1814, I was astonished to find that his words are "19″ temporis sequitur alia 8 æ mag. 10′ ad Austrum, et 41″ temporis alia 8 æ magn. 5′ ad Boream." The first of these is, of course, C, which, according to Bessel, follows A of 53 Ophiuchi at 18·2 sec., and is 10′ 5·6″ to the south of it, but where is the other? There is certainly no 8 or 9 mag. star near Piazzi's place, and unless he has made some error, the star must be a variable.

I suspect, however that Piazzi has omitted the word "præcedit" before the second "alia," and the star is then an 8 8 mag. Arg., which precedes 53 Oph. about 32·3s., and is 3′ 58″ north of it, according to Bessel; Piazzi's differences of A.R. and Decl. being in all probability rough estimations. ♅ called A of 53 Oph., white or reddish white, and B pale red in 1781 and 1782; H. and So. both blue or bluish white in 1821; Σ. both white on 5 nights in 1835; Smyth, both bluish in 1836, and A greyish and B pale blue in 1850; Se. white, blue in 1856: Main, both white in 1861; De., very white, reddish blue in 1863, and white, blue in 1871 and 1872. I called A pale yellow, B lilac in 1872 and 1875 with refractor, and A pale yellow, B blue in 1875 with reflector. There is, of course, no evidence of change in the magnitudes of C and D. Inasmuch as Dawes, from the mean of 17 nights observations, makes the magnitudes of the components of η Coronæ 5·7 and 6·0 respectively, while Dembowski, as the result of over 100 nights between 1862 and 1878, rates them 5·8 and 6·2, I think they may be considered as approximating very closely to a pair of average 6th-magnitude stars. Struve's observations being made by daylight, his estimates are probably too high. I took the distance of the components in 1831 from Struve's measure, the mean of three days' observations in 1831·63. Doberck's elements, the best I know, give for the distance at the time of Struve's observation 0·87″, and at the time of Dawes's 0·89″; the difference between observation and calculation being only 1-100th of a second—a quantity which, like the weight of the hippopotamus in the problem, may be neglected.

The two stars of 61 Cygni (about which Mr. Arkwright inquires in query 56893, page 375) are, most probably, physically connected, as they have very nearly the same large proper motion; but no signs of binarity have as yet appeared. Mr. Wilson seems to consider that the path described is hyperbolic; but if we except one or two of the older observations, deduced from differences of R.A. and Decl., there has hitherto been little or no deviation from a straight line. It is difficult to say how small stars could be seen with any given aperture in the daytime, as that depends so much on the transparency of the atmosphere at the time, and the expression "daytime" is rather vague. Burnham has seen the fifth and six stars of the Trapezium of θ Orionis seven minutes before sunrise with 6in. aperture, and the fifth has been seen in bright sunlight with 15in. γ Leonis has been measured in bright sunlight with 3¾in. only, and the close *comites* of ι Orionis and ζ Orionis with 5in., and ε Boötis and α Herculis have been seen double with the same aperture; while Dawes has measured δ Cygni and ζ Herculis at noonday, with a little over 6in. of aperture. The period of the shortest pair known to me—viz., δ Equulei, is about 10·8 years.

June 30th. **H. Sadler.**

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## ASTRONOMICAL-DOUBLE STARS.

[24439.]—Since I last wrote I have not been very much favoured with good astronomical weather. Hot, sultry days, followed by cool nights, windy, stormy, and cloudy atmosphere, are not helpful for nice, delicate work. I have, however, when relatively best, obtained a few results, which I beg Mr. Sadler kindly to examine and report.

ζ Boötis. P.A. 295° ±, in contact, power 180, split with a black line between discs; p. 208 and 370.

η Coronæ. 175° ±, somewhat easier than ζ Boötis.

Gled. 435. 110°, preceded by a star about 1′.

ζ Herculis. 90° ±, split with a black line beween discs, with 3½in. side aperture; p. 208.

Gled. 487. 330° ±.

Gled. 488. 310° ±.

Gled. 510. 50° ±, mean of three observations, but doubtful, as the star is excessively close.

Gled. 522. 215°, separated by small disc, p. 550.

Gled. 525. 150°, somewhat closer than 522.

Gled. 527. A.B. 80° C., 310° easy.

Gled. 530. 165°, divided with black line between discs, p. 370.

Gled. 536. 10°, this star looks closer than β, 0·55″ at present.

Gled. 566. 10°, preceded a little S. by a 10 mag. star, 3′ ± distant.

Gled. 572. 129°, faint.

Gled. 474. In his letter (24369) Mr. Sadler gives Sch.'s angle 7·5° : 0·33″ : 1882·47, and adds that this star is now wider. I have looked about six or seven times at this object; but I have not been able to see any elongation in that direction. It is a difficult object: to me more difficult at present than γ Coronæ. I have obtained a doubtful elongation about 130″; though on June 27, 1884, I wrote in my book, "A much more satisfactory view of its duplicity," p. 370. I should like to know if any competent observer has observed it this year, and with what results. Does Mr. Sadler think that the angle given by Sch. agrees with what is known of the orbit of this star?

γ Coronæ. Mean of six observations ranging between 140° to 125°, 135°.

Will Mr. Sadler look at XVh. 32m. + 36° 5′? I found about that place a double, which is not on any list I have, P. 260° ± mag. 6, 7·5. I believe the distance is under 1″. I found it on July 1st with p. 180; but afterwards, with inferior air, it required 208 to be seen at all. The star is S. of ζ Coronæ, and is shown on Bode's Atlas, as given by Flammarion in his "Astronomie."

**C. M. Gaudibert.**

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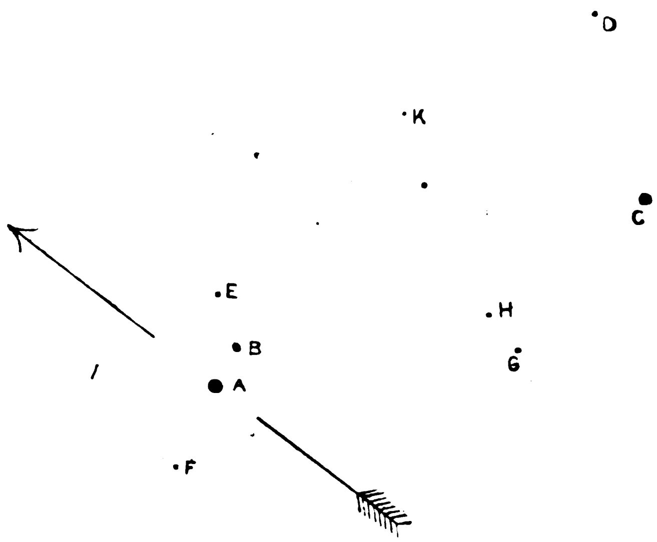
## DOUBLE STARS—53 OPHIUCHI.

[24440.]—On seeing Mr. Gemmill's note on this pair (letter 24390, page 364), I looked it up on Friday last with the following result:—The night was not good for the detection of faint stars owing to bright moonlight; but six more were found in the space shown by Mr. Gemmill, which are lettered according to magnitude in the accompanying diagram. The principal pair, A B, was rated at about 5·9 – 7·7 of Σ.'s scale—colours yellowish white and light blue; and two small *comites* were found N., a little *f.* + *s.p.* A B at about 75″ ±, rated at 11·5 ± of H. There is a minute pair (almost an exact miniature of 53 as regards distance) midway between A B and C, and another, rather wider and very much fainter, between B and D. The 8th mag. star C is orange, and decidedly larger than B, while there is a full 1½ mag. between C and D. The latter is very small, more like 10th mag. I do not find the two stars near 53 in any list I possess, but they are scarcely close enough to be reckoned *comites* in the strict sense of the term.



I have noted a similar discrepancy in the colour of the *comes* to 5 Serpentis, as given in "Celestial Objects." There it is called "pale grey"; but I have noted it on three occasions as reddish violet, very similar to the companions of δ Geminorum and η Cassiopeiæ. **K. J. Tarrant.**

Letchford House, Pinner, June 29th.

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## 70 OPHIUCHI.

[24441.]—The double star 70 Ophiuchi is one of the most remarkable binaries in the heavens. Although the companion has more than completed one revolution round its primary since the time of its discovery; yet no single orbit out of the dozen which have been calculated will satisfy both the modern and the ancient measures. Mädler, more than forty years ago, despairing of reconciling the conflicting observations, suggested that either "die Bewegung in diesem Binarsystem erfolgt nicht nach dem *Newton*schen Gesetz," or else, "die Mittelpunkte der Figuren, welche die beiden Sterne für uns bilden, sind nicht die Schwerpunkte der Massen." Jacob came to the latter conclusion, considering that the smaller star described a secondary ellipse with a period of 26 years; but if this be the case, observation has, as yet, shown no trace of the disturbing object. Two of the latest series of elements, and those which best satisfy previous observations, are those of Dr. Schur and M. Tisserand, published in 1868 and 1876. From these, I find the following places of B for the present time:—

| | |
|---|---|
| Schur's orbit | 53·3° : 2·69″. |
| Tisserand's orbit | 49·0° : 2·50″. |

I believe, from a recent observation, that Schur's angle is at least 20° too large, and the distance certainly half a second too great, if not more. Krüger found for the parallax of this object 0·162″, giving a distance one million two hundred and seventy-two thousand times greater than the mean distance of the earth from the sun, and he deduced a value for the combined mass of the two components 3·1 greater than that of the sun, the mean distance of the companion from its primary being equal to that of the planet Neptune. There is a remarkable similarity between the binary stars 70 Ophiuchi and η Cassiopeiæ. In both the primaries are yellow, and the companions purple; the proper motions are almost precisely similar in amount and are very large, that of η Cass. being 119″ per century, and that of 70 Oph. 113″, while O. Σ. deduced a parallax of 0·154″ (with a probable error of 0·045″) for η Cassiopeiæ, giving a distance of one million three hundred and forty thousand solar distances. There is a wide discrepancy in even the latest elements of η Cassiopeiæ, but with Grüber's orbit (period 195¼ years) the mass of the system is 4·6 times that of the sun, with Doberck's (period 222½ years) 5·2 times, with Coit's (period 167¼ years), 6·4 times, and with L. Struve's (period 150 years) 8·3 times the solar mass, with a mean distance nearly twice that of Neptune. In the English Mechanic for July 14th, 1882, I drew attention to a very remarkable case of proper motion in a distant companion to 70 Oph., and this case was referred to about two months afterwards in *Nature*. The small star in question has apparently an actual proper motion of 1·28″ per annum, larger than that of 70 Oph. itself, and far larger than any hitherto known to belong to so faint a single star; for it is probably not much brighter than 16 mag. in Herschel's scale. Flammarion attributes a slight proper motion, on, I think, insufficient grounds, to the Herchelian companion of Aldebaran; and also a large p.m. to a small star between 36 Oph. and 30 Scorpii, from a comparison of a diagram of Smyth's and his own, which a rather more extended acquaintance with the observations of Smyth would probably have caused him to reject. The place of the small star near 70 Oph. was, in 1878 8, 197·0° : 71·30″, according to the measures of Prof. Hall at Washington. Will any reader determine its present position? A small nine mag. star (W. B. [1] XVII. 305) less than 5° S.W. of 70, has a p.m. of 0 67″ annually, according to the Glasgow observations.

July 1. **H. Sadler.**

P.S.—I notice that Mr. Franks made the colours of both components of 70 Oph. yellow in 1876. I should be glad if he would mention the date of his observation. De. gives the colours yellow, rose, on four nights in that year.

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## PEARSON'S METHOD OF COMPUTING ECLIPSES AND OCCULTATIONS.

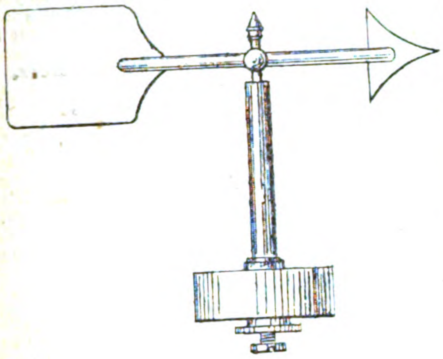
[24442.]—Referring to letter 24340, p. 322, Mr. Pearson does not seem to understand my way of obtaining the times of beginning and ending of occultations and eclipses by his partially-graphic method. I do *not* again divide the *ellipse* into hours and minutes, but the *moon's path only*. In making these computations I first complete the diagram in the usual way; then, letting the local mean standard, or sidereal time of geocentric conjunction fall at the meridian, I again divide the moon's path into hours and minutes of the same scale as before. This can be done in half a minute, and exhibits accurately and at once the local mean, standard, or sidereal times of beginning, nearest approach of centres, and ending. Mr. Pearson's rule is "Subtract the hour-angle at conjunction from the hour angle at the beginning (or vice versâ), and if the remainder be positive, add it to the local mean time of conjunction; if negative, subtract it. Similar operations are required to show the times of nearest approach of centres and ending."

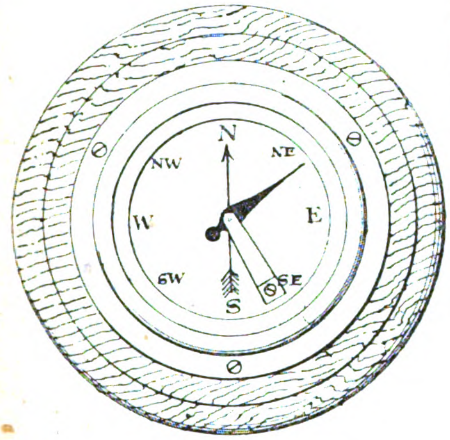
**Chas. L. Woodside.**

Boston, Mass.

### ELECTRICAL WEATHER VANE.

[24443.]—THE subjoined sketch shows a form of electrical weather vane devised and patented by me. The vane can be attached to any wall or ridge piece, and the receiver may be placed any distance from it. The arrangement of the latter permits of one, or more, being coupled-up to an existing vane, and as the current sent into it is only of momentary duration, it can be worked from any ordinary battery used for supplying bells or for other purposes. The needle used for indicating is nearly dead-beat, and accurately follows the swaying of the vane. One of these has been in constant use for six months without a hitch of any kind, and there is a complete vane and indicator at Stand No. 1378, Inventions Exhibition.





**F. M. Rogers.**

### ELSON'S FLASHING LANTERN AND INSTANTANEOUS CAMERA SHUTTERS.

[24444.]—As I see by the discussion going on in the pages of the "E. M." that some of your correspondents cannot get their so-called instantaneous shutters of their cameras to work satisfactorily, and as, doubtless, the rebound or recoil of the shutters, after springing home, is the cause of all their perplexity, allow me to offer the following, in the hope it may furnish a hint to those ingenious ones who care to think the matter out for themselves. On my constructing a double-shutter flashing lantern for signalling in the Morse on board ship, I found the one great fault which interfered with the rapid working of most flashing lanterns was in mine, and that was, when the two shutters (which open out across the front of the lantern) sprang together, they rebounded or vibrated for some little time before the light from the lamp was completely shut off, thus necessarily causing annoyance and delay in signalling, the symbols not being properly read unless a deal of valuable time and patience were lost by signalling slowly. So, to obviate this serious drawback, I constructed two hollow shutters of thin wood, so as to allow of a flattened, half-ounce round bullet having free play to roll from side to side of the narrow space inside each shutter, with the result, as I anticipated, that the shutters or screens now come together with a sharp, dead bang, as the (as I name them) leaden resonators inside them take up the recoil, and will back over the allotted space of about an inch or more. Now the light seems cut off clean, like a sharp knife cut of a rope, instead of, as before, when the shutting off of the light was as if the rope was torn or rent asunder with fagged-out ends.

The lamp has been pronounced to be perfection by the Sergeant Instructor at our headquarters. I inclose a drawing of it both open and shut, in the hope you will make it public for the benefit of our readers. Two hollow balls thrown by the same hand, the one containing another smaller ball free to move inside it, will not both reach the same distance, the momentum of the latter being expended or destroyed much soooner than the one containing nothing.

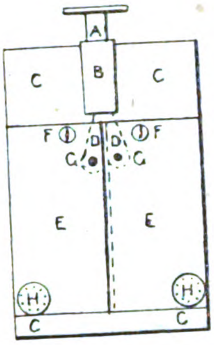


Fig. 1 shows the shutters closed and overlapping each other by the distance between dotted and plain lines running down the centre. A the key or plug surrounded by a spiral spring inclosed in the case B. The key is now pressed up by the spring, and the shutters are also kept closed by it. B the spring case—a hollowed-out piece of wood fixed to front of lantern-case C C, and overhanging the shutters E E, containing spiral spring and key plug A, which it encircles. C C C C front of lantern case. D D a pair of small flattened metal arms working in a notch on lower end of the key or plug A, and connected to the shutters E E at G G. E E the two hollow shutters working on screws F F. F F two screws as pivots for shutters E E to work on. G G two pins for the connecting arms D D. H H two flattened bullets as resonators, in the position they take up on the shutters striking together.

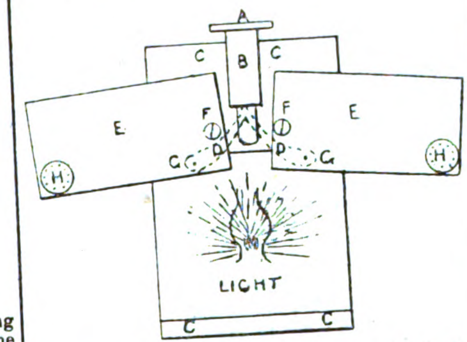


Fig. 2 shows the lamp open, with the leaden weights H H in the position they will occupy before they are sent rolling to the other side, as the shutters bang together when the thumb pressure on the top of A is released. The two metal arms D D are partially hidden between the two parts of the shutters to which they are attached by the pins G G. They are seen as dotted lines where they enter the shutters to their pins G G.

I trust the above may find a place in the pages of "Ours," of which I am the happy possessor of twelve back volumes, all bound,

**A. R. Elson.**

Gunner, Calcutta N. A. Volunteers.

Calcutta, June 1, 1885.

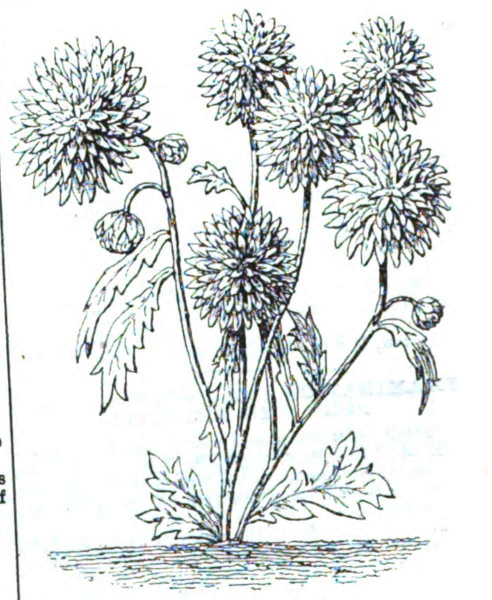
### THE NEW TIME.

[24445.]—THE adoption of the new time seems to be as far from realisation as ever, although a considerable period has now elapsed since the Washington Conference—enough, one would imagine, to show whether it is likely to find favour with the world at large. At present it must be a patent fact to every one that the consensus of opinion is decidedly adverse to it. Nor does this opposition proceed so much from the general public, who are, I fear, supremely indifferent to the question, as from a quarter where it might least be expected—from astronomers themselves. And why should they sacrifice the old 24-hour reckoning (from noon to noon), which is everywhere understood and recognised, not only by astronomers, but by seafaring men generally, in order to meet the convenience of the outside public, who really do not care a straw about it? If the public want a "universal" time, let them agitate for it; it would then be quite time enough for astronomers to consider how far they should subordinate their own convenience in adopting it. This, to my mind, is the only real argument in favour of the new system—its universal adoption; but, like many other Utopian ideas, it is better suited to the coming Millennium. As far as the abstract question of 24 hours noon to noon *v.* 24 hours midnight to midnight concerns the astronomer solely, independent of any public consideration whatever, there can be, surely, but little room for doubt as to which suits him the best. In spite of what our friend, "F.R.A.S.," says (p. 346, letter 24365) as to a solar eclipse beginning before noon and ending after it, as a difficulty with the old (*Nautical Almanac*) reckoning, it seems to me to be rather an argument in its favour, inasmuch as for every single observation of a solar eclipse made in the daytime, there are thousands of others made only at night. Although it is true that our own Astronomer-Royal has adopted the new reckoning, I am not aware that any other national observatory has seen fit to follow the recommendation of the Washington Meridian Conference. Speaking from personal experience, I have found the new system an unmitigated nuisance; breaking up observations in the middle of a night's work just at the tick of the clock, and if very deeply absorbed at the telescope, I have probably forgotten all about midnight being the precise time at which I ought, literally, to turn over a new leaf for another day's work. So, very soon after commencing to work with the new reckoning, I abandoned it again for the older system, which is in every way far more convenient and familiar. As a dutiful member of the L A.S., I had instructed the members of the Planetary section to use the new time, in accordance with the resolution passed at the December meeting of that society; but, at the same time, I own that I ignored it in my own practical work, and several of the members all along objected to the change. However, in the future, I intend to leave the new time reckoning severely alone, both in public and private. When the new system *is* universally adopted, I will, perhaps, change my mind; but until that uncertain epoch I am conservative enough to hold fast by the time-honoured reckoning from noon to noon, as amply sufficient for all the purposes of an observer.

**W. S. Franks.**

### DOUBLE CORN MARIGOLD.

[24446.]—As many of your readers, like myself, care for other things besides mechanics, I send you a rough sketch of what I believe to be a very rare variety of the corn marigold, which grows here in large quantities. The specimen is quite double; it became rather withered before I sketched it. I intended keeping the plant alive; but finding that it is only an annual here, pressed it. I also inclose specimens of the common sort and a light marigold.



**E. R. Dale, F.S.Sc. Lond.**

### COLLIERY EXPLOSIONS.

[24447.]—THE recurrence of these disasters follows the well-known old rule, a fallen barometer, a risen thermometer, an unusual escape of gas, of course, and funerals for 200 persons; and so it goes on.

Now, the barometer may have fallen ½in. in 48 hours, thus lessening atmospheric pressure 35lb. on the square foot, while the ventilation by suction of fan or furnace may have further reduced that pressure by another 35lb. on the square foot.

A ton of hewn coal is capable of giving off 10,350 cubic feet of carburetted hydrogen, which when mixed with nine times its volume of air makes 93,150 cubic feet of most explosive "fire-damp"; but a blower is known to be under pressure of 30 atmospheres, and, therefore, we may arrive at an idea of what quantity of gas one ton of coal while under pressure in the strata might produce. Thus 10,350 cubic feet of a hewn ton of coal multiplied by 30 atmospheres = 310,500 cubic feet of carburetted hydrogen, which, when mixed with nine volumes of air = 2,794,500 cubic feet of "fire-damp," which, if free and ignited, would blow up miles of workings, headings, and roads.

Now, those figures are given in order to convey some idea of the perilous nature of trifling with colliery ventilation.

There is no other means of real prevention than that of abolishing the system of ventilation by the suction of fan or furnace, and introducing instead air under pressure up to the face of the coal, by which means the atmospheric pressure may be maintained to a proper standard. For instance, every 1-10in. fall 7lb. per square foot must be supplied to meet the deficiency.

I must maintain that helping to bring about a "disaster" by easing pressure by artificial suction, when more pressure is the essential to safety, is most unwise, to use the mildest term. I hope some of your correspondents will discuss what I have said.

**J. D. Shakespear.**

25, Great George-street, S.W., July 6.

## COLLIERY WARNINGS.

[24448.]—The following dates are indicated as being periods in which a change of atmospheric pressure, combined with disturbances of the magnetic currents (earth currents) and seismic perturbations, may be expected to occur during the ensuing six months. Observation has put it beyond all doubt that an intimate connection exists between these disturbances and accumulations of gas in mines, therefore I name these dates as being *highly dangerous*, and the greatest care should be observed by miners.

Earth tremors also owe their origin to similar causes, and when they do take place will be found to occur approximately about the dates named.

This is a very interesting branch of science which has been unfortunately almost entirely overlooked by scientists. It is, however, worthy of the closest study, and although we can never expect to be able to prevent the outrush of gas in mines, there is no reason why we should not be able to indicate the periods when these occurrences have a tendency to take place, and thus be enabled to take precautions accordingly.

If colliery managers and viewers, or any other officials who have to do with mines, would keep a record of the dates on which accumulations of gas are observed to take place, and let me have a copy of such records, they would thereby greatly facilitate the investigations, and would found a basis upon which future calculations might be made.

The dates marked with an asterisk are periods of exceptional disturbance, and during these periods the utmost caution should be exercised in mines where gas is known to exist.

July 5, 6, 7*, 8, 22, 26; August 5, 6*, 15, 19, 28, 31; September 2, 4, 7, 15, 20*, 25, 26*, 29; October 2, 3*, 5*, 10*, 16, 20, 25, 27; November 6, 7*, 20, 22*; December 2, 3*, 4*, 5*, 18*, 19*, 28.

**T. J. Murday.**

Felton, R.S.O., Northumberland, June 30, 1885.

## EXAMINATION OF MINERALS BEFORE THE BLOWPIPE.

[24449.]—In accordance with Col. Ross's request, "E. M.," No. 1058, page 390, I would offer the following opinion as to the names of the minerals of which the blowpipe analyses on his system are there given:—

No. 1 appears from the analysis to be a white, "earthy" sulphate of aluminium, containing about 10 per cent. of potash. Dana ("System of Mineralogy," 1877, page 658) gives three such, under the head of "Hydrous Sulphates" (combined water not mentioned by Col. Ross, but no doubt existing in his mineral—viz., Aluminite, Alunite, and Löwigite). Of these the first contains no potash, and the last is stated to have a pale straw-yellow colour, and to be slightly subtranslucent. I therefore suppose Col. Ross's first mineral to be "alunite."

No. 2. "An alkaline aluminous silicate," containing traces of soda and lime, but chiefly silica with considerable alumina, and potash; "transparent, colourless, hard." This constitution points to feldspar of some kind or other, or, as Dana calls it, "orthoclase"; and at page 356 he gives a list of feldspars in which "the proportion of soda is much less than that of potash, from $\frac{1}{20}$th": nearly all of these contain traces of lime. I therefore suppose Col. Ross's No. 2 to be the variety of transparent crystalline feldspar (probably from St. Gothard, as he states it "is in a Freiberg Cabinet) called "Adularia."

No. 3. "A soft, greyish white, compact," aluminium silicate containing a little potash. Again, Col. Ross does not mention water, but it is evident that must be present to make a silicate of the hardest substance in the world next to diamond (corundum) "soft." I therefore turn to the "hydrous silicates of alumina" in Dana, or what he calls the "Margarophyllite section—i.e., having a "pearly" lustre. There I find, page 479, "Pinite," having a hardness of only 2·5 to 3·5; colour, greyish white; lustre feeble, waxy. In the percentage list of these there is a ratio of nearly 2 : 1 between the silica and alumina, and in the variety called "Agalmatolite" (of which the Chinese priests make their gods), a greater proportion of silica, no iron, magnesia, lime, or soda. I would suggest, therefore, that this mineral is "Agalmatolite."

No. 4. A hydrous silicate of lime with considerable proportion of potash, which "intumesces and froths up when held *per se* before the blowpipe." Looking in Dana, therefore, among the "Hydrous Silicates, Zeolite (from a Greek derivation signifying to boil up) section," I hit upon the zeolite *par excellence* called "Apophylite" (from another Greek word signifying to exfoliate or intumesce), and find—page 416—a list of apophyllites from various localities, which yielded (to different analysts) on an average 52 per cent. of silica, 25 of lime, 5 or 6 of potash, and 16 of water. But all of these, except one, contain about 1 per cent. of fluorine, which Col. Ross does not seem to have detected. Is No. 4 "Apophyllite"?

No. 5 must be "Cryolite," the well-kown fluoride of sodium and aluminium from Greenland, Arksut Fiord.

On the whole, I think Col. Ross would do well to pay more attention to the "lustre, hardness, and specific gravity" of his materials than he seems to do. A better description of these (he gives none at all of sp. gravities), combined with the results of his analysis, would very much facilitate and shorten the work of the student in hunting up names.

**Mineralogist.**

[24450.]—Now that Col. Ross (letter 24426) has opened his box, it is to be hoped that he will not close it till it becomes empty as that of Pandora. To those of your readers who possess a good work on mineralogy there will be but little difficulty in fixing the names of the Freiberg specimens: No. 1, I should call "potash-alum"; No. 2, a species of "orthoclase"; No. 3, I should call "kaolin."

Col. Ross's generalisations are admirable. Take a single instance in No. 1, where he determines the presence of sulphuric acid from "great effervescence" and unchanged pyrochrome. Though I write in haste, I sincerely hope that Col. Ross will continue his masterly analysis.

Gorton Brook. **Ex-Blacksmith.**

## PYROLOGY.

[24451.]—In order to show the *animus* against this subject still prevailing amongst many English chemists, I quote the following from the private and friendly letter of a well-known London chemist to myself. As he is not likely to see or hear of this publication, his letter will retain all the advantages of what lawyers call "a privileged communication"; and besides, it is only by making private insinuations and hypercriticisms public, that I can defend my system of Anhydrous Analysis from the many calumnies and slanders privately circulated about it, *a tergo*.

"I have just looked at pages 135 and 136 of your book, and it does not strike me as satisfactory. The logic is not complete, and this is serious in the matter of textbooks." (The reference is here made to the fact discovered by me, described in these pages, and admitted now by all German and other chemists who have gone into the matter, that quicklime, treated in pure boric acid (boron trioxide) before the blowpipe, combines with the latter to form anhydrous calcium borate, invariably containing 25 parts of lime and 75 parts of boron trioxide. Further, that if calcium hydrate be similarly treated, anhydrous calcium borate is formed as before, plus hydrated boric acid, the proportion of "water" agreeing almost to a decimal with the received chemical account of calcium hydrate).

"For junior students, for instance, it is not proved that *all* the lime is concentrated into the ball (calcium borate). Might not some of it be dispersed through the bead? Is not the rest of the bead altered in any way? When is all the superfluous water removed from the slaked lime? Is it not *assumed* that the lime has the formula CaO? and that the part of the bead which combines with the lime has the formula $B_2O_3$?"

Now, suppose I were to tell this chemist (a very clever man, and one who knows his work thoroughly): "When you tell us in your chemical textbooks that, by adding sufficient hydrochloric acid to a solution of silver nitrate, you obtain a precipitate of silver chloride in invariable proportions of chloride and of silver, your logic is not complete. You do not prove that *all* the silver of the solution is concentrated in the white precipitate of silver chloride; might not some of it remain dispersed through the nitrate solution? Is not the rest of the solution altered in any way? When is all the superfluous hydrogen removed from the hydrochloric acid? Is it not *assumed* that the silver has the formula Ag? and that the part which combines with it has the formula Cl?"

Were I to say this to any chemist, what do you suppose he would answer? I shall find out what this one replies to such queries, at all events, for I intend to send him this very letter.

**W. A. Ross.**

## WHAT IS "CREATION"?

[24452.]—"F.R.A.S.," in letter 24416, page 388, I think wrongly complains that I evade the difficulty he propounded as to albinos, &c., by referring these back to ancestral types in which they first appeared, as I say, by creation. He employs, however, a word which I never used, and which is liable to considerable misinterpretation, when he says, "suddenly created."

. The first real albino was probably, on the other hand, the result of slow, gradual, or selective creations, to which we have to this day not infrequent reversions.

"F.R.A.S.," however, ignores the more important question which I addressed to him. How, apart from creation, can he account for the first appearance of such abnormals? **H. B. F.**

## AUTOMATIC MUSICAL INSTRUMENTS.

[24453.]—The letter from Mr. Wenham to-day on the above subject contains a number of quite new ideas. I thought I knew all that could be done in this line; but his description is a revelation, at least to me. It is evidently a portable six-octave pianista. The pianista, I thought, was the best of this class of instrument; but it weighs about 1½cwt., its cost is about £30, and it has only 4½ octaves. I think Mr. Wenham should have sent his to the present Exhibition, as it would astonish a great number of musical folk. I do not, however, quite see how a vibrator can efficiently replace the suction bellows usually employed. Will he kindly explain if it is on the principle of the "Organo Piano," by Metzler and Co., and give us a sketch, as it doubtless is quite as interesting to many others as it is to me? I publish my address, and would be glad to hear from him. **Vulcanite.**

[24454.]—I have no recollection of being "frequently told that the organette is without levers"; but accepting the statement of "Gray's Inn" as correct, I can only say that those who told me so showed their ignorance of the construction of the instrument in question. I happen to possess a sketch of the mechanism sent me at the time by their original importer, from which it appears that there is a series of levers *below* the paper, which spring *upwards* through the perforations, and in so doing, open the pallets which lie immediately underneath them; but as this sketch is merely sufficient to show the principle, I have been desirous of getting Mr. G. Fryer to fulfil his promise, and send a working drawing. I presume "Gray's Inn" confuses the "organette" with the "orguinette," hence his blunder in attempting to correct me. Mr. Wenham's outline description of his pianista interested me greatly, as he has succeeded in applying a principle which I failed to "lick into shape," as applied to a wind instrument. The essential difficulty is to hold down the note without getting any tremulous sound, and yet be able when necessary to obtain a rapid repetition of it. This difficulty does not arise in Mr. Wenham's arrangements as there is no holding down required. It is just the same principle as that of the Jacquard loom, where the perforated cards push aside the hooked wires, and so prevent them being lifted by the bars of the lifting frame.

I worked out the idea in several ways; the best seemed to be to give the plungers a constant tendency to hold down the notes, but to retain them in a raised position by a kind of rapid "pick-up," something like the action of a friction-break; but the detail was not satisfactory. I am surprised at the small size of aperture in the orchestrone. I made many experiments on this point, and found a round hole ¼in. diameter was practically the smallest through which a reed (say the lowest note of an English concertina) would speak clearly without an excessive wind-pressure. On the other hand, in trials with organ-pipes I found a very much smaller channel could be used than that usually adopted.

Would Mr. Wenham kindly say how he gives the rapid motion to his "finger-piece" or "vibrator?"—whether by gearing or endless band.

**A. S. L.**

## CRANK AXLES.

[24455.]—It seems to me that the numerous contributors to this discussion overlook a fact which must largely conduce to the failure of axles generally, whether cranked or plain, and whether of engines, coaches, or trucks—viz., that each member of each pair of wheels is in rigid connection with its fellow.

As a consequence, torsional strain of a severe character is put on the axle whenever a curve is traversed. That such a practice should be continued as regards the engines one can understand, as the difficulty of providing each driver with an axle distinct from the one opposite to it would be great, seeing that a central support for the inner bearings would be needed, and in order to get room for this outside cylinders might have to be used.

But that such a barbarous and unmechanical plan should be employed for coaches where no such difficulty exists seems well-nigh incomprehensible. Possibly lubrication, or removal and replacement, may be more readily effected; but surely such matters are far outweighed by anything that tends to make the axle safer and more lasting.

July 5. **B. B.**

## THE CASSEGRAIN.

[24456.]—At last we are getting what (in common with Mr. Wassell, and no doubt many others) I have so long desired to see, and there is no doubt the subject will be handled in the same masterly manner that the achromatic telescope has been handled by the same contributor.

May I, however, ask him if it is not possible to give a formula to determine directly the distance A B (or A D) when the foci of the two mirrors (for parallel rays) and their distance apart are known. In testing old instruments the position of the point A is not known, nor is it easily discoverable by trial.

There are several curious points suggested by the formula; for instance, it would seem that in a Gregorian, if *both* mirrors were parabolas, the points C and E would coincide, and A would be thrown to an infinite distance, supposing the mirrors to be so placed as to be free from aberration. Is this really the case? **A. S. L.**

## 100 TO THE INCH ON SMALL TELESCOPES.

[24457.]—Mr. Franks states, on p. 368 of the Mechanic for 26th June, that "very small telescopes—say, of 2in. aperture and under, will not bear a power of 100 to the inch." I beg to state that I have a 2¼in., on which I frequently use an eyepiece magnifying more than 100 to the inch on lunar craters, Saturn's ring, and close double stars with advantage when the objects are at a fair altitude. I am able to speak positively on this point, as the eyepiece has been carefully tested by the dynamometer. I also know of two smaller instruments, one of 2in., and one of $1\frac{6}{10}$in. aperture, each of which bear 100 to the inch.

**An F.R.A.S.**

[24458.]—Is Mr. Franks, in letter 24409, p. 368, quite sure he has not fallen into an error?

It is with great diffidence I make this suggestion, as Mr. Franks's opinions have the approval of our valued friend, "F.R.A.S.," in letter 24416, p. 388, and an opinion endorsed by such authority seems beyond question.

Still, I have always understood that circles vary in area as the squares of their diameters.

In which case, taking Mr. Franks's illustration, it is quiet evident that a 2in. o.g. has only one quarter the light of a 4in., and so, that the images may have the same intensity of illumination (granting equal perfection of figure), given the extreme limit of power the 4in. would bear, the 2in. would bear exactly one-half the magnifying.

I do not for a moment suggest that the 100 to the inch formula is correct: my own experience contradicts it. I find that any higher power than 450 on a 6½ silver-on-glass reflector gives an unpleasantly dull image.

But I do say (neglecting any small difference of absorption caused by varying thicknesses of objectives) that with equal perfection of figure and polish, given the highest power a 1in. glass will bear, a 2in. will bear twice the power, 3in. thrice, and so on. On reconsideration, I think Mr. Franks will see this.

Some time ago I asked if any brother reader, could give me his experience of the utility of a paraffin-coated vessel for silvering specula, but have received no reply. Will any one who has tried it kindly give the result?

Ilkley, July 3. **Allan. E. Kershaw.**

[24459.]—A correspondent has written to me respecting my letter on the above subject (24409, p. 368), and requesting that my reply may be given in these columns. His statement is to this effect: "Suppose the object taken be Jupiter, and the 4in. aperture be charged with a power of 400 diameters, the 2in. with 200, and the 8in. with 800. Then, although the 2in., with power of 200, has only a quarter of the light of the 4in., yet, as the half power duly magnifies Jupiter to a quarter of the *superficial* size, the brightness of the two telescopic images must be equal. Similarly the 8in., with double power, spreads the light over four times the area, and the image will be no brighter than in the 4in." This is perfectly true, no doubt; but, as a power of 100 to the inch is quite out of the question for planetary work, I think the case is somewhat hypothetical. As Chauvenet says in his "Spherical and Practical Astronomy" (Vol. II. p. 15): "Let us suppose two telescopes, the object-glasses of which are of different diameters, to have the same magnifying power. Then the brightness of the two images formed will be proportional to the quantity of light which falls on the surface of the two objectives respectively; but these surfaces are proportional to the squares of the diameters of the objectives, and hence the brightness of the images is proportional to the squares of these diameters. On the other hand, let us suppose two telescopes, with object-glasses of equal diameters, to have different magnifying powers; then one and the same quantity of light is distributed over the larger and over the smaller image, and, consequently, in this case the brightness of the image is inversely proportional to the square of the magnifying powers." My remarks were intended as applying to *stars*; but, for objects possessing a sensible magnitude, they require modification. Suppose, then, for the sake of argument, that we assign 50 to the inch as a maximum limit for planetary magnification, putting 100 on the 2in. and 200 on the 4in. o.g. The brightness of the two images should be equal. Now I know that a 4in. o.g., if good, will give a brilliant image of Jupiter with a power of 200; but I have never seen a 2in. yet that I should care to observe the planet with when charged with a power of 100. Two other considerations come in, as affecting this question, which somewhat complicate the result. One is the part played by the *objective* itself in defining power. Take a 2in. o.g., of, say, 30in. focus, and compare it with a 4in. of 60in. focus, stopped down to 2in. aperture, the magnifying powers being equivalent. Direct the two telescopes, side by side, upon Jupiter, and although, theoretically, the central 2in. of the larger glass admits slightly less light because of the greater thickness of its lenses, yet more detail will be seen with it than with the 2in. full aperture. Why should this be so? The other point is the difference in the *eyepiece* lenses, consequent upon the dissimilar focal lengths of the objectives. To obtain equivalent power, the shorter focus must have smaller and deeper curved lenses in the eyepiece; these will admit less light, partly from greater absorption with the increased thickness of glass, and partly from the greater loss of light by surface reflection from sharper curvatures—not to mention the increased errors of workmanship in minute lenses. Further, to carry the argument to its logical conclusion, could a power of 1,300 diameters be employed on a 26in. o.g. in viewing Jupiter? I fancy the result would be a fearful and wonderful illustration of what the atmosphere can do in setting optical theories at defiance! As a fitting sequel to what I have urged against inordinate magnification, permit me to quote Professor S. Newcomb's remarks in his "Popular Astronomy," pp. 142—145: "Still another cause which places a limit to the power of telescopes is diffraction. When the 'emergent pencil' is reduced below $\frac{1}{50}$in. in diameter—that is, when the magnifying power is greater than 50 for every inch of aperture of the object-glass, the outlines of every object observed become confused and indistinct, no matter how bright the illumination or how perfect the glass may be. The effect is the same as if we looked through a small pin-hole in a card, an experiment which any one may try. . . . The great foe to astronomical observation is one which people seldom take into account, namely, the atmosphere. The amount of this atmospheric disturbance varies greatly from night to night, but it is never entirely absent. If no continuous disturbance of the image could be seen with a power of 400, most astronomers would regard the night as a very good one. . . . If seeing depended entirely on magnifying power, we could not hope to gain much by further improvement of the telescope, unless we should mount our instrument in some place where there is less atmospheric disturbance than in the regions where observatories have hitherto been built." **W. S. Franks.**

[24460.]—Mr. W. S. Franks is, I think, not quite accurate in his statement in letter 24409, to the effect that a 2in. o g., power 200, has only a quarter and an 8in., power 800—four times the amount of light of a 4in., power 400, respectively. When the power is doubled you have only one-fourth of the light, and by doubling the aperture you have four times the light; therefore the amount of light in each of the three cases cited above will be identically the same.

I take this opportunity of thanking "A Fellow of the Royal Astronomical Society" for his kind reply. The thanks of all are due to "Montmartre" for his exertions with regard to Galilean binoculars. I do not believe that there would be an *appreciable* loss of light when a 2in. o.g., power 5, was increased to power 10, because the emergent pencil would be decreased from ·4in. to ·2in., and ·2in. is as large as any human life can take in. No light can be gained by having part of the emergent pencil falling on either your eyebrow or cheek-bone.

Last night, 28th June, 9 p.m. (atmosphere very clear and steady), I saw seagulls on an islet, distant 11½ statute miles, with 1⅛ Dallmeyer, power 15, and 1⅝ Dallmeyer, power 10, and just perceived them, knowing where to look for them, with 1¼ Dallmeyer, power 8¾. **Edward M. Nelson.**

Shetland, June 29th.

## HIGH-POWER OPERA AND FIELD GLASSES.

[24461.]—Referring to the last paragraph of "Montmartre's" letter (24393), I hope that correspondent will do what he can to get the new French high-power glasses within reach of those of your readers who require them. The difference in price between them and the so-called English glasses should alone secure a good sale for the former. By the way, is it not a fact that all opera and field glasses are made in France? If so, why so much difference in price?

I should like to draw the attention of "Montmartre" to the fact that whereas the 7-power glass is priced at 82s. (or in brass and morocco at the reasonable figure of 39s.) the 10-power glass costs the large sum of 181s. The extra power seems too costly at the price. Why should the size and price of this glass be so largely in excess of the 7-power glass? Could not your correspondent get the makers to more nearly approach in size and price the latter glass, but with the 10-power?

**E. C. J.**

[24462.]—It is almost incredible that a person having any knowledge whatever of optics should persist in the delusion that increase of power in an object-glass of given size can be obtained without any sacrifice of light or field. I appeal to "F. R. A. S.," who, perhaps, will be kind enough to settle this point, and to give your readers his valuable opinion as to what power is most suitable for opera glasses—not to convince "Montmartre," but perchance to prevent the uniniated from spending their money foolishly. What can "Montmarte" mean by this? "By night it (a Ross telescope) could show nothing at all, whilst the 10-power showed everything perfectly, *by day and night equally well.*" The proper place for the French glass, which shows everything as well by night as by day, is at the Inventions Exhibition in a case with the Irish gun, which kills as well round the corner as straight in front of it. I have no pecuniary interest in any firm of opticians, English or foreign, but as I believe the former to be unrivalled in the quality of their goods and moderate in their prices (quality being considered), I have but little patience with the attempts sometimes made to puff foreign glasses to the detriment of our own manufacturers, who are prepared to give us better value for our money than can be got elsewhere.

**Experience.**

## THE MICRO-OBJECTIVE.—V.

[24463.]—This paper is to fulfil the promise made at the end of my last, p. 327.

In planning an o.g. it is well to keep to as few curves as possible. For a 1in. of good quality, grind a plano-convex flint of ⅜in. radius, ditto of ¾in. radius; double convex crown of equal curves to match the flints. Cement the two pairs with Canada balsam, and mount them at the right distance apart to correct the spherical aberration.

For a ½in., grind a plano-convex crown lens of ⅕in. radius and at least ⅛in. thick. It may be $\frac{3}{10}$in. diameter. This is the "front" of a single lens.

Now grind a plano-convex flint of ⅗in. radius, and a double convex to match; these may be $\frac{4}{10}$in. diameter, but as thin as possible; when cemented these are our "middle"—an achromatic double.

To complete the o.g. there must be a third combination, of three lenses.

A bi-concave flint, of ½in. radius, has cemented into it a plano-convex crown on one side and a double convex on the other, making a triple, over-corrected combination; all curves of the same radius. This is the "back" diam., little, if any, more than the middle.

Mount these so that the back and middle are almost in contact; then let the front be placed sufficiently distant from the middle to be correct for spherical aberration, all plane surfaces to be towards the object.

The curves given for the ½in. I have proven good for a ⅙in. and a ⅛in., as well as the ½in., so that no one need hesitate to spend their time upon the *apparently* great task of perfecting 12 surfaces in glass on the supposition that it is only an experiment, or speculation, after all.

I will, however, give here data for a ¼in., of so precise a character that only the more advanced amateur will be able to undertake it; but there may be some who will make use of it.

Beginning, as before, with the single front:—Radius $\frac{1}{20}$, diameter ·093, thickness ·057, density of glass 2·437.

Middle:—Front surface, concave to ⅜ radius; second surface, also curve of bi-convex crown in contact with it, ·1165 radius; next surface the same radius; density of the flint glass, 3·686; crown, same as front; diameter, ·138.

Back:—A triple; first surface, crown glass plane; radius of second surface, convex, also both curves of flint lens concave, ·220; bi-convex crown lens to fit the concave on one side; on the other a curve of ·156 radius; density of flint, 3·630; crown same as before; diameter of the combination, ·173; ang. aper., 130°.

This specification was in "Ours" some 12 months ago, and is hereby acknowledged to be a copy, in case the owner takes me to task for it. I think the owner was Mr. Wenham; the writer certainly was.

To return now to my own work, it will be noticed that I say nothing respecting the density of the glass used. That is a refinement which I have found it possible to avoid, as also the third decimal figure in the radii, for the distance at which the lenses are placed, the one from the other, is so very powerfully corrective a factor that the above very precise working is needed in the o.g.'s of the highest angular aperture only.

If a combination be found under-corrected for spherical errors, or correct only when the front is so far from the middle that no space remains for the object—that is, no working distance is left—the plane surface of the middle may be made concave with good effect. The radius of curvature used should be four, five, or six times the focal length of the o.g.

Testing:—Hold an ordinary lens of an inch focus three or four inches from a strip of card having parallel edges and about an inch wide. In the lens will be seen an image of the card, and, if the distance of the lens from the card be such that the image nearly fills the lens, the two edges of the card will not be straight, but barrel shaped—double convex. Now use a negative eyepiece in the same way, and the edges of the image will appear *nearly* parallel; the field lens should be towards eye in this experiment, and the eye cap removed.

In an achromatic o.g., used on the same plan, the edges of the image should be *quite* straight and parallel; it may then be tested on fly wings, podura scales, micrometer ruling, or mercury globule, as required. The last two are fine tests, which I will explain if required, but this paper will be long enough without.

The card strip test is only an index to the condition of the lens as far as spherical error is concerned, and is of no other use. In using it, don't *spy through* the lens with the eye close, but simply look *at it*. If a straight, smooth edged bit of thin metal be held in the focus of the lens, and the eye be placed as close as possible to the "back," light coming from, say, the right, and the edge of the metal plate passed as far as possible to the left, a rough estimate may be formed of the colour correction of the combination; more rigid inquiry may then be made as before on scales, &c.

To "Optical," p. 390.—I would say that the difficulty he finds often arises from washing the emery too finely, for by over-doing the emery washing—that is, the "optical mud"—all the emery settles in the 5 and 10 minute washings, and the so-called 30-minute emery is nothing but glass dust. This dust makes plenty of cobweb lines on the lens being ground, but cannot properly cut it. I never use any washings but what have a good brown tint, and they don't usually take more than five minutes to settle, or ten at most.

**Rob. Crus.**

### THE RIGHT-ANGLED PRISM INSTEAD OF A PLANE MIRROR IN THE MICROSCOPE.

[24464.]—In your issue of January 30 last, Mr. Nelson replied to a query (55722) thus: "Right-angled prisms are used in telescopes for the purpose of economising every particle of light. In the microscope, however, even with a ½in. wick, there is more light than one knows what to do with." With great deference to Mr. Nelson, it is not the *quantity* of the light (which can easily be controlled) but the *quality* which renders the prism, I believe, preferable. For a long time I have always used the prism whenever delicate management of the light was required. I do not exactly see why it should be so, but I believe the reflected rays from the posterior silvered surface and from the front unsilvered surface prevent the lights from being brought accurately to focus on the object on the stage. This belief is founded on the following interesting experiment, for the idea of which I am indebted to one of Dr. Royston Pigott's papers which I read some years ago.

In the winter time, when the leaves are off the trees, I placed my microscope with a prism and achromatic condenser at an open window opposite an old oak, about 250ft. distant. With a little management, the reduced image of the oak formed at the focus of the condenser was viewed by a ⅛th objective. With suitable apertures in the diaphragm of the condenser, and in an iris diaphragm fitted on to the lower portion of the condenser between it and the prism, a most exquisite image of the tree was seen. The definition of this was charming, every little twig and incipient bud being distinctly visible. Then, nothing else being altered, a plane mirror was substituted for the prism. What a change! The larger branches were there indeed, but the slender twigs were involved in hopeless "fuzz," which no amount of manipulation could eliminate. The experiment was varied by forming the image of a net window curtain about three yards distant from the microscope. With the prism, the picture of the network and pattern was perfect, every detail being exquisitely shown. With the plane mirror, the image was very markedly inferior, thought less so than in the former experiment. My attention was first drawn to the prism by a kind friend and distinguished member of the Microscopical Society, who has employed one for years.

**George Hunt.**

Alleyn Park, West Dulwich, July 4th.

### A NOVEL CLOCK—ALUMINIUM—HIGH POWERS FOR TELESCOPES AND FIELD GLASSES.

[24465.]—In answer to "A. H." (query 56491), a brass bowl will do very well, but it should not be too thick, else a strong magnet will be required. A pudding bowl would do also, but I prefer a china one for appearance and because it is so much thinner. If a brass bowl be chosen, the inside rim might be coated with wax, the figures made through the wax with a pointed instrument, leaving the metal bare, which can then be eaten into with nitric acid. But I would not eat the figures too deep, as the magnet on the fish might catch in them. I hope "A. H." will let me hear how he succeeds. I am obliged to the correspondents who have pointed out prior clocks of this kind. It is not easy to invent anything quite new in these days.

I may tell "Ex-garrison Gunner" (query 56949) that I spent my spare time during three years in trying to find a cheap method of extracting aluminium, but without success. There were some letters in the English Mechanic a year or two back, giving new methods which I tried unsuccessfully. I do not believe that there is any other commercial method of obtaining the metal than the old method of acting on the chloride or the native fluoride (kryolite) with sodium. I can give "Ex-G. G." full particulars of this method if he wishes. I will also suggest an experiment which I had no opportunity to try myself, but think would succeed. If alumina be fused with iron, part of the latter is oxidised at the expense of the oxygen in the alumina, and the two metals combine to form an alloy. As sulphuric acid does not act on aluminium it might be possible to dissolve the iron out. If this succeeded I should say that plates of the alloy might be used in galvanic batteries as the active metal, and thus the aluminium be produced for next to nothing. Anyhow, I make the idea a present to any one who cares to try it.

With reference to all the late letters on high powers for day telescopic use, I believe the fact to be that persons accustomed to telescopic work can use high ones, when ladies and non-scientific men care more for a bright view. I have used a 3in. refractor for years, both here and in the Channel Islands, for day work, and always employ a power of 55, which I find most suitable for reading the names of ships—a good test.

"Aqua" (query 56961) will, if I remember right the tales I read in my boyhoood, find a device of the kind he mentions referred to in that wonderful book "The Swiss Family Robinson," where the fortunate family of that name finds in the course of time everything it can possibly require. I have heard something also of a "water tricycle," but do not know how it worked.

Tynemouth. **Garrison Gunner.**

### AËRIAL NAVIGATION.

[24466.]—Can any of your readers assist me by the suggestion of some very light material suitable for the construction of aëro-fans? In the model of my aërial propeller, now at the Alexandra Park, Muswell Hill, in the Exhibition there at present being held under the auspices of the Aëronautical Society, I use oiled calico as the material for their construction, and this material does sufficiently well to show the conception of the apparatus, and also gives a fair idea of its probable power; but I am not satisfied that the best results are obtained from it, and wish to change the material for something of a lighter character. Oiled silk would probably be an improvement on the calico, but I should prefer something lighter even than that, if I can procure it. In fact, I desire to employ a material of as low a specific gravity as possible; my theory being that the lighter the propellers are, the greater propelling power they will possess.

To render my meaning plain, and to support my theory, I will suppose that a solid cube of some material of considerable specific gravity, such as iron, be at a state of rest, and another cube of similar size but of lesser weight, such as wood, be projected with moderate force against it. The result of the impact would be that the heavier cube would remain unmoved, while the lighter one would rebound by the blow, owing to the moving force of the lighter weight failing to overcome the inertia of the heavier; and it is exactly this condition of things that I desire to realise with my propellers. I do not anticipate being able to construct them of any material less ponderable than air; but the lighter the material is, the more nearly will the approach be to the desired condition, as the lighter they are the less will be the movement of the air, the greater resistance offered to their action, and consequently the more effective propulsion. No doubt the shape of a bird's wing is a factor in its power of flight; but it is probable that the material of which it is constructed is of equal importance with the shape. If the numerous plumelets of which a feather is composed were deprived of the more ponderable or quilly portion of their construction, it is probable that the feathery or downy portion that remained would be less ponderable than the air itself; and if so, the action of these comparatively imponderable propelling surfaces against the air would be similar to the action of the wooden cube against the iron one; owing to deficiency of gravity, their movement would fail to overcome the inertia of the air, and the resistance to their action would result in effective propulsion, and consequently flight. **Chas. Groombridge.**

### ELECTRICAL.

[24467.]—With a battery of a given number of cells the maximum current is obtained, as is well known, by such an arrangement as makes the internal resistance of the battery as nearly equal as possible to the external resistance with which the battery is to be used. Thus, if we have $n$ cells, and connect the battery so as to have $a$ cells in series, and $b$ cells abreast ($n = a\,b$), that is, so as to have a battery of $a$ cells each $b$ times as large as a single cell. The resistance of each of these large cells is $\frac{r}{b}$ when $r$ denotes the internal resistance of one cell, and if further, E denotes the electromotive force of each cell, and R the external resistance, the current (C) is

$$\frac{a\,\mathrm{E}}{a\,\frac{r}{b} + \mathrm{R}}$$

$$\text{or } \mathrm{C} = \frac{b\,a\,\mathrm{E}}{ar + b\mathrm{R}} = \frac{n\,\mathrm{E}}{ar + b\mathrm{R}}$$

Very few textbooks attempt to give any *proof* that C is a maximum when $a\,\frac{r}{b} = \mathrm{R}$. The following simple proof may, therefore, be interesting:—If $x$ and $y$ are two numbers whose product is constant, then $x + y$ is *least* when $x = y$. For, since

$$(x + y)^2 = x^2 + 2xy + y^2$$
$$\text{and } (x - y)^2 = x^2 - 2xy + y^2.$$
$$\therefore (x + y)^2 - (x - y)^2 = 4xy$$
$$\text{or } (x + y)^2 = 4xy + (x - y)^2$$

Now, since $xy$ is a constant, $4xy$ is also constant; and we see that $(x + y)^2$ is greater than a certain constant number by a quantity $[(x - y)^2]$, which is *least* just when $x = y$. $(x + y)^2$, and therefore, also $x + y$ is a maximum of $x = y$. Hence, in the formula

$$\mathrm{C} = \frac{n\,\mathrm{E}}{ar + b\mathrm{R}}$$

the condition of maximum current is that $ar = b\mathrm{R}$, or that $a\,\frac{r}{b} = \mathrm{R}$; or in words, the internal resistance of the battery must equal the external resistance. **X. N. X.**

### NEW TRAINS, &c.

[24468.]—Can some correspondent say whether the 8 p.m. from King's Cross is correctly timed in Bradshaw? It would seem that it runs from Newcastle to Edinburgh without the usual stop at Berwick, 123 miles in 2 hours 55 minutes. How do the engines manage about water? Do they pick it up, or are the N.E.R. tenders of such abnormal size as to carry all that is necessary. There have been some very great developments in speed lately, and increase in the number of trains running at high speed, and I think that, at present, the L. and N. W. are running the fastest. Their 12 noon to Rugby runs from Willesden there in 88 minutes, a distance of 78 miles, and just beating the Dutchman. Another improvement which has been gradually noticeable is the punctuality observed on the important lines. The G. N. R. and the M. R. always were praiseworthy in this respect, and now a train five minutes late is the utmost rarity on the G.W.R. and L.Y.R., on both of which lines I travel frequently. I can understand a driver on a long trip—say, from Rugby or Grantham—with a good head of steam, getting ahead of the time-table; but I always have wondered how, as on the G.N., they can in a two hours' run hit their time almost to a second.

Are there any engines on the L. and N.W. which run to Crewe and back on the same day? I have always understood that a run of 200 miles was looked upon by drivers as a full day's work. I have seen at the Inventions Exhibition a brake called by its inventor "The Gravity," an improvement, so the prospectus states, on the ordinary method of working the vacuum, in that the brake block is allowed to fall on the wheels by its weight, and no force is used save that which releases it. Is this anywhere in practical use?

**John T. Lawrence.**

### DYNAMO MACHINERY.

[24469.]—In his recent work on this suliject Prof. S. P. Thompson makes some calculations on the efficiency of large and small dynamos. In the experimental data the effects of two sets of wire coils are given, one pair of coils being double the linear dimensions of the other one, and the working effect of the larger coils is estimated as 32 to 1. I should like to know from some of your readers who are more advanced in the modern methods of mathematical determination, whether this is strictly correct, as in my view of the matter the proportion is 8 to ½, that is as 16 to 1:

For the larger coils have the effect 2 by 2 by 2 = 8, which is the cubic capacity of the coils and the distance from the neutral point of magnetic attraction will be twice that in the case of the small coils, hence 8 by two gives the mechanical pressure of 16, which is according to observed experiment, and the small coils by the same kind of calculation give the pressure 1; but the working effect in moving from the pressure 16 to zero, or the neutral point of magnetic attraction will be $\frac{16 + 0}{2} = 8$, which is the mean pressure for the large coils, and in the same way $\frac{1 + 0}{2} = \frac{1}{2}$, which is the mean pressure for the movement of the small coils to the neutral point of attraction; therefore the working power is as 8 to ½, and not 32 to 1, as estimated. The late Dr. Page made some calculations in regard to his axial engine coils similar to those of Prof. Thompson, but they were not evidenced by experiment.

In proportionate electromotive machines, so far as I have observed, for the same strength of current the effect is in proportion to the length of wire; but the very remarkable coincidence that copper conducts eight times better than iron, gives as a result that the maximum effect of electromotive engines is produced by winding solid iron cores for electro-magnets to *one quarter their diameter* instead of one half, as is the general rule for ordinary electro-magnets, and for the same reason the length of a round magnet should not exceed sixteen times its diameter.

**J. Sutcliffe.**

### LOGARITHMS.

[24470.]—Charles North (letter 24427) has almost answered himself. It would require logarithms of nine places at least to show the difference that he is in search of; he has used only seven-place logarithms.

**Dublinlensis.**

[24471.]—Why should Charles North expect a change not affecting the first seven figures of his $a^2$ to affect the seven-figure logarithm? His $b^2$ is but 121, which, by addition to his $a^2$ touches none of its first seven figures. Nor would it by subtraction, if the last three exceeded 121, which they do in more than seven cases out of eight. Or rather, it never would, if the seventh figure be rightly reckoned.

**E. L. G.**

**London Stereoscopic and Photographic Co.**—Elsewhere this week will be noticed the prospectus of the London Stereoscopic and Photographic Company, a firm so well-known as hardly to require mention at our hands. This business, which has hitherto been carried on as a private partnership, should still further develop as a limited company. It will be seen in the prospectus referred to that the average profits are taken over a period of twenty-three years, and that owing to the very large increase in the amateur photographic trade, the latter results are even still more satisfactory. Although to recommend our readers investing their moneys is usually somewhat out of our line, we can safely, in this instance, make the exception, and will only add that any one desiring to become a shareholder should apply at once, for we understand that more than half the capital was subscribed for immediately it was announced. In conclusion, we would draw the attention of those amateur photographers who are amongst our readers to the fact that 1,000 shares are to be reserved to them, and it is quite expected that owing to their co-operation the dividends will be considerably increased.

## REPLIES TO QUERIES.

⁂ *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[56031.] — **Reservoirs.** — Many thanks to "Glatton" for noticing my query. It is not "misworded"; but I will explain. I want to evaporate a large quantity of liquid, and it must be done at a temperature not exceeding 112deg. F. Of course, to do this it will be necessary to work at a pressure below that of the atmosphere—that is to say, in a partial vacuum. I propose to have a boiler similar to a Lancashire boiler, with two or more tubes, if required. No heat to be applied to the bottom of boiler, so as not to disturb the sediment that would take place; the sediment to be taken out at end of week. The liquid is not very dense. I suppose there would be about four bushels after about 140 hours work, the quantity of liquor being as much as would flow through a ¾in. pipe, with a fall of 5ft. The vapour or steam from the boiler would have to be led into a surface condenser, and a pump fitted to condenser to clear it of water and to keep a vacuum. As this water would be very soft, and much better for my purpose than fresh water, I should use it over again. The condenser could be put 15ft. or 20ft. above the boiler, and the pump as much below condenser. I should be glad if "Glatton," or any other readers of the "E.M." could give me some idea as to the size and construction of pump suitable for my job. There would be no air to contend with, except the little that would be contained in the liquid. As I think there would be a small quantity in it, I should like to get a vacuum of some 10lb. or 12lb. per square inch if possible, and what I wanted to know by my query was, what thickness of boiler-plate would be required in a boiler or reservoir to stand this outside pressure of from 10lb. to 14lb. per square inch. I should be glad of any information upon the matter from anyone who will give it.—J. G., Bristol.

[56577.] — **Soap.**—Yes; cotton-seed oil (not deprived of its stearine) is used very largely indeed on the Continent in the manufacture of soaps, especially "silicate" soaps.—Percy W. Stanley, 119, Manchester-road, Poplar, E.

[56584.]—**Silvering Solution.**—Roseleur's bisulphate of silver method is by far the best, but rather tedious. The following gives fairly good results, though not to be compared with the above, which is almost as permanent as electro work: Dissolve 1 part nitrate silver in 20 parts water, and add ½ part sal-ammoniac. You will then get a precipitate of chloride of silver, which will dissolve on the addition of 2 parts of hyposulphite soda; add to the clear solution 2 parts of a milk of chalk and water, and it will be ready for use.—Percy W. Stanley, 119, Manchester-road, Poplar, E.

[56587.]—**Telephone System.**—The Leclanché No. 2 cell is the best. A ten-cell Leclanché is on at each station, arranged so as to use the whole ten cells for outward ringing and only four for the transmitter. There is a circuit with seven stations connected up on this system between Goole and Knottingley (length of line wire about 16½ miles), and has been working well for the past two years; could mention several others. Are you certain that you obtained a good earth at the stations which failed? Of course, for short circuits, say, under two miles, a six-cell Leclanché would do at each station and two of the cells for the transmitter, though for long telephone circuits it is best to use the magneto call bells with two to four cells Leclanché for transmitter. Will "S. M." kindly tell me how "intermediates" may be called up, as he says they are not in circuit when telephone is on hook.—R. F. S.

[56600.]—**Focal Distances of Images (U.Q.)**—This query has been overlooked by our mathematical correspondents, or, perhaps, not answered because an exact reply would be difficult of expression without algebra; but if the querist is willing to neglect the aberrations in the mirror, and the aberrations and nature of the glass in the lenses, perhaps the following will answer his purpose: Multiply the distance of lamp from mirror by twice the focus and divide the product by twice the distance of lamp, less twice the focus. In the case he proposes it will stand thus: $\frac{20 \times 6}{40 - 6} = 3\frac{18}{34}$, or a little over 3ft. 6in. in front of mirror, and if a double convex lens of 3ft. celestial or shortest focus be used, the answer will be the same, only the image will be the other side of the lens. Convex mirrors do not form a real image; their focus (virtual) is half their radius, same as concave.—A. N. H.

[56606.]—**Ink for Rubber Stamps (U.Q.)**—I presume by "preservative" you mean "fast" or "permanent." The usual stamp inks are simply solutions of aniline dyes in glycerol ("glycerine") and gum water, and have the disadvantage of drying slowly, and being easily washed off. This disadvantage may be got rid of in the case of dark colours, admitting a yellow colouring matter, by dissolving gum in a solution of bichromate of potash in water, so that the glycerol becomes mixed, and the colouring matter, if not of a dissolvent nature, is "buryed." As a substitute for glycerol, water-glue has some excellent properties, especially that of making the impressions fast after drying. Vermilion and Prussian blue would be the best colours, if you do not care to use the aniline dyes.—Percy W. Stanley, 119, Manchester-road, Poplar, E.

[56620.]—**Steam-Carriages.**—Apropos to or with "Nun. Dor.," "Progress No. 2," and whom it may concern, I beg sincerely to inform them that a practical system of steam tramway locomotion is manipulated daily upon the common or ordinary traffic road now in existence from Stamford-hill in Tottenham to Ponder's End, and *vice versâ*. As the writer has had the opportunity and pleasure of witnessing the usual working of the engines and cars, he can speak favourably of the result. There appears no steam or smoke emissions from the chimneys, and the usual noise through the general working is no more, or as much as when worked formerly by horses. The stoppages and startings are effected in about a similar time, and with as much ease, certainty, &c., as was done on the former system. Taking into consideration all facts, I am apt to believe it ought to be called "Progress" decidedly, especially as I have been informed that the usual life of horses employed in pulling tram-cars is, on an average, five years; also, as steam has practically superseded horse labour in the mentioned direction, surely it is worthy of the title of progress. Honestly speaking, I think all those interested in progress can waste time worse than by going to Tottenham, Edmonton, or Ponder's End to witness the working of the steam locomotive and car tramway, and kindly apprise our brother readers with the result.—E. F. Baker.

[56620.]—**Steam-Carriages.**—Before proceeding further with the question of motive power and vehicles for highway roads, I think it absolutely necessary to determine as to the bearing the wheels of the vehicles are to travel on, as that will distinctly alter the conditions as to build of the carriage, also the class and power of the motor. In my letter, p. 371, I wished to refer more particularly to their future position: and looking back to correspondence which has appeared in the "E. M." since this discussion began, it may be considered satisfactorily proved that there is not any difficulty in providing mechanical power in lieu of horses; but the difficulty lies in using that power on macadam (broken stone) road, and the principal causes of that difficulty arise—first, from a rough surface of stone; and, second, from the principle of applying the power of the engine through the medium of the wheel-tire's adhesion to the road to obtain, or rather transmit, tractive force to draw the load, both of which difficulties can be overcome—the first by a better (hard level) style of road; and, second, by using the force to "propel" instead of to draw the load—a crude description of which I will attempt to give. I have seen specification and drawings of patent now filed for completion by which it is proposed to provide either wheel tracks, each of about 8in. to 12in. wide on surfaces, or "ways" of about 6ft. wide, the whole surface of which can be made to same pattern, either of iron or of artificial stone, and thus give a bearing for either flange wheels or any description of vehicle, from a bicycle to an omnibus or tramcar, with wheels of any width within the width of "way." Most of the correspondent's notions seem fixed on steam power. I had an idea of having a steam-carriage built, but weight was an obstacle I could not overcome, and which being the cause of such a great increase in first cost and after maintenance of road, that I have abandoned steam in favour of gas as a motive power. As inventors are by other people at first supposed to be rather crazy, they will, no doubt, dub me so when I say I am preparing to build a train of five vehicles, close-jointed as one carriage, and almost turn a circle within its own length; four of the vehicles will seat ten persons each (on a double seat back to back), the other will seat two persons (driver and lad), also contain reservoir of compressed gas; each vehicle with its own small gas-engine will propel itself by the piston's pressure direct on the road (approaching the action of a horse's foot on the ground), the gas to ignite by electricity under command of the driver. The same description of train-carriage (minus the gas arrangement) can also be worked either by pedal or hand power of the passengers, and all cost of motive power avoided. Of course the iron bearing and flat tire wheels are included as part of the arrangement. As I have stated before, I believe there are very great undeveloped advantages pertaining to the joint use of the iron rail and mechanical motive power, and which ought to be brought into more general use. There are still seven or eight queries and statements in my letter on p. 328 I should like discussed for mutual advantage; ridicule, the unfailing fate of new notions, can be dispensed with until our ideas are better comprehended.—Progress No. 3.

[56626.]—**Fermentation in Horehound and Hop Beers (U.Q.)**—Does a "Poor Brewer" fine, or, still better, filter before bottling? Almost all "brewers' chemists" sell various "preservatives" or "antacids," or "antiferments," for the purpose of preventing secondary fermentations. The best of these is, perhaps, dry calcic sulphite, as it does not impart taste as does bisulphite of lime. I shall be happy to give any further hints if desired.—Percy W. Stanley, 119, Manchester-road, Poplar, E.

[56633.]—**Cleaning Glass.**—I have never found anything to equal for this purpose a strong solution of carbonate of ammonia.—Percy W. Stanley, 119, Manchester-road, Poplar, E.

[56650.]—**Lead - Burning.**—To Mr. Davies and Mr. Holmes.—At the Inventions Exhibition, South Gallery, North Court, Stand 220, there is a machine for lead burning, &c., and also with it there is some very good specimens of work done with it at a comparatively small cost. It does away with all zinc and vitriol, and the flame is very clean and is easily regulated. Amongst other things, it is strongly recommended for safety, economy, cleanliness, and the machine can be carried and used anywhere, and the cost of charging it is but very little. I trust that if any of "Ours" get one, they will kindly give us the benefit of their experience.—W. C. Crick.

[56650.]—**Lead-Burning.**—Referring to correspondence now passing between Mr. P. J. Davies and Mr. Holmes upon the above subject, and considering the same emanated through my queries addressed to Mr. Davies, I think it would not be out of place to here state that after making the machine, I unfortunately charged the same with sulphuric acid purchased from a druggist's shop, and have since discovered this was the sole cause why the machine would not work satisfactorily, hence my letter, p. 267. I have since bought acid direct from chemical works, as per instructions, and am pleased with its results, having no trouble to contend with, and am able to say that the machine is a 6in. one, made from "Practical Plumbing Work," page 54, and will work without the least attention for about three hours. With reference to Mr. Holmes's remark that Mr. Davies always brings his book into question, I should most certainly say that well he may, for I am convinced, speaking as a practical man with about 25 years' experience, nothing better for good sound practical instruction could possibly be published, inasmuch that it is just the thing required to prevent young plumbers getting into a slovenly method of executing their work.—A Beginner.

[56679.]—**Supported Beam.**—With reference to the remarks under this heading in the "E. M." for June 19th, I have only to repeat the statement made in my previous reply. If your correspondent will carefully analyse the conditions which insure the stability of the beam, he will find that there is a tendency to break by shearing at every point. It used to be assumed that no such strain existed at the centre, but I did not think that idea was entertained nowadays. In any case, however, the correct answer to the query is that there are not any points at which the beam would have no tendency to break: otherwise it might be cut through at that point without producing any weakness. It must be remembered that, as stated by the querist, the question is one set by the Science and Art Department, and the general instructions at that exam. state that the student must confine himself strictly to the question proposed, for if he does not do so his paper will be cancelled. It is not the business of the student to discover what the examiner really means to say, he has only to deal with what actually is said. I presume, of course, that your correspondents were aware of the regulation quoted above; if they were not, I submit they were incompetent to answer the question.—Bacchus.

[56680.]—**Induction Coils.—Vertical Plan (U.Q.)**—All that is needful is to wind tightly, and maintain a uniform speed. If the disc were placed between the operator and the light, there would be no difficulty in seeing how the wire was going on; but, in practice, sections so narrow as $\frac{1}{20}$in. are never necessary, and, if employed, they would involve a great waste of space. The narrowest divisions which I have myself used were $\frac{1}{10}$in., and this was in dealing with extremely fine wire. Much, however, depends upon the quality and thickness of the covering; and in determining the dimensions of the sections for any coil, the concurrent details of construction would have to be considered.—Ernest Baugh, Haverfordwest, Pem.

[56689.]—**Battery for Electric Lamps.**—I think "Sm" ought to explain where he found the statement about the "new batteries," and possibly also apply to the "authority" for the further information he requires. I do not mean to say that such a question ought not to be put to the readers of the English Mechanic; but really there are so many of them who would like to have 14 to 16 lamps of 8 to 10-candle power capable of running for 12 to 14 hours from a battery of 16 cells that the querist ought to furnish more information himself, when some of us may be able to hunt out a battery which has hitherto been contented to hide its light under a bushel. I suppose it costs nothing for exciting materials, as the products are sold for a high price.—Nun. Dor.

[56691.]—**Water-Gas.**—The composition will depend to a slight extent on the nature of the fuel used; but in any case the bulk of the gas will be hydrogen and carbonic oxide. There is a great deal about the subject in back volumes.—Essar.

[56696.]—**Conductive Glue or Cement.**—This query is certainly a most peculiar one, for a conductive cement is readily obtained by using ordinary solder. Any of the cements that can be applied with a brush would probably be found to be non-conductors unless the litharge and glycerine mixture would do. If the plates are not thick, why not couple them by bending the corners together?—Nun. Dor.

[56704.]—**Soft Black Carbon.**—This stuff will not do for blacking, I should think, though it is not quite clear what it is. It might be used for moulding battery plates by cementing it up with treacle and carbonising.—Nun. Dor.

[56713.]—**Coal versus Coke.**—Coke is an excellent furnace fuel, but requires large grate area and free admission of air. According to some statements it is at least quite as efficient as coal from the "evaporative power" point of view.—Essar.

[56714.]—**Heat Absorber.**—I would suggest asbestos; but until the querist gives one a definite idea of what he wants to do, it is useless guessing.—Essar.

[56716.]—**Hartley's Gas Calorimeter.**—At the stand of A. Wright and Co., 1478, East Arcade, Inventions Exhibition, the querist can see a Hartley's calorimeter, and on sight will be better able to judge of his ability to make one.—Essar.

[56719.]—**Waterproofing Cloth.**—This is one of those queries which no one cares to answer. Surely, if your correspondent wishes for information on the subject, that is easily obtained by making a few experiments. He may, however, be told that all solutions of the kind should always be made with hot water.—T. J. M.

[56720.]—**Mirror Painting.**—Clean the glass thoroughly, and paint with oil-colours, such as are used by artists. See p. 520, Vol. XXXIX.—Mirror Painter.

[56724.]—**Accumulator.**—"P. T. H." should pay a visit to the Inventions Exhibition, but how long the accumulator would "last" depends on what is meant. If its age is meant, that depends on the arrangement and how it is treated; for its capacity for lighting at one spell, that depends on its size and charge.—S. P. T.

[56729.]—**Clock Winding.**—Surely this query is of no interest to anyone but the questioner. He must make his private arrangements himself, and if he does not know what he can do for a given sum, he does not understand his business.—T. J. M.

[56730.]—**Six's Register Thermometer.**—Try the effect of gentle heat, which will vapourise the spirit and cause it to take its proper place. Shake gently, so as to give it an opportunity of escaping from the mercury.—Philos.

[56732.]—**Dyeing Damask Curtains.**—If this querist cannot refer to back numbers he had better give his curtains to the dyers. On no account must he dose with Judson's dyes.—Dyer.

[56744.]—**Softening Water.**—I find the Porter-Clark process a perfect success in softening water, so far as regards carbonates (of lime or magnesia) by the use of caustic lime only. But, in the case of sulphates (of lime and magnesia) also present in the water, I find it necessary to add carbonate of soda with the caustic lime. This prevents all hard scale in steam boilers; but there is still some precipitate of soft mud in boilers; therefore the filters do not appear to keep back all insoluble matter. Or probably the sulphates are not decomposed (and rendered insoluble) until affected by the heat in steam boilers. If so, then the usual soap test for hardness is delusive for sulphates (on the addition of soda), as the presence of free soda will naturally neutralise the reaction of soap on lime. Perhaps some chemist will now kindly explain the correct reactions which occur.—Jib.

[56796.]—**Boiler.**—Many thanks to "J. B." for kindly drawing my attention to an error very possibly arising from the peculiarities of my caligraphy, thus leading the compositor to set up 2oz. when it should have been 2lb. My rule is as follows: Multiply area of valve in square inches by pressure of steam required. Divide total length of the lever by the distance of the centre of fulcrum to centre of valve to find the ratio; then divide the first product 12·00 by the ratio 6, which will give the weight required in pounds.—in this case 2lb. Weight of valve and lever in such a small valve not included in the calculation, but allowed for, as you will see in my reply as estimated.—Invicta.

[56813.]—**Fracture of Water-Gauge Tube.** "Nun. Dor.," in commenting upon my reply to this query, appears to have floundered out of his depth, and his remarks lack the sound sense we are accustomed to expect in all his statements. I unhesitatingly dispute the assertion that glass tubes often break after they have been cleaned, unless, indeed, the man who cleans them is culpably careless. I have never known an iron wire to scratch a glass tube, and it is certainly not the means usually employed to break them. If "Nun. Dor." has been told that this is the case, he has been grievously misinformed.—Bacchus.

[56847.]—**To Mr. Lancaster or "Rob. Crus."**—Neither the 40in. nor the 50in. o.g. would be preferable on account of its focal length simply. The shorter focus is long enough for anything in the ordinary way astronomical, and too long for a portable terrestrial glass. The longer focus would be nice in use on the moon, if its optical condition was good. You don't say if you mean to make your o.g.—Rob. Crus.

[56856.]—**Engine Query.**—The replies given by "R. W." and "A. B. C." are both incorrect, or there is a misprint, as they will find on looking through the figures again. According to the working of the latter, the excess of work done over power of engine is 293·333 foot-lb. The question should read *gauge* pressure, not pressure on piston, which would then give a pressure of 25+15=40lb. per sq. inch. Then, working as follows, you get the right answer. Work done in six minutes in foot-lb. = 400 × 2240 × 10 = 8,960,000.;Power of engine developed in six minutes = 400 × 40 × 4 × 2 × 15 × 6=11,520,000. ∴ No. of foot-lb. lost = 2,560,000, or $\frac{2}{9}$ths of the power. I may add this question and the two following ones are from Prof. Goodeve himself, and not from someone bearing his name, as suggested by "Invicta" in yours of June 26, and were set by him in a recent examination. The above is a favourite "catch" of the Professor's.—Fred. A. Robinson.

[56859.]—**Vertical Galvanometer.**—The detector of which "M.M.I.Sc.S." speaks, probably fails from its pivots being too short for their holes, so that when laid on its back the axis of the needle takes its bearing on the shoulder of the pivot instead of on its sharp end; this should not occur in a well-made instrument. Of course, as "Sigma" so well explains in your last issue, it cannot be used in this position as a *galvanometer;* its use as a galvano*scope*, to detect if a current passes or not, is all that is spoken of by "Culley." For the rest, I can add nothing to "Sigma's" reply; but I may inform "Os." that at a time when no more sensitive instrument was to be had, I often found I could detect a leak in a wire with the detector when horizontal which I did not detect when it was vertical, and I think it useful to describe this way of making the apparatus more sensitive in case of need.—R. S. Culley.

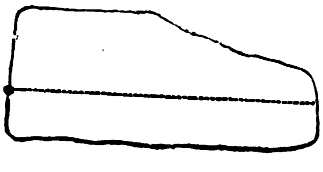
[56878.]—**Mineral Water.**—Acetic acid is used very largely in the making of aërated waters in some of the large towns. It is only fit to use in goods for a shop trade to be sold at 1d. per bottle, and makes very decent stuff. It is not so very much like drinking vinegar and water as "Os" seems to imagine. Of course, only the best must be used—either Champion's or Beaufoy's. Don't use pyroligneous acid. Quantity: 4oz. to one gallon of syrup.—Carbonado.

[56882.]—**Catalogue for Lending Library.**—If I were to compile a catalogue for a lending library I would first arrange the books under their titles, next under their author's names, and thereafter under the subjects upon which they treat as astronomy, fiction, &c.; of course, in every case they would be arranged alphabetically and would have their numbers opposite. By this means, when only the title or author's name is known, the book can be at once found, and any person wanting a book upon any subject would find it under its heading. As to bookkeeping, I would keep two books, one ruled with three columns, with the reader's name at the top. In the first column I would enter the date (in figures) when the book was given out, in the middle column the number of the book, and when returned would mark the date in the third column. As these columns are very narrow, three or four could be put in a page. The second book would contain only the numbers of the books, and when a book was given out I would mark the page and column opposite the number of the book given out, so that, if a book were to be missed, by turning up its number the page and column containing the name of the reader who had it last could be found.—James M'Cash Govan.

[56884.]—**Gramme Dynamo.**—About 9in. long, 3in. diameter; substance of ring $\frac{3}{8}$in., height of cogs above the ring $\frac{1}{4}$in.—S. Bottone.

[56895.]—**Cutting Wards of Keys.**—I cut those that are required about the house with a hacksaw or with a file. I should fancy that a small emery wheel would do very well for the purpose if you used it lightly.—Thos. H. Hall.

[56903.]—**Steam.**—A non-condensing engine is one which exhausts into the atmosphere, and so has a constant back pressure upon the piston of 15lb. per square inch, thereby reducing the effective pressure by that amount. A condensing engine, on the other hand, exhausts into a condenser, the construction of which will be found fully explained in issues June 5th and 12th, in replies to query No. 56699 by Mr. Plucknett and "Invicta." A jet of water coming into contact with the steam escaping from the cylinder condenses it, and creates a partial vacuum, thereby reducing the pressure on the back of the piston to about 4lb. per square inch. Assuming this to be the pressure, obviously the gain in effective pressure will be 11lb. The diagram shows roughly the advantage gained by condensing. The dotted line represents the line of atmospheric pressure; and if the engine were non-condensing, the part above this would represent the power. But if the back pressure is reduced as shown above, the indicator pencil drops, and increases the area of diagram, such increase accurately representing the gain derived from using a condenser. In reply to the third part of this question: By Boyle's law, the pressure of a gas is inversely as the space it occupies; therefore, by dividing stroke into five parts, the pressures at the points will be 55lb., 27½lb., 18⅓lb., 13¾lb., 11lb., which added together and divided by 5, gives an average pressure of about 25lb. per square inch. Therefore, h.p. for one stroke of engine is $\frac{25 \times 144 \times 3 \times 32}{33,000 \times 12}$ $= \frac{48}{55}$ h.p.—Fred. A. Robinson.



[56904.]—**Problem.**—"Bunsen" wants the coefficient of the middle term of $(x + a)^{4n}$. Let him, for convenience, assume $2n = r$ ∴ then the $r + 1)$th is the middle term, and is

$$\frac{2r\,(2r-1)\,(2r-2)\ldots\ldots(r+1)}{1\,.\,2\,.\,3\ldots\ldots r}$$

$$= \frac{1\,.\,2\,.\,3\ldots\ldots r\,.\,(r+1)\ldots\ldots(2r-1)\,2r}{(1\,.\,2\,.\,3\ldots\ldots r)^2}$$

$$= \frac{1\,.\,3\,.\,5\,.\,7\ldots\ldots(2r-1) \times 2\,.\,4\,.\,6\ldots\ldots 2r}{(1\,.\,2\,.\,3\ldots\ldots r)^2}$$

$$= \frac{1\,.\,3\,.\,5\,.\,7\ldots\ldots(2r-1) \times 1\,.\,2\,.\,3\ldots . r \times 2^r}{(1\,.\,2\,.\,3\ldots\ldots r)^2}$$

$$= \frac{1\,.\,3\,.\,5\,.\,7\ldots.(2r-1)}{1\,.\,2\,.\,3\ldots\ldots r}\,.\,2^r$$

and replacing the value of $r$

$$= \frac{1\,.\,3\,.\,5\,.\,7\,.\,(4n-1)}{1\,.\,2\,.\,3\ldots\ldots 2r}2^{2n}$$

—Q. E. D.

[56904.]—**Problem in Algebra.**—$(x + a)^{4n} = x^{4n} + 4na\,x^{4n-1} + \frac{4n\,(4n-1)}{1\,.\,2}\,a^2 x^{4n-2}$ + &c. The middle term of the expansion will be the $(2n + 1)$th term; and its coefficient will be—

$$\frac{4n\,(4n-1)\,(4n-2)\ldots\ldots\ldots[4n-(2n-1)]}{1\,2\,3\,4\quad\ldots\ldots\ldots\quad 2n}$$

which

$$= \frac{4n\,(4n-1)\,(4n-2)\,..\,(2n+1)}{1\quad 2\quad 3\quad 2n}$$

$$\times \frac{2n\,.\,\overline{2n-1}\ldots\ldots 3\,2\,1}{2n\,(2n-1)\ldots\ldots 3\,2\,1}$$

$$= \frac{4n\,(4n-2)\,(4n-4)\ \ldots}{2n\,(2n-1)\,(2n-2)\ \ldots}$$

$$\frac{8\,6\,4\,2 \times (4n-1)\,(4n-3)\ldots\ldots 5\,3\,1}{4\,3\,2\,1 \times (2n\qquad(2n-1)\ldots\ldots 3\,2\,1}$$

$$= 2^{2n}\,\frac{1\,3\,5\ldots\ldots\ldots\ldots(4n-1)}{1\,2\,3\ldots\ldots\ldots\ldots 2n}$$

—Geo. Smith.

[56904.]—**Problem in Algebra.**—By binomial theorem, the middle term of $(x + a)^{4n}$ is $\frac{4n\,(4n-1)\ldots\ldots(2n+1)}{1\,.\,2\,.\,3\ldots\ldots 2n}$. We have, therefore, to show that the numerator of this fraction is equal to $2^{2n}\,(4n-1)\,(4n-3)\ldots\ldots 5\,.\,3\,.\,1$. Put $n = m - 1$, and assume the theorem to be true for this value of $n$, so that

$$(4m-4)\,(4m-5)\ldots\ldots(2m-1)$$
$$= 2^{2m-2}\,(4m-5)\,(4m-7)\ldots\ldots 5\,.\,3\,.\,1.$$

Multiply both sides of this by $4\,(4m-1)\,(4m-3)$ and we have

$$4m\,(4m-1)\,(4m-2)\ldots\ldots(2m+1)$$
$$= 2^{2m}\,(4m-1)\,(4m-3)\ldots\ldots 5\,.\,3\,.\,1.$$

Hence, if the theorem is true when $n = m - 1$, it is true when $n = m$; but it is obviously true when $n = 1$, and therefore, when $n = 2$. Hence, when $n = 3$, &c., it is generally true.—C. Planck.

[56909.]—**To Mr. Bottone.**—Diameter of ring (exclusive of cogs) 4in., length 4in., thickness of ring ½in., height of cogs ⅜in.—S. Bottone.

[56913.]—**Weatherproof Paint.**—Try the patent indestructible paint, sold in several colours at 4d. per lb. I believe it resists nearly everything. —A. Richardson.

[56914.]—**Socket Joint-Making.**—Equal parts white and red lead and boiled linseed oil to form a putty is a very good cement for water apparatus, or boiled linseed oil and red lead. I would recommend "Anxious" to caulk with the following cement:—2lb. iron borings, 1oz. sulphur, and 1oz. sal-ammoniac.—A. Richardson.

[56921.]—**Heat for Workshop.**—Our Editor kindly illustrated the very thing you want on page 139. It gives 4 to 6 candle-power six hours for one penny. Perfectly safe, clean, and simple; is cheap, and lasts a lifetime.—T. Wood.

[56924.]—**Logwood and Gall Liquors.**—The strength of liquors is usually tested by an instrument styled an hydrometer. There are several varieties, the best known being those of Twaddell and Beaumé; I employ a form of the latter for this purpose. You nearly fill your solution glass with the liquor to be tested, and insert the hydrometer (a hollow glass spindle and bulb weighted at the bottom with mercury). Now, it is evident that since the weight of the liquor displaced is equal to the weight of the instrument, the latter will sink far into a light liquid, and a less distance into a dense one. The spindle is marked into degrees, 0 to 25°, the former indicating the gravity of water. I have no rules by me; but I should imagine a decoction of a pound of logwood in one gallon of water would mark about 5° B. The strength of a solution of extract compared with that of a decoction of the chips (equal weights) would probably be about 6 to 1.—Percy W. Stanley, 119, Manchester-road, Poplar.

[56930.]—**Three Problems.**—The odds being three to 1 against, 5 to 1 against, and 7 to 1 against, the chances of winning will be represented by the fractions $\frac{1}{4}$, $\frac{1}{6}$, and $\frac{1}{8}$, and the chances of losing by $\frac{3}{4}$, $\frac{5}{6}$, and $\frac{7}{8}$. The chance of—

Winning 1st and 2nd, and losing 3rd
$$= \frac{1}{4} \times \frac{1}{6} \times \frac{7}{8} = \frac{7}{192}$$
Winning 1st and 3rd, and losing 2nd
$$= \frac{1}{4} \times \frac{1}{8} \times \frac{5}{6} = \frac{5}{192}$$
Winning 2nd and 3rd, and losing 1st
$$= \frac{1}{6} \times \frac{1}{8} \times \frac{3}{4} = \frac{3}{192}$$
Winning all three $= \frac{1}{4} \times \frac{1}{6} \times \frac{1}{8} = \frac{1}{192}$

Since these are dependent events, the chance that one or other of them comes off will be given by their sum $= \frac{16}{192} = \frac{1}{18}$. Thus the odds against winning at least two are 17 to 1. If we wish to win just two, neither more nor less, we must exclude the case of winning all three, and the chance $= \frac{15}{192} = \frac{5}{64}$, the odds being 59 to 5 against. The chance of winning two running depends, of course, on the order of the events. Assuming they occur in the order printed, the chance that he wins the first two $= \frac{1}{4} \times \frac{1}{6} = \frac{1}{24}$, and the chance that he loses the first and wins the other two $= \frac{3}{4} \times \frac{1}{6} \times \frac{1}{8} = \frac{1}{64}$. ∴ The chance that he wins two running $= \frac{1}{24} \times \frac{1}{64} = \frac{11}{192}$; or the odds are 181 to 11 against. Concerning the third question, as asked, it is identical with No. 1. Possibly "Perplexed" fancies that since, if the runner wins the first two heats he has not got to run in the third, there may be some difference in the result, but such is not the case.—C. Planck.

[56932.]—**To "M.I.C.E."**—In the expression for the value of $r$ in my reply to this query, the fractions attached to the figure 2 in the numerator and denominator are intended for indices, and not as they are printed. A good sequel to this problem is to suppose *two* holes at right angles to each other bored through the sphere, the axes of holes passing through centre of circle. Find what the radius will be (both holes being same radius) when the volume of sphere is reduced by one-half. There is some very neat integration required where the two holes cross each other, and the result is also neat.—M.I.C.E., Bath.

[56932.]—**To "M. I. C. E."—Hole in Sphere —Periphery of Ellipse.**—I was glad to see that my problem had interested "M. I. C. E.," and that he had worked it out so as to obtain a definite expression for the radius of the hole. I quite agree that it is merely a chance approximation, but it is a close one. Taking "M. I. C. E.'s" figures, we have 3·648 × 2 = 7·296 for diameter of hole (I had made it 7·3), while the mean between the side of pentagon and its arc is 7·2967. As "M. I. C. E." takes such interest in questions of this nature, I will call his attention to a problem that I have been working at—viz., to find the periphery of an ellipse, say, of one whose axes are 8in. and 4in. The common rule is very inaccurate, while the more exact expression takes the form of an awkward and slowly-converging series. Looking at such an ellipse, it is apparent that the common rule of using the half-sum of the two axes as a mean radius fails, because it does not recognise the proportion of the periphery due respectively to the longer and shorter radii with which we may consider the curve to be described. In order to obtain a mean radius we must give more weight to the greater length of the flatter than of the sharper curve, and it is in this direction I have been working. Having drawn the ellipse, we will (for brevity's sake) deal only with one quadrant of it. Divide the semi-major axis into (say) 10 equal parts, and from the extremity of the minor axis draw through the points of division lines cutting the arc of the ellipse, which will thus be divided into 10 unequal parts, gradually diminishing from the centre to the extremity of the ellipse. Join each point of division to both foci (found in the usual way), bisect the angles, and draw the normals. Produce these normals till each intersects the previous one, and we shall have a series of approximate radii of curvature. Measure the lengths of these radii and the angles between them. Multiply each radius by the angle between it and the next radius. Divide the sum of these products by the sum of the angles (which will always be 90°), and the quotient will be the required mean radius. In the above example I get a mean radius of 3 082in., which gives 19·36 for the periphery, while by actual measurement I made it 19·40. I would, therefore, ask "M. I. C. E.," in the first place, what he makes the periphery of this ellipse; secondly, whether it is practicable to obtain by calculation, instead of by measurement, the lengths of the different radii and the angles between them; thirdly, whether he considers it possible to devise a general expression that shall embrace the whole, and give the corresponding mean radius? Can "M. I. C. E." also inform me what is the curve on which lie the intersections of the radii obtained as above? It is suggestive of an ellipse whose major axis is equal to twice the maximum radius of curvature, and minor axis equal to the distance apart of the foci of the original ellipse; but I scarcely think such is the case in reality, as the curve is imperfect towards the extremity where the radii are least: it is not evident how it would end if completed.—A. S. L.

[56935.]—**Choke Damp.**—$CO_2$ = carbonic anhydride = carbonic acid gas. It is formed, when an explosion occurs in a mine, by the union of the hydrocarbons in coal-gas with the air.—R. A. R. Bennett.

[56935.]—**Choke Damp.**—This is the name given to the products of combustion of marsh gas, usually termed fire-damp (and of which there are often great quantities in mines) and the oxygen of the air; the chemical name for this exceedingly dangerous gas is carbonic anhydride ($CO_2$) and the combustion thereof, expressed in a symbolic equation, is—

$$CH_4 + 2O_2 = 2H_2O + CO_2$$

The pressure of this gas after an explosion has, very often, more dangerous results, as it gives rise to suffocation, than the explosion itself.—A. B. C.

[56936.]—**Patent Law.**—No; it is a uniform rate, whether the patent be worth a shilling or a thousand pounds. You can obtain provisional protection for £1 1s. 6d., £1 the stamp, and 1s. 6d. the affidavit.—C. D. R.

[56936.]—**Patent Law.**—The fees payable to the Government are the same in all cases; but they are now reduced to £1 on the provisional, and £3 on the complete specification, so that for £4 Government fees a patent can be obtained. Of course the patent agent's fees for his services would be in addition to this £4.—Invicta.

[56936.]—**Patent Law.**—The amount payable as fee for any invention is, on application for provisional protection, 20s.; on filing complete specification 60s.; or on filing complete specification, omitting the provisional, £4. In either case protection is obtained for four years, if the application is accepted.—F. M. Rogers.

[56936.]—**Patent Law.**—The amount to pay on a patent does not vary according to the invention. First tax to be paid is £1 with the provisional specification. After filing the above, a period of nine months is allowed, during which time you must lodge a final, and pay the sum of £3. At the end of the fourth year from the date of the provisional, a fee of £50; and at the end of the eighth year from the date of the patent, £100 must be paid. But if you do not care to pay in a lump sum, the office allows it to be done by instalments of £10 10s. Any further information I shall be happy to give.—Thos. H. Hall.

[56938.]—**Electro-Magnet.**—You can fit the magnet on to a brass support without fear of interfering with the holding power.—C. D. R.

[56938.]—**Electro-Magnet.**—The power of a magnet is always concentrated at the extremity of the poles, so that a hole bored through the centre for a spindle of brass will not affect the holding power.—Bobadil.

[56939.]—**Armature.**—There are two forms of Siemens armature—viz., the old, or H-pattern, and the new or Siemens-Alteneck, or drum-pattern. Will you kindly indicate which you desire, and I will describe?—S. Bottone.

[56940.]—**Ammeter.**—A simple measuring instrument may be made by inclosing a small magnetic needle in a few turns of thick copper wire, calibrating same in the ordinary way. The needle should be as light as possible to insure its being dead beat, and should be carefully pivoted. It should be re-calibrated frequently to insure accuracy.—F. M. Rogers.

[56942.]—**Electro-Magnet.**—It is not the kind of electricity you want. If properly made, and wire insulated, a battery (preferably Daniell's) would turn it into an electro-magnet instantly.—R. A. R. Bennett.

[56942.] — **Electro-Magnet.** — "D. W." has been trying to make an electro-magnet by employing the current from a magneto machine. Ordinary magnetos are never made for this purpose. Their work is to give shocks, and nothing more. Electric bells are not rung by similar machines, but with machines entirely different.—Bobadil.

[56942.]—**Electro-Magnet.**—It is hardly to be wondered that you failed. You had nothing near sufficient wire. To get a good result you should have had sufficient cotton-covered wire to form a coil equal to the thickness of the iron; the wire was also too thickly insulated to get enough on; but six turns would be quite useless. Then, did you cross the wire from the one bobbin to the other? because that has to be done in a specific way, and not at mere haphazard, whilst the magneto-electric machine you have is not suited to produce a current for exciting a magnet.—Invicta.

[56942.]—**Eectro-Magnet.**—You say that you have used "pitch-covered wire." I suppose you mean guttapercha? Whether or no, it is of no use. Cover the legs with either cotton or silk-covered wire. There is no occasion to insulate the wire with anything save what is already on it. By using guttapercha or pitch, as you term it, you entirely destroy the effect of the current. The magneto machine will not give you a current you can utilise, and therefore all the speed you can put into it is only loss of time. You must have a battery. The magneto bells as used in some telephones are of different construction to the ordinary ones.—C. D. R.

[56943.]—**Engineer's Bookkeeping.**—There is no standard of profit in estimating cost, which varies in most shops. Cost can only be correctly carried out by embracing every item concerned—viz., rent, wear and tear of tools, use of machines, files, labour; to be safe, a slight profit, 5 per cent. or $7\frac{1}{2}$ per cent., should be added to actual cost.—F. M. Rogers.

[56948.]—**Gas-Producing Apparatus.**—You have only to refer to the back Nos. of this journal for the information you want. Look up page 374 and you will find the drawing of the generator and air-pump, whilst on page 459 will be found further details and description. If you want more information, I am always glad to give you a little help. I must say that although now some four or five of these generators made from the descriptions quoted are at work satisfactorily, yet I would prefer an oil gas to benzoline or gasoline gas. Oil gas can be made from a fairly simple apparatus, but is necessarily more complex than the benzoline generator mentioned. That is entirely automatic as driven from the engine. Oil gas requires a fire and attendance.—Invicta.

[56949.]—**Aluminium.**—Aluminium is obtained from aluminium-chloride ($Al_2Cl_6$), by passing the vapour thereof over metallic sodium. But the aluminium-chloride has first to be prepared by heating a mixture of alumina ($Al_2O_3$) and charcoal in a current of chlorine gas.—A. B. C.

[56949.]—**Manufacture of Aluminium.**—The following is Webster's process for the manufacture of aluminium:—A given quantity of alum and pitch, which are first finely ground, are mixed together and placed in a calcining furnace, by which means 38 per cent. of water is driven out, leaving the sulphur, potash, and alumina, with oxide of iron. The calcined mixture is then put into vertical retorts, and steam and air are forced through, which leaves a residue of potash and alumina only. The residue is afterwards placed in a vat filled with warm water, which is heated with steam. The potash is then leached out, and the alumina left as a deposit. The potash liquor is then run off and boiled down, while the alumina precipitate is collected in sacks and dried. It is then ready for making chloride of aluminium. The alumina deposit thus obtained contains about 84 per cent. of pure alumina, while that which is obtained by the old process of precipitation has only 65 per cent. It is certified that the constituents of Webster's alumina deposit are as follows: Alumina, 84·10; sulphate of zinc, 2·68; silica, 7·40; water, 4·20; alkaline salts, 1·62. In order to complete the process, and convert it into aluminium, the aluminium chloride is treated with sodium, in order to withdraw the metal. The operations are completed in a few days, instead of nine months (which was the time it required to complete the old process), and the product costs only about £100 per ton, instead of £1,000. The sources of raw materials are inexhaustible, and everywhere distributed; 1 cub. in. weighs ·0972lb., the sp. gr. is 2·688, and its ultimate tensile strength is about 12 tons per sq. in. The range of elasticity is large, the extension at the yielding point being $\frac{1}{200}$ of its length. The modulus of elasticity is 10,000.—P. E. W.

[56951.]—**Dynamo.**—To Mr. Bottone or "W. H. E."—Wind the magnets with No. 16. Use No. 14 or even 12 on the armature, if you require only a low resistance, and are going to wind for a shunt machine. It is almost impossible to state exactly what quantity of each is to be used, unless the external resistance is specified.—S. Bottone.

[56954.]—**Boiler Query.**—Theoretically, $\frac{3}{16}$in. thick would carry the pressure; but I would warn you that such a boiler as you describe would be unsafe. The reason is that the oval flue would collapse before anything like 80 pounds pressure was reached. I am assuming that if you used copper plates with a theoretical strength of 33,000 per sq. in. of section, at anything like 80 pounds, you would be safer with even a slightly thicker plate, as copper rapidly loses its strength when exposed to heat, such as in the furnace; but on no account use an oval firebox. Let all parts be true circles, or you will most likely meet with a very serious smash.—Invicta.

[56955.] — **Photography.** — If you consider that dry-plate photographing does not answer so well as wet plate, I am afraid I must differ from you. If you use sodic sulphite developer, you will get black negatives, similar in all respects to those obtained by the wet-plate process. I think it is ten to one that the "street photographers" use dry plates too. You will find it an awful bother after using dry plates; but "chacun à son goût"—my "goût" being decidedly for dry plates.—R. A. R. Bennett.

[56955.]—**Photography.**—(1) Yes; you can take wet-plate negatives with any instrument that can take dry plates. (2) You will find the wet-plate process described in all the cheap manuals of photography. Your reasons for going back to the antiquated wet-plate process are incorrect, and rather show that you must improve your working of the dry plates. All trade photographers use dry plates, and you are quite in error in thinking that they take longer to develop and fix than wet plates. If you wish to turn out work like that exhibited in the streets, you will require to expend some money, beginning with, say, a Dallmeyer portrait lens at £23.—B.Sc., Plymouth.

[56956.]—**Ball Bearings.**—I am not at all surprised he has found his ball bearings have worn away as he states: it shows the amount of friction that has been going on, and hence the amount of unnecessary work. My advice to all bicycle riders is to avoid all ball bearings—it's quite a mistake, and no engineer in his senses would think of using them for the bearings of an engine or any other machine. If you want a bicycle to run easy, have the bearings made as wide as possible and made of the very best gunmetal, and well fitted, then you will find your bearings will hold their lubrication and run easy and last longer than any other bearings.—Chas. Hosken.

[56957.]—**Ball Bearings.**—I may add to the remarks of this gentleman that a mechanical friend who was busy making his own tricycle, brought me for my opinion a set of balls, which he had paid full price for as steel ones, but which on a casual test he felt sure were something softer. On applying the usual test I unhesitatingly advised him that they were cast iron hardened by immersion whilst hot in acid, thus giving them the appearance and surface hardness of hard steel. On my strong representation to the makers, they stated some mistake had been made, and sent my friend a new set, which were undoubtedly steel.—Invicta.

[56958.]—**Microscopical.**—This subject was thoroughly thrashed out about six months ago in "Ours." Every device was explained and illustrated.—S. Bottone.

[56959.]—**Castings.**—Try dusting the mould with a little East Indian plumbago.—F. M. Rogers.

[56960.]—**Riparian Rights.**—The bed of a river belongs to the owners of the banks, each having up to the middle of the river opposite his bank. If the river is navigable the public have a right of way over the bed; if it is not, there is no right of way, and no one can take a boat on such a river without the leave of the owner of one bank at that part.—M.

[56961.]—**Boating.**—Innumerable attempts to propel boats by paddle or screw worked by hand or foot have been made. All have been utter failures as compared with oars.—M.

[56961.]—**Boating.**—There are plenty of water velocipedes on the Thames; but they entail a lot of hard work, and very little speed can be got out of them.—C. D. R.

[56961.]—**Boating.**—I would advise a small screw pinion of, say, 20 teeth on screw shaft, driven by wheel of 60 teeth. Some years ago I saw quite a large boat propelled by an arrangement of this kind, and I believe it answered well.—F. M. Rogers.

[56961.]—**Boating.**—"Aqua" can see a small boat at Blackfriars Bridge fitted with paddle-wheels and worked by hand or foot power, or both; it is adapted for one or two riders, and will go eight miles an hour, with half the labour of rowing.—J. Adams.

[56961.]—**Boating.**—Yes, the plan has been tried many times. If you turn to the *Mechanics' Magazine*, No. 96 for June 25th, 1825, you will find there what is termed a "water horse." In that machine the paddles were driven by a strap put in motion by a drum turned with a winch handle. More recently we have the water velocipede of the "Wheeleries" fame; whilst in the Inventions will be found a tricycle with buoyant wheels for marine propulsion as well as on land. It would be easy for me to give you a plan of a propeller worked by handles and steered by the feet. But it is not possible to do so without you are prepared to put forth a certain amount of labour. I have seen several fairly large canoes or boats driven thus. Whilst the earlier pages of this journal will show that hand levers have been tried with a screw propeller, and with very fair results. I will help you gladly to anything within the range of possibility.—Invicta.

[56963.]—**Engine Flywheel.**—I think you cannot do better than take the dimensions of the flywheel on page 95 of the present volume of the "E. M." for your engine, the capacity of your cylinder being only 4in. less than the one for which that wheel is designed. But, as explained in that article, the particular work the engine has to do governs the dimensions of the flywheel.—J. H.

[56966.]—**Australia.**—I went out to Australia by way of the Cape in August, 1882, and, so far as my experience goes, no great expense need be incurred in outfit. I should advise six woollen shirts (not too thick), twelve pairs socks, four pairs trousers of any dark colour, two of which may be old ones for rough wear, four pairs of pants, two or three ordinary serge jackets, and one or two thin white ones, three waistcoats, and three pairs of stout canvas shoes. Collars and neckties are only in the way, for the weather after you get into the tropics is pretty warm, and trousers, shirt, and jacket are all you want. I did not observe any canvas suits worn by passengers. The great drawback to white clothing seemed to be the continual need for washing, which is generally a troublesome and inconvenient operation on board ship. It is well to be provided with half a dozen towels, a bar of soap, a good stout pocket knife, scissors, needles, threads, tapes, and a bag of odd buttons. These things may appear trifles at home, but they become invaluable when you cannot get them; at any rate, my little collection was always in request by those who had not thought of these things. Your querist signs himself a "Sick Mechanic"; but I fancy that if he answers to this description when he starts, all will be changed before he gets back, for I know of no better cure for ill-health than a voyage to Australia. There were about 200 steerage passengers on the ship I went out in, and when they came on board many of them looked thin and haggard, and showed evident signs of privation; but when they passed the doctor at Melbourne, a finer, fatter, and more healthy body of people I never saw.—C. Grover.

[56969.]—**Hydraulic Ram.**—I presume he refers to the pulse valves, if so, it is not necessary to have these valves weighted: it is only necessary to have them strong enough to stand the constant blows they receive. The reason the valves don't remain closed is as follows: When the water running down the injection pipe has obtained its greatest velocity the pulse valve closes; when this takes place, the water in the ram returns and leaves a space and a vacuum under the pulse valve, when the atmospheric pressure on the outside of the valve allows it to open, when again the water commences to run. The pulse valves must be made stronger for high fall than a low one.—Chas. Hosken.

[56970.]—**To Mr. Bottone.**—Speed, 3,000 revolutions of the armature per minute; No. of volts, about 30. Not dangerous, as such a current will not pass through the human body at all. It will give a shunt shock by the "extra current," if the contact of the brushes with the commutator be suddenly broken by lifting, &c.—S. Bottone.

[56971.]—**Insects in Telescope.**—This is a great nuisance, but may, I believe, be remedied by using a little pyrethrum, in powder. Insects of all kinds seem attracted by this substance, and soon become stupefied and die. It should be scattered sparingly.—F. M. Rogers.

[56973.] — **Dynamo.** — To Mr. Bottone or "W. H. E."—The wire on this dynamo is rather fine. Heating will certainly ensue, when driving to obtain best results. Resistance of fields, about 2 ohms. Resistance of armature, if in four sections as stated (though this is wrong, for the four arms of Walker's armature should constitute but two sections really) will be 1⅜ ohm. I have not much practical experience with F. Walker's armatures; but I should judge you could get an E.M.F. of about 65 volts and about 20 ampères of current if driven at from 2,400 to 3,000 revolutions.—S. Bottone.

[56976.] — **Water-Meter.** — "Anxious" can easily find out how much water is wasted by means of comparison. Observe the meter while the water is using, say for half an hour, counting the "knocks" it gives, and reading the index at the commencement and end of the half-hour. Example: If it consumes 900 gallons and gives 30 knocks, that is equal to 30 gallons per knock, and the waste will be 120 gallons per hour. Or write to "Kennedy's Water-Meter Co. (Limited) Kilmarnock," giving particulars, and they will answer your query.—B.Sc., Plymouth.

[56977.]—**Load on Short Span.**—In solid beams of rectangular section the strength varies as ⅙ area by depth, and of circular section as ⅛ area by depth.

$$\begin{array}{llcl}\text{Then} & (1)\ \tfrac{1}{6} \times 8 \times 4 & = \tfrac{32}{6} = & 5{\cdot}333 \\ & (2)\ \tfrac{1}{8} \times 11{\cdot}3411 \times 3{\cdot}8 & = & 5{\cdot}387 \\ \text{and} & (3)\ \tfrac{1}{6} \times 12\tfrac{1}{4} \times 3\tfrac{1}{2} & = & 7{\cdot}146\end{array}$$

The three results are the relative or proportional strengths of the beams.—J. S. C.

[56977.]—**Load on Short Span.**—Let the strength of the first bar, 4in. deep and 2in. wide, be called 16; then the strength of the second bar, cylindrical and 3·8in. diameter, will be 18·29; the strength of the third bar, 3·5in. square and set with a side uppermost, will be 21·43; and the strength of the same with an edge upppermost will be 20·21.—Dubliniensis.

[56978.]—**Engine Query.**—Give the valve a throw of 4½in., and set the eccentric 124° in advance of the crank. The obliquity of the connecting-rod will upset the accuracy of these proportions; but it might be partially rectified by equalising the lead in the usual manner.—Bacchus.

[56980.]—**Electrical.**—As the current circulates round the iron core, it causes the passive iron to become a magnet, and consequently draws the bobbin towards it, as it would any other iron in its vicinity. All electro-magnets are on the same principle.—C. D. R.

[56981.]—**Preparing and Mounting Small Skeletons.**—Ants are of no use in this country. Maceration and bleaching is the process needed. First clean off all the flesh carefully with a knife, leaving ligaments to hold the bones together where suitable, and bore a hole through to the brain cavity so as to get it emptied, then leave the skeleton in running water if possible till the bones are quite clean, bleach in the sun, and join where necessary with brass wire.—B. Sc., Plymouth.

## UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

Since our last, "A. N. H." has replied to 56600; Percy W. Stanley, 56606, 56626; Ernest Baugh, 56680.

| | |
|---|---|
| 56460. | Observatory, p. 200. |
| 56462. | Locomotive History, 200. |
| 56465. | Boiler Tubes, 200. |
| 56480. | Impure Iron, 200. |
| 56489. | Solar Eclipse, 200. |
| 56490. | Wooden House, 200. |
| 56492. | Jacket Pan, 200. |
| 56494. | Soapstone Firebricks, 200. |
| 56496. | Mineral Customs of Derbyshire, 200. |
| 56497. | Sellers' Screw Thread, 200. |
| 56498. | Linen Manufacture, 200. |

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|---|---|
| 56688. | Rifle, p 289. |
| 56692, | Carbon in Cast Iron, 289. |
| 56693. | Silos, 289. |
| 56694. | Butter Kegs, 289. |
| 56707. | Electro-plating, 289. |
| 56712. | Shutter, 289. |
| 56723. | Chaster's Electro-motor, 290. |
| 56731. | Midland Engines, 290. |
| 56735. | Water Gauge, 290. |

## QUERIES.

[56983.]—**Window Glass.**—When I lived in London some years ago, it was very common to see fixed outside of a window, a contrivance which enabled people inside of the house, to see the passers-by on the outside. Can you or any correspondent favour me with the name of the contrivance, and say how to arrange it?—Clyde.

[56984.]—**Legal.**—I keep a lodging house in Dorset; I supply them occasionally with eatables; if they require ale with them, having no license, I used to ask for the money and send out to the public house for what they wanted; but it not always being convenient to send, I keep it in the house and if ale is wanted, I give them a glass; I make no charge for it. My tariff of prices is shown in the room, and cutomers bills are made from these prices, but ale never, as I give the ale and make no charge. Can I legally do this, or am I liable to be fined for not having a license?—W. H. P.

[56985.]—**Planing Machine.**—Would the author of "Directions how to Make a Planing Machine," before finishing, give directions for making the carriage run in V grooves in top of sides of bed, with dimensions? Is the carriage as described, heavy enough to retain its position in such grooves under heavy cuts? The pinion being above the rack (the most favourable position), would a separate casting, like a flanched sleeve bolted on to side of bed for pinion shaft to come out of, be efficient, as it seems easier to make than that proposed, one bracket only being used inside? Querist thinks that it would be a great boon to many if some known firm advertised the set of castings in your paper, with these grooves planed, and also the V's on underside of carriage to fit them, at a reasonable price, thus determining the truth of the most important part of the machine, and giving a chance to a much larger number of amateurs to finish it truly.—J. C. G.

[56986.]—**Pansies.**—Can any reader who is a pansy grower, say how pansies may be protected from wireworms, &c.? Dressing the bed with petroleum and water was tried last autumn, but the bed is attacked this year, and the plants eaten off.—E. C. J.

[56987.] — **Volvox Globator.** — Will some experienced pond-hunting reader explain how this interesting object may be kept alive, also how it can be killed and mounted whole? My specimens break up into dust-like particles, and leave no trace of the original shape.—E. C. J.

[56988.]—**Siphon.** — To "Invicta" or Others.—Will "Invicta" kindly inform me on the above query? I put a siphon into a tank of water, it will not run out. I take the siphon and fill it full of water, and I put it in the tank again, now it runs out. I would like to know how it is, and if it makes any difference to the length of the pipe outside, I was told the longer the pipe, the faster the water would run.—Young Fiber.

[56989.]—**Willesden Canvas.**—Can anyone inform me what is used in the preparation of Willesden canvas and paper, and also give a description of the process?—R.

[56990.]—**Bell Telephone Circuit.**—To Mr. S. Bottone, "Nun. Dor.," and Others.—Would you kindly inform me how to connect up a pair of telephones, microphone, and one battery and coil if necessary, and using only two line wires and no earth return. Should a battery be required at each microphone, how connected up? A sketch will oblige.—Transmitter.

[56991.]—**Blown Hole.**—In the cylinder of my engine there is a small blown hole. Would any of "ours" kindly say what should be done with it? I have been advised to fill it up with solder.—C. M.

[56992.]—**Hydraulic Ram.**—Would some reader of the "E. M." kindly give me information as to the working of hydraulic rams? The one I saw working was for pumping water to the cistern of a house, situated about 80ft. above the ram, and the water which supplied the ram had a fall of about 9ft.—Cumbrian.

[56993.]—**Water Analysis (Qualitative).**—Would some chemical friend kindly describe a simple process, whereby a sample of water can be tested qualitatively for sewage contamination and other impurities likely to be found in spring or river water? Is there any simple way of estimating the degree of hardness of water?—Cumbrian.

[56994.]—**Lobster Back Cowl.**—Many thanks to "Glatton" for his reply. Will he kindly inform me if he has ever seen one with the laps as he described, and would he answer my query about copper band.—Plate Worker.

[56995.]—**Fixing Boiler.**—Would anyone advise me the best way to fix a plain boiler 3ft. by 2ft., with one 1½ stay, to drive an engine 3in. by 5¼in.? Also, how full to keep it in water, and what pressure to use? It is a ⅜ plate, with single rivets, and appears in good condition.—H. B.

[56996.]—**Melting Points of Gums and Resins.**—I should be glad if someone would kindly give me a list of gums and resins (such as shellac and rosin) which are liquefied by heat, with their melting points?—J. L.

[56997.]—**Hydropathy.**—Having been troubled with nervous headache and depression for a long time, and not receiving much benefit from several doctors whom I have been under, I was induced to try cold water sponging, &c., which is much recommended as a great tonic for the nervous system, but from which I have not derived the benefit I expected. As I am probably wrong in my mode of procedure, having nothing but a tub of water and sponge, possibly some of your numerous readers will be able to give a few simple directions in the "cold water cure" as to the best way to brace up the nervous system and avoid depression after. As this is a subject which will no doubt be of interest and benefit to many readers of the "E.M.," I shall be glad if those who can do so will give us a few wrinkles, for which no doubt they will receive the thanks of many, besides—Quixote.

[56998.]—**Vibration from Steam Hammers.**—Will any reader kindly inform me how to prevent the shaking of the beds in houses situated near to steam hammers.—No Sig.

[56999.] — **Question in Algebra.** — If twelve soldiers and twelve sailors be drawn up in line, in how many different ways can the twenty-four men be arranged so that four soldiers, and not more than four, shall always stand together?—Geo. Smith.

[57000.]—**Spark Coil.**—I have a spark coil in parts, and now wish to put it together. I am puzzled to know how I am to unite the tinfoil of the condenser with the silk-covered wires which come one from the pillar the other from the spring; all seem too delicate for common soldering with a hot iron. Will some expert tell how this is done and oblige?—Young Spark.

[57001.]—**Carbon.**—If I place a large carbon between two plates of zinc like as is done with silver and zinc in a Smee cell, will this simple arrangement, excited with a solution of common salt (chloride of sodium) have power to work a coil, a bell, or a motor of any kind?—E. B. Fennessy.

[57002.]—**Voltaic Cell.**—I find in the syllabus of the science school of Kensington instructions for making a voltaic cell which consists simply of a piece of carbon, such as is ordinarily used for electric purposes, and a length of iron hoop, the exciting liquor being ferric chloride. Will some friend say if such a battery will answer for working coils for bellringing? The carbon and iron are cheap and easily procured, but what about the chloride of iron. Is it an expensive salt? Can I make it from sulphate of iron?—Far Away.

[57003.]—**J. K. P.'s Gas Engine.**—Will "J. K. P." letter No. 24378, page 348, kindly say the quantity of gas consumed in his gas-engine per hour? I have a new gas lamp that gives a pure flame with very great heat—can it be utilised to make the gas as wanted?—T. Woon.

[57004.]—**Grinding Machine for Polishing Sheet Iron and Steel.**—Will some friends kindly inform me a little in making the above machine? I want to grind and polish sheet iron and steel for making stands and fire-irons. I want to know where I can get emery wheels and grindstone for the purpose, and what speed they must turn? Please give me a little help, as I am quite in the dark, and oblige—Tool Maker.

[57005.]—**New Steam Motor.**—To "Invicta."—Might I take the liberty of reminding our kind and instructive friend "Invicta," that his promise relative to the "new steam motor," is still unfulfilled, and of asking him when he intends conferring a great favour, not only on myself, but I am sure on numbers of readers of the "E. M."?—J. Myles, Hanna Mount, View-road, Dalkey, Ireland.

[57003.]—**Unicomb Observatory Hive.**—I am desirous of constructing a beehive, as above, to hold six frames. Will some of "ours" kindly oblige by giving measurements and method of internal construction? Is it necessary, as the hive will be indoors, to have the case double glazed? Any hints will greatly oblige—One in the Wilds of Wales.

[57007.]—**Fishing-Rod Joints.**—Will some reader of the "E M." kindly inform me of the best composition for securing the brass sockets and ferrules of fishing-rod joints? I have tried common glue, but find that after a few weeks' fly-fishing the joints get loose. Also the best varnish or polish to finish the rod with—should it be oiled before varnishing?—Cumbrian.

[57008.]—**Granule Battery.**—Is it possible to make a six-cell granule battery in a deal box with partitions arranged so as to give solid content of 8in. by 5in. by 4in. per cell, of sufficient power to work a 5-c.p. lamp? I suppose it must be coated with marine glue; can this be procured at oilshops, and how is it applied? I hear it has an unpleasant smell. Is there any other substance for coating battery boxes with? What is the E.M.F. of an ordinary granule, charged with sulphuric acid, as a Fuller? I should prefer making above battery in wooden box, as it is very compact, and square stoneware cells too expensive. Is 8 by 5 by 4in. large enough to keep down internal resistance?—it gives nearly the same result (160 cubic inches) as 8 by 5 diameter (157 odd cubic inches) which is the usual size for round cells.—W. Y. K.

[57009.]—**High Speed.**—Will "Meteor," or any of our railway friends give some account of the running of the new Mail Express from Euston without passengers, and of the new fast 8.25 p.m. from St. Pancras; both trains started on the 1st inst.?—Traveller.

[57010.]—**Swan's Studio Plates.**—Will some photographic reader kindly give me a good developer for the above plates? I bought them from Chapman, of Manchester, and on my asking for instructions for developing, &c., his assistant informed me that "any developer would do." This is not true, as I have tried four developers, and none of the resulting plates were presentable. Any hints as to manipulation will be most acceptable.—N.

[57011.]—**Continental Railways.**—What is the composition of the briquettes used as fuel on many Continental lines, and what results do they give compared to coal?—W. B. P.

[57012.]—**S. E. Engines.**—As the Midland 19in. 7-footers are such failures, how have the two S. E. ones answered so far?—W. B. P.

[57013.]—**Boiler.**—To "Invicta."—I thank you for your reply to my query. Before fitting up the boiler mentioned in my last query, I would like to know if the following boiler would give a better supply of steam? Length 20in., diameter 11in., 5 copper tubes 1in. diameter, made from ⅛in. plates.—C. J. F.

[57014.—**Watch Jobbing.**—Will any kind reader inform me of a good watch jobbing tool for turning and other purposes—one that anyone might do nearly all the work in jobbing, as there are so many tools for this kind of work?—Lever.

[57015.]—**Steam Canoe.**—I am desirous of fitting engines into Canadian canoe, 8ft. long and 19in. wide. Would any kind-hearted reader of the "E. M." tell me the size of cylinder, boiler, and propeller required to drive it satisfactorily;—whether the boiler should be horizontal or perpendicular, and the amount of pressure it ought to be able to stand? I have a very good oscillating cylinder, 2in. bore—would this be any good

Any information or advice would be gratefully received by—W. W. Howard, 64, Charlotte-street, Fitzroy-square, London.

[57016.]—**Am-meter and Voltmeter.**—Will any of the electrical readers of this valuable paper kindly give me full descriptions, with sketches, of a simple and good am-meter and voltmeter, to measure currents of about 15 ampères, and 20 volts potential difference?—W. E. H.

[57017.]—**Electric Brake.**—I should be greatly obliged if a reader of the "E.M." would give me a full description of Howard's electric brake for tramcars, of the Automatic Car Brake Company's electric brake, or of any good reliable electric brake, that can be applied to an electric tramcar, using a current of about 20 amperes and 150 volts?—W. E. H.

[57018.]—**Gas Works.**—In the tar well at our gas works, the tar floats on the water, the overflow goes on some land. What must I do with the water—it seems stronger than the tar?—Alps.

[57019.]—**Chemical.**—Can any correspondent inform me of a chemical that will cement pulverised granite? I have tried silicate of soda, but after burning in the kiln the articles are very brittle. Would exposing them to the air for a month or two, before baking them, do? Is there any substance that would answer in place of the silicate and require no firing?—A. J. Sells.

[57020.]—**Piano Repairs.**—To Mr. Davis.—I have a piano in which the holes in the wrestplank have been bored (by mistake) so large that no pins will fit—the plank is not split. Would it answer to plug the holes with beech plugs and rebore them, using small pins? Would it be best to bore in the original holes leaving a crescent-shaped piece of the plug on one side of the pin, or make fresh holes above and below the plugged ones? If a new wrest plank is necessary, would it answer to cut away the old plank above the bridge, chipping out the beech only, leaving the pine plank intact on bracings, and on to this to glue new beech plank, securing it to bracings by bolts.—Cabinet Maker.

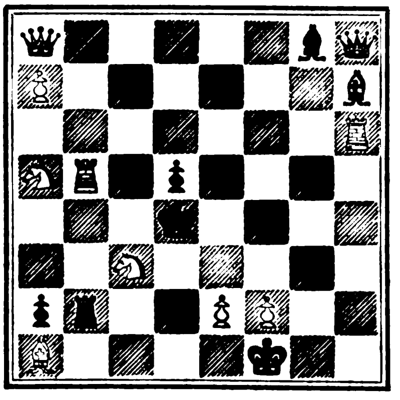
[57021.]—**Brush Drilling Machine.**—If some kind reader of your journal would answer me the following inquiries, I should be extremely obliged:—Two automatic brush drilling machines are working at the Inventions Exhibition, both drill, as it is called in the trade "spread work," or drill the holes upon the face of the brush at an angle. The first machine is exhibited by Raper and Co., and works very rapidly; but the principle by which the spread is obtained has been tried years ago, and was not found correct enough to use it to drill hair-brushes. The second machine, exhibited by G. B. Kent and Sons, has struck me the most. The work I have examined while there seemed quite equal to hand drilling, so far as spread and regularity of line; and it is the first machine I have seen and know to drill the centre row of an oval upright. Now, what I want to know practically, if this last machine can be worked quicker? If not, can a machine be made to work quickly, say 110 holes a minute in hard wood? Also, can this machine drill any other set of work or quantity of holes on any other shape than oval.—Brushmaker.

## CHESS.

All Communications for this department must be addressed to J. Pierce, Langley House, Dorking.

PROBLEM DCCCCXLVII.—"Aut Vincere Aut Mori."

*Black.*



*White.* [11+6

**White to play and mate in two moves.**

Solution to 945.

| *White.* | *Black.* |
|---|---|
| 1. Q-K 8. | 1. Anything. |

(Eight variations.)

### NOTICES TO CORRESPONDENTS.

Correct solutions to 944 by G. T. Stringfellow, A. A. E. Lecluse, and T. L. Robins.

To 945 by G. T. Stringfellow, J. A. Miles (very easy and idea not new; the W B seems to be quite unnecessary), R. A. Bennett, F. O'N. H., N. and F., and E. Stanley Follwell.

To 946 by E. S., Streetgate, and Rev. W. Anderson (Old Romney).

A. A. E. Lecluse.—The list of successful competitors will be given at the close of Tourney, that is in about seven weeks. As you surmise, several are very near together.

## ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

### HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

*** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, July 8th, and unacknowledged elsewhere:—

J. Williams.—Cuttriss and Co.—G. Calver.—C. E. Peek.—C. B.—J. B. N. Ashford.—Medical Battery Co.—C. A. W.—E. Pelham.—R. B.—W. W.—Weekly Subscriber.—Morosi.—T. Handel.—Cymro Gwledig.—Jolly Miller on the Dee.—E. B. F.—Pith Ball.—A Beginner.—Montmartre.—R. B. Gant.—M.—A. Atkinson.—W. Bradbury.—Dumbarton.—A Fellow of the Royal Astronomical Society.

An Old Subscriber and Engineer. (You will find as much information on the subject as you can require in your back volumes. We known of no book on the subject. If the vapours of the hydrocarbons are mixed with air in proper proportions, a flame of any kind will explode the mixture.)—Nauticus. (How can anyone answer such a question? What was the length of tube, what eyepiece? or briefly, how did you mount your o g.?)—Bolton. (The best carbon plates are cut out of retort scurf. See p. 166, last volume, for "How to Make Carbon Plates.")—Vibrator. (See the indices for many references to such a subject. The best microphone of the kind you want was illustrated on p. 544, No. 750.)—Watchmaker. (Guthrie's "Electricity and Magnetism," Collins; Thompson's "Elementary Lessons in Electricity and Magnetism," Macmillan; and Sprague's "Electricity: its Theory, Sources, and Applications," Spon—the last-mentioned being the best, if you want to obtain a thorough comprehension of the subject.)—Puzzler. (Of course there is, by going twice over the same line. You have omitted that condition.)—Alps. (The "Gas Manager's Handbook" (London: W. King), may help you.)—H. A. (We do not understand what is meant by "more powerful.")—Igno Porto: (See the "History of the Steam Engine" in No. 828. Many steam-engines were at work before James Watt made his important improvements.)—Herman Wilson. (Tomlinson's "Mechanics," in Weale's series is suitable—Crosby Lockwood and Co., Stationers' Hall-court, E.C., price 1s. 6d.)—Lux. (If the matches will "light only on the box," we do not know how you are to get a light without the box or another light.)—Keeper. (Your query should be sent to the "Wanted" column. See Hints No. 4.)—Blowpipe. (See the indices for both in considerable variety.)—Country Mechanic. (See indices of Vols. XXXVII. and XXXVIII.)—T. C. (We do not know of any books on the subject except the pharmacopeias and similar works, which necessarily contain information of the kind. You will find recipes in back volumes; but a special knowledge is required to produce the essences which remain clear when mixed with water. Most spirituous essences when first made contain gums which are soluble in spirit, but which appear as "clouds" when the spirit is diluted with water. It is necessary to extract these gums and retain only the flavouring ethers.)—John Windsor. (You will find a full account of the "Electric Furnace," in No. 912, p. 80, Vol. XXXVI.)—T. Wood. (Perhaps they think that people would not take to benzoline, or perhaps you have applied to those who make wick lamps. At any rate, the best way will be to let the French firm make them if English firms will not.)—W. Ouin. (Will be noticed when we get round to that group.)—Velocity Ratio. (Why not procure some of the examination papers set in previous years? If you joined one of the science classes, you would be able to obtain all information of the kind.)—V. R. (The Vacuum Brake Co.'s offices are at 32, Queen Victoria-street, E.C. We do not know the price. 2. Maxton's "Engineering Drawing," Lockwood and Co.)—Young Watchjobber. (It is probably not compensated for change of temperature. See the letters on the subject in Vol. XXXVII. and earlier.)—J. E. M. (Possibly an advertisement in the "Address" column might find you a maker. We cannot undertake to do so.)—Libra, J. S. B., D. A. P., C. E. Stretton. (In type.)

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Subscribers receiving their copies direct from the office are requested to observe that the last number of the term for which their subscription is paid will be forwarded to them in a Pink Wrapper, as an intimation that a fresh remittance is necessary, if it is desired to continue the Subscription.

**Holloway's Pills** are suitable alike for the peer and the peasant; the soldier, sailor, and emigrant may rely on them as the means of banishing sickness in all climates, and under all circumstances. They readily check bilious and feverish attacks, and prevent inflammation of the brain, liver, lungs, and kidneys.—[Advt.]

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*** It must be borne in mind that no Displayed advertisements can appear in the "Sixpenny Sale Column." All advertisements must be prepaid; no reduction is made on repeated insertions; and in cases where the amount sent exceeds One Shilling, the publisher would be grateful if a P.O.O. could be sent, and not stamps. Stamps, however (preferably halfpenny stamps), may be sent where it is inconvenient to obtain P.O.O's.

The address is included as part of the advertisement, and charged for.

Advertisements *must* reach the office by 1 p.m. on Wednesday, to insure insertion in the following Friday's number.

## OUR EXCHANGE COLUMN.

*The charge for Exchange Notices is 3d. for the first 24 words, and 3d. for every succeeding 8 words.*

**Good Value Offered** (cash or instruments) for all kinds of sound or repairable Scientific Appliances.—Caplatzi, Science Depot, Chenies-street, near British Museum. Established 1862.

**Telescope,** 2½in. Reflector, two eyepieces, tripod stand, in oak case, for English made Air Gun, with pump complete.—Job Blain, Albert-square, Carlisle.

Patent **Vulcanite Hydrometer,** by Savigny, St. James'-street, in case complete. Will exchange for good long-range Telescope, or Microscope.—Z., 49, High-street, Dingwall, N.B.

**Organ Bellows,** Windchests, or small Harmonium, 5 octaves, double pedal, complete except keys. Exchange for Tricycle, or 40in. Bicycle.—W. Johnson, 12, Moxley, Wednesbury.

Magnificent English Silver Lever, centre seconds, **Chronograph Stop Watch,** full jewelled, gold joints, chronometer balance; exchange £10; offers requested.—E. Pownall, Prescot, Lancs.

A large **Flywheel,** with pulley, on iron stand, steel roller bearings. Will exchange for a small back-geared Lathe.—Wetherilt, West Chapel-street, Mayfair.

New £18 **Operatic Musical Box,** 6 airs, select, richly inlaid Zither, patent winder, inlaid glass lid, all improvements. What exchange?—Seel, George's-road, Bolton.

Iron Grand £60 new **Piano,** by Grunow, all improvements, including voix celeste, treble; bronze medallion front, walnut, £25. What offers?—Seel, George's-road, Bolton.

American walnut 280 dollar new **Organ,** two new swells, 12 stops, &c., all improvements, five years' warranty, £20, part exchange.—Seel, George's-road, Bolton.

Eight Original **Oil Paintings,** signed Slater, artist; grapes, &c. Approval with pleasure. New frames, English gold; choice. What exchange in clothes?—Address above.

"**Knight's Dictionary of Mechanics,**" complete, in parts, and Supplement to date. What offers?—G. Mackie, 2, Collingwood-street, Newcastle-on-Tyne.

Double-action brass **Oscillating Cylinder,** 1in. bore, complete. Exchange offers wanted.—H. S. Scott, Neville-street, Newcastle-on-Tyne.

What offers for small **Lathe,** cash or otherwise? Bicycle preferred; value £4; wood or iron. Will deliver.—Particulars, P. Hurst, 15, Radnor-street, Plymouth.

**Clothing,** new, men and boys'. Exchange broken Bicycle, Tricycle, Lathe, or offers.—M., 14, Church-street, Oldbury.

"**English Mechanic,**" about 250 odd numbers, many consecutive, in Vols. XIII. to XXX. What offers? Whole or part.—Linscott, Ramsgate.

**Dark Slide,** quarter-plate, mahogany, double, for Lancaster's cameras; also ½-plate ditto. What offers?—F. B., 15, Southgate-road, Wood Green.

Strong and superior finished half horse-power **Horizontal Slide-Valve Engine,** cost £8. Wanted, double driving, front steering Tricycle, or horizontal Boiler, internal firebox.—Below.

Will exchange my **Ledger Copying Press** for an electric engine, electric bells, vacuum tubes, or electrical offers.—T. A. Carter, Jun., Wheat Sheaf Hotel, Bridge-street, Uttoxeter.

Pulvermacher's **Galvanic Chain Band,** an effectual cure for various complaints, cost 50s. What offers?—W. F., 5, Brand-street, Greenwich, S.E.

Valuable rosewood inlaid **Spanish Guitar,** in case, cost £21, magnificent instrument, for landscape photographic apparatus (dry plate), back-geared lathe, &c. Offers.—Scriven, Chelmsford.

**Wealden Fossils** (a lot of), comprising 30 varieties. Fish, Crustacia, Molluscs, and Plants. Advertiser requiring room, desires any offers; scientific or philosophical books preferred. See Sale Column.—R., 2, Croft Villas, Hastings.

Horizontal **Engine,** nearly finished, ⅞in. bore, ⅞in. stroke; parts of a Beam Engine, cylinder, 2in. bore, and a small Engine on cast boiler.—64, Ravenscliff-road, Kidsgrove, Staffs.

Two **Lathe Wheels,** 23½in. diameter, and crank-shaft grindstone, &c. Wanted, offers. Stamp for reply.—Apply as above.

Good exchange for ¼ or ½-plate **Camera,** Lancaster's Le Merveilleux.—Roberts, 31, High-street, Mold.

Splendid new Silver Lever **Watch** (Benson, London), compensated balance, jewelled movements, cost £6. Wanted, large portrait lens.—W. J. Brown, 46, Foregate-street, Worcester.

"**Colenso on the Pentateuch,**" 3 vols., published 21s. 6d. "Apocalypse revealed, Swedenborg," 2 Vols., 6s. or offers.—F., 60, Plimsoll-road, Finsbury Park, N.

Handsome **Micro. Slide Cabinet,** holds 1,000 flat, solid mahogany, glass door, equal to new, 84s., or part exchange.—F., 60, Plimsoll-road, Finsbury Park, N.

Compound **Slide-Rests,** Jaw, Drill, and Bell Chucks, Eccentric Rests, Headstocks. Offers.—W. Bundy, 62, Holborn Viaduct, London.

# THE LONDON STEREOSCOPIC & PHOTOGRAPHIC COMPANY,

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## INCORPORATED UNDER THE COMPANIES ACTS.

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6, Old Jewry, E.C.

**SECRETARY.**

S. M. CLARK.

**OFFICES:**

No. 54, CHEAPSIDE, LONDON, E.C.

## PROSPECTUS.

This Company is formed for the purpose of taking over and carrying on the well-known business of the London Stereoscopic and Photographic Company, which was founded by the late Lord Mayor (Mr. Alderman Nottage) and since carried on for upwards of 23 years with great success at 54, Cheapside, and 108 and 110, Regent-street, in co-partnership with Mr. Howard John Kennard, and latterly with Mr. C. G. Nottage also. The death of the Lord Mayor renders it desirable to provide for the continued conduct of the business under the facilities provided by the Joint Stock Companies Acts, but Mr. Nottage will continue to direct the management of the Company as Managing Director, while Mr. Kennard will act as Chairman.

The Company will acquire the Firm's Freehold Manufactory and Works at Southgate (erected in 1881), as well as the Leasehold Premises of the Firm at 54, Cheapside, E.C., and Regent-street W., together with the Machinery,. Plant, and Stock-in-Trade. The Cheapside Premises are held on a Lease, of which 22 years are unexpired, at the nominal rent of £400, which was accepted in consideration of the premises being pulled down and rebuilt in 1874. The Regent-street Premises are held on Leases, of which 5¾ and 13 years are unexpired, at rentals of £350 and £450 respectively.

The Vendors agree to accept for the Works, Leases, Plant, Stock-in-Trade, and Goodwill, the sum of £90,000, one-third of which they will take in 6,000 fully paid-up Shares of £5 each.

The Business will be taken over by the Company as from the 31st December, 1884, the profits for the present year, when ascertained, being divided between the Firm and the Company in equal shares. The Vendors, however, agree that the expenses connected with the recent Amateur Photographic Exhibition shall be borne by them exclusively.

The profits of the Business for the last 23 years (as certified by Messrs. R. MACKAY and Co.) have averaged £6,280 per annum, and for the year 1884 they exceeded £6,700.

The existing net income of the Company is therefore sufficient to pay Seven per cent. on the Capital (or £6,300), leaving a surplus for the expenses of the Board. The Directors will not receive any remuneration until Seven per cent. has been paid on the Ordinary Shares, but they will then be entitled to £700 per annum. During the present year the sales have largely increased, especially in connection with the Amateur Photographic Business, and from an examination of the accounts, there is every reason to anticipate that the profits for the present year will exceed those of last year.

All expenses of and incidental to the formation of the Company are borne by the Vendors, so that the Company will commence business without any outlay for preliminary expenses.

A contract has been entered into, dated 1st July, 1885, and made between CHARLES GEORGE NOTTAGE and HOWARD JOHN KENNARD of the one part, and SAMUEL MARK CLARK as Trustee on behalf of the Company of the other part. There are in addition other Contracts that have been entered into in the ordinary course of the business of the old Partnership, which it is impossible to specify in this Prospectus, and reference to which must be considered as waived.

Of the 12,000 Shares now offered for subscription 1,000 will be reserved for preferential allotment to amateur photographers or customers of the Firm.

Applications, accompanied by a deposit of 10s. per Share, should be made on the accompanying Form. The balance of £4 10s. per Share will be payable on Allotment.

The Memorandum and Articles of Association of the Company, and the above mentioned Contract, may be inspected at the Offices of the Solicitors of the Company.

Prospectuses and Forms of Application for Shares may be obtained from the Bankers and Solicitors, or at the Company's Offices, No. 54, Cheapside, E.C., and 108 and 110, Regent-street, W.

In the event of no Allotment being made, the deposit will be returned in full. If a smaller number of Shares are allotted than applied for, the surplus will be credited towards the amount payable upon Allotment.

## THE LONDON STEREOSCOPIC AND PHOTOGRAPHIC COMPANY, Limited.

## FORM OF APPLICATION FOR SHARES.

To the Directors of the LONDON STEREOSCOPIC & PHOTOGRAPHIC COMPANY, Limited.

GENTLEMEN,—Having paid to your Bankers the sum of £ .................................. being a deposit of 10s. per Share on .................................. Shares, I request you to allot me that number of Shares, and I agree to accept the same, or any less number that may be allotted to me, and to pay the balance in terms of the Prospectus, and I authorise you to insert my name on the Register of Members for the number of Shares allotted to me.

Usual Signature ..................................................
Name in full ..................................................
Residence..................................................
Profession ..................................................

Date ..................................1885.

## THE SIXPENNY SALE COLUMN.

*Advertisements are inserted in this column at the rate of 6d. for the first 16 words, and 6d. for every succeeding 8 words.*

**Motor Castings,** materials for Electric Bells, Batteries, Galvanometers, Intensity Coils, Microphones.—King Mendham, and Co., Bristol.

**Insulated Wire Table,** showing size, weight, resistance per foot, feet per ohm, &c., price 3d.—King, Mendham, and Co., Bristol.

**Standard Ohm,** in box, copper poles, guaranteed correct to ten thousandth of ohm, 21s.—King, Mendham, and Co., Bristol.

**Wimshurst Influence Machine.**—Sole Manufacturers of Improved Pattern. Numerous testimonials as to thorough efficiency.—King, Mendham, and Co., Bristol.

**Galvanometer Cards,** improved for tangent and ordinary combined, 2½in., 8d.; 4in., 10d.; 6in., 1s.; post free.—As above.

Write for **King, Mendham, and Co.'s** large new and reduced Price List, post free 4 stamps.

**Trouser Lengths,** 5s. each. Cheap Cloth for Ladies' Dresses, Mantles, Boys' Suits.—Hewitt, 27, Winfield Mount, Leeds. Patterns free.

**Electric Depot,** 10, Deansgate, Manchester.—Electric Breast Pins, 25s. Electric Bells, 4s. Induction Coils, 8s.—Millar, Proprietor.

Hard **Vulcanised Fibre** for Magnet Heads.—Mosses and Mitchell, 68a, Chiswell-street, London, E C

Hard **Vulcanised Fibre** for all kinds of insulation.—Mosses and Mitchell, 68a, Chiswell-street, London, E.C.

**International Inventions Exhibition,** East Avenue, Group 21, Stand 1683.—Mosses and Mitchell, 65a, Chiswell-street, London, E.C.

**Chemical Apparatus.** — Catalogue, 90pp., 500 illustrations, posted 2d.—W. Hume, Lothian street, Edinburgh.

**Photographic Apparatus and Chemicals** for professionals and amateurs. See new illustrated catalogue, post free.—Hume, Lothian street, Edinburgh.

**Mica,** otherwise Talc.—RICHARD BAKER & Co., 9, Mincing-lane, London.

**Vermilion,** best, 2s. 4d. lb.—PINNELL BROTHERS, 214, Whitechapel-road, London, E.

**French Polishing,** Staining, Painting, and Varnishing. 192 Recipes or Trade Secrets, with full instructions and details, post free, 1s.—I. Tomlin, 28, Highfield-terrace, Barnsley, Yorkshire.

**Castings.**—Half horse-power Horizontal, Vertical, or Launch Engine Castings, complete, with brass work and forgings, 12s 6d One horse-power, 25s.—Tomlin, Highfield-terrace, Barnsley, Yorkshire.

**Castings.**—Bench Drilling Machine Castings, complete, 3s. 6d.—I. Tomlin, Highfield-terrace, Barnsley, Yorkshire.

**Castings.**—All Brass Engine Castings, horizontal or vertical, suitable for model work, 2s. 6d. set.

**New Designs and Price List** of Perfected Engines and Castings, post free.—I. Tomlin, Engineer, 28, Highfield-terrace, Barnsley, Yorkshire.

New Illustrated Price List of **Screws, Bolts, and Nuts** for Model Work, drawn to actual size, sent on receipt of stamp.—Morris Cohen, 132, Kirkgate, Leeds.

**Oxygen Gas,** compressed in cylinders, handiest and safest for limelight.—Clarkson, Compressed Gas Chemist, Bartlett's-buildings, E.C.

**Oxygen Gas,** compressed into iron bottles, liquid nitrous oxide and carbonic acid.—Clarkson, Compressed Gas Chemist.

**Oxygen Gas,** compressed into iron bottles: prices on application.—Clarkson, 28, Bartlett's-buildings, Holborn, E.C.

Astronomical **Telescopes** of all kinds and Apparatus or Fittings made by A. Clarkson, 28, Bartlett's-buildings.

**Eyepieces.**—Huyghenian of any power to fit any telescope, 15s. each. Sun Diagonals, £1. Star Diagonals, 30s.

Astronomical **Telescopes,** second-hand, by best makers.—Clarkson, 28, Bartlett's-buildings, Holborn, E.C.

Marvels.—Double **Opera and Field Glasses** from 5s. 6d. Lists, with engravings, one stamp.—J. B. Dancer's Opera Glass Depot, 53, Hamstead-road, Handsworth, Birmingham.

**Stammering Cured by Correspondence.**—"Practical Guide," and 600 Cases, 1s. 4d. Books of testimony (1s., or returned).—N. H. Mason (B 40), 10, Stavordale-road, Highbury, London.

**Gas Governors,** reliable and durable, half inch, 7s Illustrated list free.—Caldow and Burnett, Kilmarnock, N.B.

"**Warne's Sheet Metal Worker**" to be sold, cheap, covers soiled.—94, St. Augustine's-road, Camden-square.

**Piles.**—Worst cases cured first application. Indian Ointment, sent 13 stamps.—Thomas Palmer, St. Helen's, Auckland, Durham.

**Harness Oil,** or for Caps of Wheels, 3s. 6d. per gallon.—Pinnel Brothers, 214, Whitechapel-road, London.

**How to Preserve Eggs,** and keep them fresh for twelve months. Recipe, post free, 7 stamps.—J. Wood, Booth-street, Burley-Wharfedale, Leeds.

**Cat Gut.**—Gut Hooks and Eyes for lathes and machinery.—James Bellaers, Regent-street, Leicester.

**Bellaers' Gas Stoves,** 1s. 3d., 2s. 3d., 3s. 3d., for oiling. Breakfast Stoves, 8s., 11s., 14s. 6d. Send for lists.

**Model Steam Engines,** made or repaired, separate parts fitted up, boilers made to order; sets of castings of every description.—Lucas and Davies, 21, Charles-street, Hatton Garden, London.

**Bamboo Fishing Rods,** 10 or 6-joint, 1s., 15 feet; 5-joint, 9½d., carriage 3d —Bristow and Co., Hull.

**Gas Engine,** bargain, 1-man, off Dorrington's castings, built for exhibition, no further use for it, cylinder, 4½ dia.—Wm. Ainsworth, *Gazette* Office, Accrington.

**Tic.**-This excruciating agony completely cured by Thomas Palmer's new remedy, and health and strength restored, 13 stamps.—St. Helen's, Auckland, Durham.

**Engine,** Vertical, 2-horse, £6. Semi-portable Boiler, 3-horse, £9.—79, Dudley-road, West Bromwich.

**Electro Motor,** free, 2s. 6d., with Battery 3s. 6d. Model Engine, 1s., fee. Not approved, money returned.—Below.

**Batteries.**—Bunsen's, Daniell's, Bichromate, 1s. each, in box 1s. 6d., post free.—G. Hailey, Novelty Stores, Seaforth, Liverpool.

**Launch** and other Steam Engines, Boilers, Lathes, and all kinds of machinery at reduced prices.—S. Smith.

**Propellers,** improved pattern, from 12in., to 30in., in stock.—S. Smith, Engineer, 11, West-street, Soho, W.C.

**Swan Holders,** 5s. dozen. Switches, Machines, Lamps, at large discounts.—Nicholson, 5, Rumford-place, Liverpool.

**Glass Blowing.**—Instruction given. Special apparatus, pumps for high vacua; instruments repaired.—H. Newbold, 25, Calthorpe-street, W.C

**Fishing Bait.**—"Red Ching."—This celebrated Chinese bait received first prize in Fisheries Exhibition. Will keep for years. Salt and fresh water fish attracted from a long distance in large numbers by its peculiar odour and colour, take the bait voraciously. One packet will take bushels of fish.—Post paid, 1s. 2d.—Address, Dr, Evans, Importer, Shirley, Southampton.

**American Organ,** wonderful bargain, in solid walnut wood, 9 stops, knee swell and grand organ, two couplers, rich and pipe like tone, would suit small church; owner having no use for it. Cost 35 guineas; for cash, 15 guineas. Approval, carriage paid.—G., 17, Sherbourne-street, Islington, N.

**Piano-Making.** — Instruments supplied at trade prices. Photo. and List post free. Also Piano Fittings.—W. G. Whittingham's Piano Factory, North-street, Clapham, London, S.W.

4¼in. With-Browning **Reflector,** altazimuth mounting, on angle block for equatorial motion, with screw motion, perfect condition.—Further particulars from J. Dixon, Postmaster, Kendal.

Watchmakers and Jewellers.—**Remains of Stock,** consisting of silver and jet goods, and American clocks. Exchange for good bicycle or tricycle, or offers. Invoice price about £11. Will take 20 per cent. off for cash.—Rowland, 45, Bellenden-road, Peckham.

**Do we get Heat from the Sun?** No! Every one interested in science should read this little work. By R. Humphreys. Post free, 1½ stamps.—11, Cambria-street, Fulham, S.W.

**Batteries** (to the trade). — Pint Bunsens, Daniells, Bichromates Other sizes in proportion. List free.—Below.

Small **Electro-Motors,** 14s., 24s., 78s. per dozen.—J. Hanks and Son, Seaforth, Liverpool.

**Study Chiromancy.**—Chart of the hand, with full explanation, 7d. — H. Dyke, 21, North-street, Taunton.

Three-horse **Boiler,** £4. 7in. Lathe, all iron, £3 10s. Photo 3 stamps.—M., 14, Church-street, Oldbury

**Boiler,** horizontal, all fittings, 12ft. by 2ft., £6 10s. Chaff Cutter, 30s.—M., 14, Church-street, Oldbury.

**Oils.**—Lard and Olive Oils (substitute for). Reliable information. Stamp for reply.—J. M., 6, Hamlet-street, Bootle, Liverpool.

**Ash-pan,** steel, brass-mounted, double sliding action, with under pan, 3ft. by 11in., cost £5 5s. Price 30s. or offers.—Braun, 1, Kilburn-square, N.W.

**Patents, Designs, and Trade Marks** procured at moderate rates by F. M. Rogers, 21, Finsbury pavement.

**Engine** (2 H.-P. Horizontal) and Boiler (Vertical, 4ft., 2ft., 12 tubes), good as new, £22.—G. H., 36, Hayles-street, St. George's-road, London, S.E.

**Gas Engine,** half H.-P. Otto, by Crossley Bros.; can be seen at work.—98, King's-road, Camden road, N.W.

**Type,** Cases, Leads, Ink, Rollers, Brass Rule, &c., to be sold cheap.—Stationers, 55, Rhodeswell-road, Limehouse.

**Dynamo Castings,** laminated armature, 30 candle-power, partly finished, price 12s.—R. G., Hendall House Redhill.

**Inventions Exhibition.**—Hot-Air Engines, small size, for driving models in shop windows, or for driving sewing machine or light lathes, price £9.—Britannia.

**Hot-Air Engines,** larger size, suitable for 4ft. lathe, £27.

These are both **Heated by Gas.** That at £9 cost about 1½d per day. A lady can manage it. No risk, no noise —Britannia.

**Prize Medals**—We have obtained Six Prize Medals for Lathes and Tools.—Britannia Co, Colchester.

**Lathes.**—Nearly 200 varieties. Hundreds of Parts, rough or finished. Catalogue, 6d.—Britannia.

**Model Engine Castings,** best and cheapest. See list (stamp) and compare.—Wood, Dalley-street, Broughton, Manchester.

**Read and Study** Stanley's announcements, each Sale Column from May 8. Terms last week.—Write at once.

Capital **Gas Engine,** 1½ man-power, Turner's patent, cost £30; sacrifice for £17.—Hughes, Engineer, Ross, Hereford.

**Standard Ohms,** 2s. 6d. each. Delicate Galvanometers, astatic, 5s.—S. Bottone has a few for Sale.

**Am-meters,** indicating up to 8 ampères, 5s. Voltmeters, 5s. Model Electro-Motors, 5s.—S. Bottone.

**Wheatstone's Bridges,** 5s. each. 6in. Tangent Galvanometers, glass shades, 10s.—S. Bottone, Stanley-road, Carshalton.

**New Time.**—Alter your Clocks and Watches. Twelve Sets of figures, with instructions, 6d.—Wheeler, Preston.

**Water Motors,** for sewing machines, organettes, window advertisements, 32s., 42s. List one stamp.—Wheeler.

**Fan Castings.**—Improved Registered Designs; sets 4in., 3s.; 6in., 4s.; 8in., 5s. Drawings, 4d.—Wheeler, Engineer.

**Water Motors.**—Complete one horse-power, £9. Half, £6; Quarter, £4; Eighth, £3.—Thomas Wheeler, Preston.

For sale, 48in. **Bicycle,** with bent handle, bright, with lamp, bell, keys, oilcan, &c. tyres good as new, £3 3s.—E. Boyce, Flanshaw, near Wakefield.

Hardy British **Ferns.**—Lastrea Æmula (hay scented) Oreopteris (lemon scented), Rigida, Thelyopteris, Colina, Dilitata, Asplenium, Marinum, Viride, Crenatum, Trichomanes, Parsley, &c. 15, 1s. 6d. 20 large Rockery Roots, 2s. 6d.; 50, 5s., botanically named, carriage paid.—John Burns, Fellside, Kendal.

**Old Scientific Instruments,** Broken Model Engines, &c. For estimate of cost for repairing, relacquering, &c., send particulars to H. F. Lovegrove, Optical Works, Slough, who makes this class of work a speciality.

Last 87 numbers of the "**English Mechanic,**" quite clean, for half price. — James Gibson, South Queensferry, N. B.

"**Engineer,**" 16 Vols., from 1869: "**English Mechanic,**" 1881-1885; "Science for All," first two vols.; 1 cwt. Gas Carbon. Offers.—F. Ball, Milford Works, Queen's-road, Battersea.

**Dorrington's Engine, Machine Castings** and Working Drawings. List, 1 stamp.—A. Dorrington, West Gorton, Manchester.

**Wealden Fossils,** 30 varieties, 3s., including Lepidotus and some rare Plants and Cones.—See Exchange Column.

Odd **Spiral Springs** made to order. Mattress Springs, 9d. per dozen.—James Parish, 52, Bard-street, Park, Sheffield.

**Piles cured at once** by using Dr. Farquharson's Remedy, free by post for 2s.—2, Standish-street, Burnley.

**Steam Canoes** from £30 upwards. Engines, Boilers, and Propellers for Launches. State requirements.—Cashnall, Eastville, Bristol.

**Boiler,** 5ft. 2in. diam., sound, £3.—Tom Brown, Whitfield-street, Workington.

**Gas Engines,** 1, 2, and 4 man-power, cheap and good; numerous references; guaranteed.—Ellis Butterworth, Rochdale.

For sale, **Tricycle,** back-steerer, in capital order, price £3 10s.; a bargain.—11, Regis-place, Wrexham.

For sale, Coventry Rotary **Tricycle,** balls to cranks and small wheels; perfect condition, guaranteed; only £9, cash.—11, Regis-place, Wrexham.

For sale, **Bench Lathe,** back-geared, bench and all fittings, complete. Price £5 10s.—As above.

**Sheet of Zinc,** weight about 80lb., ¼in. thick, for Batteries. Price 3d. per lb.—As above.

For sale, **Lime Jets,** Gas Bags, Slides, Retort, and other Appliances, cheap.—As above.

Whole-plate **Lens,** good condition, rackwork, diaphragms, £2.—Hennis, Houghton-le-Spring, Fencehouses.

**Photographs,** Scottish Scenery, cabinet size, extra ordinary value, 4d. each.—Address, Photo, 183, Trongate, Glasgow.

For sale, three gallons rich **Silver-plating Solution,** 21s. Instruction given.—Rousseau, Clarendon-road, Walthamstow.

For sale, six-cell **Battery,** carbons 9 by 5, mechanically worked, constant action. £2 2s. Instruction given.—Rousseau, Clarendon-road, Walthamstow.

**Incandescent Carbon Lamps,** low resistance, 3s. each. Fairy Lamps, 3s. 6d. Platinum Lamps, 1s. 3d., post free.—Todd, 14, Wentworth-road, Manor Park, Essex.

**Incandescent Lamp Holders,** new pattern, best in the Trade, 12s. dozen. Sample, post free, 1s. 3d.—Todd, as above.

£20 **Astro. Telescope** for £12 10s., party ordering having forfeited deposit paid.—Theobald, South street, Greenwich.

Brass **Slide-Valve Cylinder,** 1in. bore by 1¼in stroke, 7s. 6d.—Edward Dyson, 28, John William-street, Huddersfield.

100-light **Dynamo**; several smaller ones; Arc and Incandescent Lamps. Inquiries invited.—Warne, 39, St. John-street-road, E.C.

Powerful **Field Glass,** nearly new, in case; wanting cash, take 15s. 6d.—Foreman, 17, Albion-grove, Lewisham, London.

Steel **Name Stamps,** 3d. per letter. Figures (set), 3s. 4d Letters, 6s. 4d. per post.—R. F. Baldwin, Robinswood-hill, Gloucester.

Watchmaker's **Jacot Tool for Pivoting,** in morocco case, as good as new; cost 18s. 6d.; will take 14s.—W.C., 169, High-street, Deptford, S.E.

**100ft. Glass,** cut sizes, packed, 12s. 6d. Pamphlet, "Polarised Light as Applied to the Microscope," 3 stamps.—Holmes, Essex-road.

**Lawn Mower,** Shanks' 16in. roller, good condition, but wants sharpening, cheap.—53, Oseney-crescent, Camden-road, N.W.

**A Treatise** on the Manufacture and Medical Value of Koumiss, 12 stamps. — R. Lawrence, 63, Aitkenhead-road, Glasgow.

**Microscopic Slides,** well mounted, stem sections, double stained, 5s. doz. Sample, 8 stamps.—Balmford, 12, Bessborough-street, London, S.W.

**Lathe,** 3½ centre, planed iron gap bed, iron standards, gunmetal riggers, 7-speed wheel, double crank, slide-rest, no chucks, £4.—R. Singleton, Clifford-road, Hermit-road, Plaistow, E.

**Taper Screw Chuck,** new, fits ½in. Whitworth mandrel, 4s. free.—Franks, 21, Conduit-place, W.

43 **Photographs** finest Express Locomotives in Great Britain. Caledonian 8ft. 6in., L. and N. W. 8ft. 6in., G. W. R. Broad Gauge, &c., cost £6 once; £3.—B. Webb, Kirby-street, Ancoats, Manchester.

Two **Lanterns** for Photographic Enlarging, 15s. and 25s Splendid value.—Dyson, 28, John William-street, Huddersfield.

**Electric Indicators,** Bell, &c., royal letters patent.—Halbert Marks, 27, Penton-place, Pentonville hill. Price list trade.

A hollow mandrel **Lathe** for sale, with slide-rest and stand, complete.—M., 58, Dean-street, Soho, London.

**Gramme Dynamo,** 120 c.-p., new, made by Dale, for working with hand or power. Price £7.—H. Jones.

**Formulas Worked Out** for winding Dynamos from 10 c.-p. to 500 c.-p., 8 stamps each.—H. Jones.

**Dynamo Castings,** Jones's patent H: 8 c.-p., 5s.; 16, 5s. 6d.; 20, 6s. 6d.; 30, 7s.; 70, 16s. a set.—H. Jones.

**Dynamos,** finished: 8 c.-p., 30s.; 16, 36s.; 20, 40s.; 30, 50s.; 70, 100s. each.—H. Jones.

**Dynamos** for house lighting. — Jones's Patent Laminated Fields and Armatures, 5, 6, and 7 lights, £6, £7, and £8 each.—H. Jones.

**Dynamo Machines Repaired.** Motors, with wire, 5s. 6d.—H. Jones, 48, High-street, Lambeth, S.E.

**French Polish.**—Brown and White Hard Varnish, 4s. 6d., 5s. per gallon. Cheaper kind, 4s. 3d.

**Methylated Spirit,** 3s. 4d. All kinds of Glues, Nails, Varnishes, &c.

**Virgin Cork,** 28lb., 4s. 6d. Finest Citrate of Magnesia, 11½d. per lb.

Finest **Oil** for stoves or lamps, 6½d. Finest Kerosene 8½d. per gallon.—H. Jones and Co., Viaduct-street, near Bethnal-green Junction, G. E. Ry.

3½in. back-geared **Foot Lathe,** slide-rest and chucks, scarcely used, £7. Lot of tools and chucks, £2. Photo.—Smelt.

Geared hand **Shearing Machine** for bench, equal to new, £4 5s. Photo and metal cut, 2 stamps.—Smelt.

Enlarged Lathe and Tool **List,** 1 stamp.—W. R. Smelt, 7, Goldsmith's-row, Gough-square, E.C.

Bisschopp 1½-man **Engine**; also 2-man and 1½-horse, cheap.—Smith, Post Office, Higgenshaw, Oldham.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
*FRIDAY, JULY* 17, 1885.

## HISTORICAL NOTES ON THE CASSEGRAIN.

By DR. ROYSTON-PIGOTT, F.R.S.

THE subject takes a much wider range than I at first surmised. Owing to severe, and, I may say, long-continued and dangerous illness in my family (eleven weeks), I have found myself utterly incapacitated from writing scientific papers. "The breaking down," alluded to by A. S. L.," is thus to be explained.

With respect to curvatures for the Cassegrain, I am perfectly sure of one thing: there exists no possible method of testing the curvature of the convex mirror except by experimentally marrying it to the parabolic mirror. A rough correction may be obtained by making both mirrors spherical. In the case of the Gregorian, which has a slight disadvantage of requiring a longer tube or shorter focal length for the parabolic mirror, the convex must be hyperbolic; whilst for the Gregoriam form it must be accurately elliptical: a curve which can readily be tested without the use of the parabolic mirror at all. As already before stated, in my Cassegrain Mr. Calver, in the most praiseworthy manner, patiently figured many convexes, alternately grinding and polishing them to produce either over-correction or under-correction — or balance.

It is now time that I should say something of my experience as to its performance. My parabolic was 129in. focus; with an eyepiece of 1in. focus it magnified 129 times as a Newtonian (to which form I also fitted it); with a convex increasing the power six times the virtual focal length became 774in., or 65ft. nearly, and multiplying this by the sine of 32′ the diameter of the moon, the moon's image was, in this case, nearly 7in. diameter. I was greatly impressed with the delightful flatness of the field of view in an eyepiece having a 3in. field-glass. It presented a sharpness of definition and brilliance of detail never to be forgotten, the various terraces deepening and glistening in the abysses of the most interesting craters seemed to leave nothing further to be desired for lunar observation. The Cassegrain seemed eminently to distance the Newtonian in magnifying power: six-fold for the same eyepiece.

I have not hitherto been able to find any description of Mr. Nasmyth's 18in. reflector sufficiently detailed to show the arrangement of his mirrors; but I imagine he must have had a flat, a convex, and a parabolic. He accomplished the desideratum of a fixed horizontal eye-tube by a turn-table which could be made to rotate both telescope, stand, and observer, whilst drawing-board and eye were in one constant position. This necessitated the altazimuth form of stand, and precluded the refined adjustments of an equatorial for finding objects invisible to the naked eye. His drawings of lunar details are not soon likely to be surpassed; to wit, the minate craters visible at times at the eastern base of Pico. The form used must either have been Gregorian or Cassegrainian, with a flat at 45° interposed.

The history of this telescope is well worth writing. M. Cassegrain is thought to have invented a better form than the great Sir Isaac. Mr. Gregory, in his "Optica Promota," described a reflecting telescope very similar to Cassegrain's in 1663. Newton used a plane at 45° as small as possible, the eyeglass to which was fastened in the side of the tube as closely as possible, and the focussing was done with a screw attached to the big concave. Cassegrain's alteration was merely the substitution for Gregory's concave of a convex speculum, Gregory having already conceived the idea of piercing the large mirror for insertion of the eyeglass. Cassegrain evidently adopted the English invention. This, however, magnified much more than either Gregory's or Newton's, and on that account Sir Isaac strongly objected to the arrangement; for it was impossible in those days to execute the proper curves, and he declared this excessive amplification would render the errors intolerable.

Although correct in theory, and assisted assiduously by the optician Rieve, Gregory died without having obtained any satisfactory results. We now know that had he been able to obtain a parabolic figure for the large mirror, an elliptical figure for the smaller mirror would have obtained a final success. Newton was fully alive to the enormous advantages of a parabolic mirror, and, had means been at hand, he would have produced it. In Gregory's concaves the spherical aberrations of each tended to compensate each other. Sir Isaac says: "When I first set myself to try the effects of reflexions, Mr. Gregory's *Optica Promota* (printed in the year 1663) being fallen into my hands, where there is an instrument (described p. 94) like that of Mr. Cassegrain's, with a hole in the middle of the object-metal to transmit the light to an eyeglass placed behind it; I thence had occasion of considering that sort of construction. . . ." In the convex of Mr. Cassegrain an extraordinary degree of exactness is required in its figure, and the errors of the perimeter of the concave object-metal, caused by the sphericalness of its figure, are much augmented by the convex, whilst at the same time, it must render objects dark and confused by reason of its being overcharged with magnifying power. Nor is there any convenient remedy for this. For if the little convex be made of a larger sphere, that will cause a greater inconvenience by intercepting too many of the best rays, and if the eyeglass be made so much shallower as is necessary, the angle of vision will thereby become so little that of the object when found there will be but a very small part seen at once."

Cassegrain's invention was given to the Royal Society in 1672. M. Salvetti constructed this instrument the same year, but declares he believes the Frenchman "only devised it to disguise as much as possible his pretended new invention, which he endeavours to make anterior to Mr. Newton's most noble one" (No. 87, p. 5069). The first Newtonian was presented to the Royal Society in March, 1672; but Newton had been driven from Cambridge by the plague in 1666, when he was then busily engaged constructing these telescopes. As Cassegrain's paper was dated or received in May, 1672, he had abundant time to re-invent almost the Gregorian mentioned by Newton, substituting a convex for the little concave mirror.

In studying these records, the extreme sagacity of Newton is interesting. His objections to the French form are cogent and hold good now. The small field if viewed[*] with the lowest power of the great Melbourne telescope is apparently hardly suitable for the delineation of nebulæ for which it was specially constructed.

I shall allude more minutely to these matters further on.

(*To be continued.*)

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[*] 15 minutes.

## THE INTERNATIONAL INVENTIONS EXHIBITION. — XI.

### Clocks and Watches.

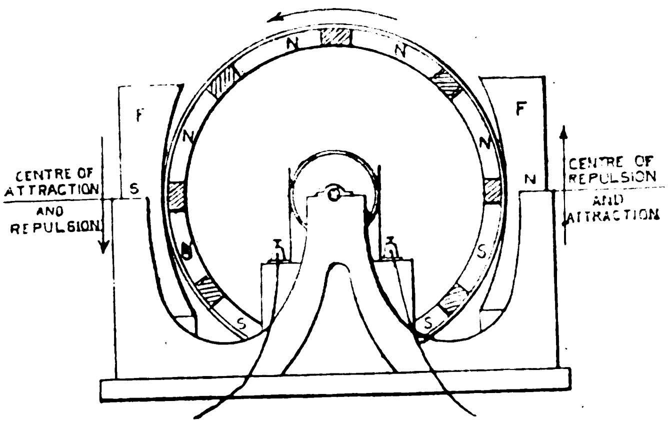
THE group devoted to clocks, watches, and other timekeepers contains a number of interesting exhibits, and is fairly representative of the trade. Some of the stands are, no doubt, little more than shops; but the majority contain one or more exhibits which are really inventions or improvements since 1862. For several reasons the stand of the American Watch Company, of Waltham, Mass., is the leading feature amongst the exhibits connected with the watch and clock industry; but it is especially interesting to those who have the mechanical turn of mind, because several of the more ingenious automatic machines employed by the company in the manufacture of watches are shown in working order. Altogether there are twelve machines in operation; but they represent only a percentage of the actual number of different machines employed to make and finish a watch, and are engaged in the manufacture of screws, escape wheels, train wheels, crown wheels, pinions, dial feet, &c. To the practical horologist, the pinion-making machines will probably be of most interest; but the general mechanic will be attracted more by the wonderfully ingenious screw-cutting machine. This machine makes jewel screws at the rate of 400 an hour, and it is so independent of human care that one attendant is sufficient in practice to look after seven machines. His principal work is to supply the hollow mandrel with a suitable piece of wire, which is fed forward through a split chuck, and is reduced to the rough shape by a cutter; then the mandrel stops for an instant or so, and a live spindle carrying the die advances and cuts the thread. The motion of the die is reversed, it is run off the screw, and the spindle retires, while the wire is advanced a sufficient length for another screw. Meantime, however, the portion of wire already threaded has been severed from the length, and is seized by a rocking arm, which carries it to a cutter situated at the back and parallel to the mandrel, which cutter, a little circular saw, slits the head, and a needle rod pushes the finished screw into the shoot leading to the receptacle. The admirable lubricating arrangements can be well seen in connection with this machine; for wherever steel has to be cut, a constant, if minute, stream of oil is supplied at the working face, which oil is taken by small gutters to a filter beneath the bench, whence it is constantly pumped to the supply pipes. In some cases, however, the oil has to be applied by an attendant. The pinions are roughed out in a machine which consists of two small lathes on the same bed; one of these is fed with the wire and cuts the staff, and also measures off the length, at the same instant forming a portion of the pinion that is to follow. The partially roughed-out pinion, when cut off, is seized by a carrier or rocking arm, which takes it over to the other lathe, where the point at the short end is cut, and the pinion has thus taken its first rough shape. This "blank," as it is termed, is then taken to another machine, where by sundry operations it is reduced to accurate gauge, and has a finishing cut taken all over it. The leaves are cut in the pinion by means of a milling-machine, which carries three distinct and different cutters in one head. This head revolves step by step as required, and rotary motion is imparted to the cutter which happens to be lowest, whilst a reciprocating movement is given to the pinion, and also a step-by-step rotating movement according to the number of leaves. The first cutter is a small circular saw, and underneath that the pinion passes as many times as there are leaves to be cut; then the head makes the third of a turn, and brings another cutter into play which forms the leaves, while the third takes a light finishing cut. These little milling tools are made of discs of steel with ten slits at equal distances around the periphery, and in order to give clearance for the rear of the teeth, a saw-cut is made from one corner of the slit at an obtuse angle. Pressure being applied round the periphery, the saw-cuts are closed, and the disc becomes a milling tool with ten teeth, which are well supported and have ample clearance. The escape wheels are made in a similar manner, except that in their case 50 are threaded on a mandrel or quill, and are cut at the same time. This quill has slits into which the arms of the wheel blanks pass, and the latter are held quite firm, while they are perfectly supported. Fifteen spaces have to be cut in the rims of these wheels, for which purpose six tools are employed, two of steel and four of sapphire. These tools are carried by a head which revolves as required, a rotary motion being imparted to the spindle of the tool which is lowest, or, in other words, nearest to the work. The 50 blanks have a reciprocating motion imparted to them, and after every "retreat" a slight rotary motion of the quill presents a fresh surface to the milling tool. Fifteen cuts having thus been made by the first tool, the head makes a sixth of a revolution, and another tool is presented to the work, an operation repeated six times, the last four tools having cutters of sapphire, which are shaped and sharpened as required by grinding them with four grades of diamond dust. The cutters in this machine run at a very high speed—in the factory at more than 8,000 revolutions per minute; but the constant stream of lubricant is found to give excellent results, and is really very economical. The Waltham Watch Company's exhibit will be found in the court devoted to America, and it is sufficiently near to Group 27 to be considered in this notice, as also are those which have stands in the Swiss Court. In walking through the group itself, we come first to the stand of Messrs. Frodsham and Co., of Gracechurch-street, who, besides a collection of chronometers and watches, show their non-magnetic compensated gold and palladium balances, working in close proximity to a permanent magnet. A curiosity at this stand is shown in the shape of several watch movements without balance springs, the motion being kept up solely by the impulse of the mainspring on the lever and the heavily-weighted balance. When finished, these watches will, of course, be fitted with springs, and they are shown to illustrate the accuracy of workmanship.

Mr. J. W. Benson, of Ludgate-hill, makes a specialty of his three-quarter plate going-barrel English lever at a low price. The advantages of the three-quarter plate, as compared with the whole plate, are not unknown to our readers; but the "Ludgate" watch is also supplied with the patent ring-band, fitted round the movement, between it and the case, which, while excluding dust, permits the employment of a larger barrel, containing a 60-hour spring instead of the usual 30-hour. By this arrangement, as only one-half of the spring is used, a fairly constant and equal power is applied to the movement, and a steadier rate of time is obtained. The maker, in fact, appears to have substantiated his claim to combine the merits of both the fusee and the going barrel without the defects of either. Amongst the elaborate specimens of the watchmaker's art shown by Mr. Benson, the visitor will be attracted by a watch which gives the time at two different longitudes, strikes the hours and quarters, and repeats them if desired. It also indicates leap year, the month, day of month, day of week, and phase of the moon. As if that were not enough for one instrument, this watch has a treble chronograph action, with "fly-back" minute and split seconds hands, so that the time of the winner and the second in a race can be taken; an alarum that can be set to any time, a thermometer, and an "up and down" hand to indicate the state of the winding action. Some of the visitors will doubtless consider a greater marvel the miniature watch, no larger in diameter than a shilling, which shows the month and day, and repeats the hours, quarters, and minutes—altogether a unique specimen of skilful workmanship. E. Dent and Co., of the Strand, besides watches and parts, exhibit their galvanic contact apparatus for dropping a time-ball, and detached pieces of machine-made clockwork; Bailey and Co., Salford, show an improved turret clock for four 6ft. dials, and a "universal clock dial," made for the Jesuit Church, Manila. It is impossible in the available space to notice all the exhibits of the different firms; but it may interest some of our readers to learn that there are not many signs of 24-hour dials, nor any great endeavour to induce the public to take up the "new time." J. Smith and Sons, of St. John's-square, E.C., show clock dials of various patterns with the 24 hours arranged on them, and their improvements in electric time bells, &c. Kendall and Dent, of Cheapside, exhibit watches with dials having two sets of figures. Two separate dials placed back to back show both old and new time. A patent clock has two dials, placed either at an angle or on a plane, showing 1 to 12 and 1 to 24 respectively, while the other has a self-changing dial—a principle applied to a watch (but without hands), in which two figures are exhibited, the one indicating the hour, the other the minutes past. A "touch" watch for the blind has a metal dial with raised Arabic figures and strong hands. Mr. R. G. Webster, of Queen Victoria-street, shows the improved gravity escapement, watch balances affected and unaffected by a magnet, a 24-hour clock with shifting dial figures seen through orifices, and a marine chronometer with improved balance. At the adjoining stand the Standard Time and Telephone Co., of Queen Victoria-street, exhibit Lund's system of synchronising by altering whan necessary the position of the minute hand at each hour by sending an electric current to all the clocks on the circuit. At this stand is a 24-hour clock dial, with the figures alternately black and red; but this is not an outcome of the "new time" scheme: it is a clock for ringing bells at any five minutes in the twenty-four hours, and is fitted with contact springs to complete the electric circuit. Twenty-four hours are necessary in this case, because otherwise if the clock were set to ring at 12 noon, it would also ring the bells at midnight. In the collection of the British Horological Institute, Mr. Whipple shows his patent watch-glasses, in which the hours from 13 to 24 are marked in red on the glass, which is an ingenious way of meeting the wishes of those who desire to read time to 24 hours. We have thus specially alluded to the "new time" scheme in order to show that, so far as the exhibitors in this group are concerned, there are few who pay any attention to it. If a demand should arise, as business men they are prepared to meet the wishes of the public; but the paucity of designs shows that they have little faith in it. As we are at the stand of the British Horological Institute, we may mention that it contains a collection of special interest to watchmakers, and at the risk of being invidious, we would call attention to Mr. Curzon's models of escapements as a notable item in the collection. For some reason or other, which we cannot attempt to fathom, the exhibits of the Polytechnic School of Practical Watch and Clockmaking have been placed in the adjoining group—that devoted to Philosophical Instruments—although Mr. Herrmann's patent trinograph (for setting off angles and distances) and the other exhibits are directly connected with the watch and clock industries.

Grimshaw and Baxter, of Goswell-road, have a splendid collection of tools and appliances, including the "Boley" designs, which have recently attracted the attention of English watchmakers. Haswell and Sons, of Spencer-street, E.C., also exhibit a collection of tools and materials, including balance springs of a palladium alloy, which are proof against rust and the effects of magnetism. These springs are also said to obviate the middle temperature error, for experiments show that whereas steel springs have an ascensional error from the extremes of heat and cold, the palladium alloy gives a small ascensional difference from the extremes and a remarkable depression in the middle. At the stand of Messrs. A. and H. Rowley, of Gray's Inn-road, we find a splendid collection of clocks, including as a centre-piece a large chiming clock with new figure work and perpetual calendar. The curtain at the top rises 1½ minute before the quarters and discloses the bell-ringers, with another figure to strike the hours. The principal exhibit of Messrs. Rowley, from our point of view, is the movement of a fine modern quarter clock, which strikes on eight bells or four gongs, has a 15lb. pendulum, and a lifting power in the going mainspring of only 4¼lb. This clock is wound and regulated entirely from the front, and as the latest specimen of the English clock manufacture is worth special attention. As our readers are aware, the so-called cheap clocks are not made in this country, the lowest-priced specimens of the horological art being the familiar 8-day clocks; but as a really good clock chiming the quarters is a desideratum in many houses, we have taken the trouble to ascertain the price, and find that it is as near as possible five guineas for the movement; or, as in a specimen shown by Messrs. Rowley, in a polished mahogany ornamental case, £6 10s. A clock like that is not to be compared to a regulator for accuracy; but it will keep time to within, say, a minute in a month (probably better than that), and, allowing for the chiming movement, is no doubt the cheapest really good clock in the market.

At the stand of A. Légé and Co., of Turnmill-street, which is in the group devoted to Philosophical Instruments, the parts of clocks are shown, including a mercurial pendulum, in which the mercury is contained in a number of tubes inclosed by a perforated cylinder, in order that the temperature of the air may more readily exercise its effects. Messrs. Wycherley, Hewitt, and Co., of Prescot, have a fine show of tools and parts of watches as made by machinery. It was the intention of the firm to exhibit some of their machines at work; but as they would have had to provide motive power themselves, they abandoned the idea, and it remains with the council to explain why an exhibit which would have been of at least as much interest as that of the Waltham Watch Company is thus put, as it were, in the background, for the Messrs. Wycherley are the representatives of the original inventors of machinery for making watches. The English Watch Company, Birmingham, show a number of their watches, but do not exhibit their methods of manufacture — perhaps for the same reason that has made the Wycherley stand a "dead" instead of a "live" one, in the mechanical sense. Postmasters and telegraphists will find a watch that will appeal to them in the exhibit of Mr. J. F. Hills, postmaster, Sudbury, Suffolk, consisting of watches with dials carrying the code letters besides the ordinary figures. Perry and Co., Holborn Viaduct, exhibit in their collection Mr. C. Lange's device for use with stem-winding watches. In the new keyless action watches the bow cannot be fastened to the pendant by a screw for obvious reasons, and in many cases the ends are simply pressed into sockets from which they are liable to escape. In Lange's patent the bow is reduced to a ring of small size, which has a stem inserted in the pendant in such a manner as to swivel within the stem and not to interfere with the winding of the watch. There are several other exhibits of more or less interest in this group, but considerations of space prevent us from naming all the firms. Those interested in horology will, however, not need to be told that they should examine closely the stand of Mr. V. Kullberg, of Liverpool-road, N., for there they will find some of the most important of recent inventions, though it is rather puzzling to account for the fact that, while some firms have large stands which are little more than shops, Kullberg's collection of high-class chronometers, &c., is rather cramped for space.

Mr. Squire, of Myddelton-square, shows a watertight watch, and his removable barrel and adjustable isochronal balance spring stud, which is intended to avoid the risk of forcing or straining the spring. Camerer, Kuss, and Co., New Oxford-street, have a collection of cuckoo and trumpeter clocks, which naturally attract the attention of visitors generally; while G. Bendon and Co., of Ely-place, show a practical improvement in their keyless clocks, which are wound by a jointed winding stem sliding in the canon or pipe carrying the minute and hour hands. A button enables the operator to pull out the stem, which, being jointed, then forms a crank by which the clock is wound as by an ordinary key. This arrangement, at all events, obviates the annoyance of a "lost key." Mr. F. Sage, of Gray's Inn-road, and Mr. N. C. Firth, of Chester, exhibit workmen's time checks which are ingenious arrangements, but are of interest only to a limited class from the practical point of view. The De Gruyter Clock Manufacturing Co., of Aldersgate-street, E.C., exhibit Warder's patent torsion pendulum clock, which is said to require winding only once a year, and there are some other exhibits which may attract attention; but we believe we have now mentioned all that are likely to interest the public, while the profession will scarcely need to be told that in the exhibit of the British Horological Institute, which includes most of our foremost horologists, they have a perfect feast, and a variety of subjects to argue about for a whole twelvemonth and longer. The exhibit of the Kew Committee will attract both the public and the profession, for the certificates are already being utilised quite outside the trade, and possibly the question in the future will be not whether a watch is a lever, a chronometer, or what not, but what certificate it obtained at Kew.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## GANT'S PATENT ELECTRO-MOTOR.

THIS motor differs from any previous type; the central part is a drum constructed of metal or wood, with as little weight as possible. The conducting wires from the pole reverser to the armature magnets are inside the drum. The armature magnets are bar electro-magnets laid parallel with the axis and connected throughout. The construction gives, with the same weight as former ones, increased leverage and momentum.

It will be seen by inspection of the sketch that by the letters N and S on the armature magnets and on the field magnets F, that the magnetic influence causes the armature to revolve in the direction of the arrows; increase of diameter giving increased power, and weight on the periphery giving momentum to its utmost value. As the two opposite plates of the pole-reverser come in contact with the springs or brushes, the polarity of the magnets immediately connected with them is reversed, without changing the others, so that the top and bottom sets of magnets continue of the same name, unless the current is reversed by a reverse connection with the battery. The armature above carries eight electro-magnets, but any even number to sixteen may be employed if requisite.

## ON SOME MATTERS IN THE THEORY OF MIRRORS.—III.

By W. BRADBURY.

THE last term, or coefficient of $y^2$, is the increment of $1/v$, or the alteration in the value of $1/v$ due to the extent of aperture. To find the increment of $v$, this small quantity is treated as a differential, and using the notation of the calculus, we have—

$$d\left(\frac{1}{v}\right) = -\frac{dv}{v^2} \text{ or } dv = -v^2\, d\left(\frac{1}{v}\right).$$

Hence, to find the aberration or change in the value of $v$, the coefficient of $y^2$ in equation (26) must be multiplied by $v^2$. It must also be noticed that whenever the sign of the reciprocal increment is positive, the focal increment itself is negative, and shows that the aberration shortens the focus. In equation (26) it will be seen that the error is negative and shortens the focus, and is unaffected by the signs of the quantities within the brackets.

Hence, the aberration for diverging rays on a concave mirror is—

$$-\frac{v^2}{2f}\left(\frac{1}{2f} - \frac{1}{u}\right)^2 y^2$$

or, in another form, without the value of $u$—

$$-\frac{v^2}{2f}\left(\frac{1}{v} - \frac{1}{2f}\right)^2 y^2 \dots\dots\dots\dots (27)$$

When the rays are parallel $v$ and $f$ are equal, and we get for the aberration for parallel rays—

$$-\frac{y^2}{8f} \dots\dots\dots\dots (28)$$

which is the common rule for spheric concave mirrors.

Equation (27) may be put in a simpler form by employing the auxiliary quantity $a$. For since

$$\frac{1}{v} = \frac{1-a}{2f}$$

we find—

$$\frac{v^2}{2f} = \frac{2f}{(1-a)^2};\ \left(\frac{1}{v} - \frac{1}{2f}\right)^2 = \frac{a^2}{4f^2}$$

so that the whole coefficient of $y^2$ is—

$$-\left(\frac{a}{1-a}\right)^2 \cdot \frac{y^2}{2f} \dots\dots\dots\dots (29)$$

This formula is applicable only to a concave mirror.

It may be useful to exhibit in a tabular form the aberration values for different focal positions.

TABLE OF FOCAL AND ABERRATIONAL VALUES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $u$ | $\frac{f}{2}$ | $f$ | $\frac{3}{2}f$ | $r$ | $3f$ | $\infty$ | $-\frac{f}{2}$ |
| $v$ | $-\frac{2}{f}$ | $\infty$ | $3f$ | $r$ | $\frac{3}{2}f$ | $f$ | $\frac{f}{2}$ |
| $a$ | $3$ | $1$ | $\frac{1}{3}$ | $0$ | $-\frac{1}{3}$ | $-1$ | $-5$ |
| $\left(\frac{a}{1-a}\right)^2 \frac{y^2}{2f}$ | $\frac{9}{8}\frac{y^2}{f}$ | $\frac{y^2}{2f}$ | $\frac{y^2}{8f}$ | $0$ | $\frac{y^2}{32f}$ | $\frac{y^2}{8f}$ | $\frac{25}{72}\frac{y^2}{f}$ |
| Ratio to parallel aberration. | 9 | 4 | 1 | 0 | $\frac{1}{4}$ | 1 | $2\frac{7}{9}$ |

The last horizontal row gives the ratio of the vergent to the parallel aberration. Thus, when the radiant point is at half the focal distance in front of the mirror, the conjugate focus is at the same distance behind the mirror virtually; and the spheric error is nine times that of the same mirror for parallel rays. The second ratio 4 is meaningless, except as a quantitative result, for the reflected rays, issuing parallel from the mirror, come to no focus; but a spheric error must necessarily exist among them, and the term parallel is only applicable to a certain part of reflected rays, the vergency showing itself more and more as the aperture becomes increased.

It will be noticed that the ratios on each side of the column headed $r$ are the least, as would naturally be excepted, because the nearer the two conjugate foci approach the centre of curvature, the less becomes the spheric error.

(*To be continued.*)

## GLYCERINE AND ITS USES.*

GLYCERINE is perhaps well known to be a useful addition to the sulphur type of lotions for the hair, as the sulphide of lead which is supposed to be formed renders the hair almost as stiff as a board without some such addition.

A very recent hair dye, and one which is said to be good, may be made by dissolving freshly-prepared ammonio-tartrate of bismuth, or the ordinary scale citrate of bismuth and ammonia, in weak glycerine, and mixing this with a solution of hyposulphite of sodium in glycerine and water, and finally diluting with more water.

Teeth lotions have also come much into use, and of the many formulæ published the following is a type:—Tincture of quillaia, eau-de-Cologne, water, borax, glycerine, with colouring. Such a combination is as excellent for its purpose as it is elegant in appearance.

Almost all cosmetic solutions are greatly improved by the addition of a little glycerine. Of these we may name freckle lotions, zinc oxide and rose water lotions, calamine lotions, &c.

Liquid starch glosses and finishes have glycerine in them as a *sine quâ non*. Here is an example from *Popular Science News*:—Spermaceti, 1oz.; gum arabic, 1; borax, 1; glycerine, 2½; water, 14½; perfume, q. s. Three spoonfuls added to about 4oz. of boiling water.

Lime juice and glycerine inseparable may easily be made by the subjoined formulæ, but I cannot say how much will be the percentage of glycerine. A saturated solution of borax should first be prepared. Here is a note I made a long time ago:—"One drachm of powdered borax to be dissolved in 21½ drachms distilled water, and during solution warmed slightly to keep the temperature just a few degrees above that of a summer's day, and to insure accuracy it is perhaps better to weigh the materials into a large-size 3oz. bottle. The oily material consisted of 14 parts of oil of almond and 2 parts of castor oil, thoroughly mixed. To this quantity of mixed oil was added, all at once, 4 parts of the solution of borax as named (each being accurately measured). On being well shaken a very white uniform emulsion which did not separate resulted. I believe soap is sometimes added to this preparation to increase its white appearance and to prevent separation, but I do not know that it is a desirable addition, or that it is effectual in preventing separation." I have, up to this period, had no fault to find with my note.

*Glycerine Jelly.*—This combination may be made opaque or transparent. For the former, soap, glycerine, almond oil, and perfume are used; for the latter, isinglass, gelatine, or transparent soap, 1oz., dissolved in glycerine and a little added water, this usually being a perfumed water.

I hope, by the introduction of a few brief notes under this head, that we shall not be doing any serious injustice to the medical profession. Glycerine is reputed to be a safe and very effectual emetic for infants. As a substitute for cod liver oil, iodised glycerine with iodide of potassium forms a good tonic, &c., for phthisical patients whose stomachs are unable to bear this oil. A combination of a fluid extract of *Cascara Sagrada*, glycerine, and a little tincture of nux vomica is highly praised as a tonic laxative. Ferric chloride and its preparations are very astringent, and hence, when taken internally for some time as a tonic, are liable to do harm. This astringent effect is greatly counterbalanced by the addition of glycerine, with which this chalybeate is perfectly compatible. An excellent simple remedy, in place of the old-fashioned rum and figs, for tightness of the chest and the cough of old people, is a mixture of 40 fluid drachms of glycerine, 10 of rum, with 1 minim of oil of anise or peppermint. The combination, as an aperient, in doses of 1 drachm, of glycerine and castor oil in equal parts, is now so old that it has almost sunk into oblivion, but it is undoubtedly, when prepared *secundum artem* and with a little flavouring agent, a valuable and highly efficacious, elegant preparation. The activity of the oil is said to be increased.

An excellent application for scalds and burns is composed of equal parts of glycerine and oil of peppermint. Glycerine, as an external application, is said not to be absorbed by the skin, hence it is of especial value as a basis when such agents as a mercuric chloride, iodoform, &c., have to be superficially applied in cases of certain skin diseases, as scabies, &c. 1½ drachm, dissolved in 3 fl. oz. of glycerine, is reported to possess valuable powers in the treatment of scabies, &c.

Iodised glycerine prevents the pitting which may result after an attack of small-pox. As a liniment, in combination with chloral hydrate, camphor, &c., it receives the commendation of sufferers of rheumatism. When vaporised in a suitable apparatus, and its fumes inhaled, glycerine is a simple expedient in cases of bronchial affections and distressing coughs; and here we may remark that many eminent vocalists are fully alive to the value of this substance as a voice strengthener and throat invigorator.

Salicylate of sodium, dissolved in glycerine, has its medicinal effects greatly enhanced. A good remedy for dyspepsia consists of pepsine, sherry, glycerine, and tartaric acid.

Naphthaline, recommended as an antiseptic agent with a view to checking diarrhœa, and said to be efficacious in cases of intestinal catarrh even when chronic, may be administered in glycerine, in which it is soluble when the solvent is slightly warmed. Indirectly connected with glycerine is the use of nitro-glycerine, as a 1 per cent. solution in diluted alcohol, for neuralgia, &c.

Mercuric iodide, with glycerine, is a good paint for corns.

An excellent simple febrifuge drink is thus made:—Glycerine, 1oz., citric acid, ½ drachm; water, 6oz. Dose, one to two tablespoonfuls every hour for an adult.

Glycerine is very largely used in the manufacture of printing, stamping, and letterpress inks, as also in the preparation of inks for the numerous forms of "graphs." The following is an example of an indelible stamp ink taken from the *Pharmaceutical Record*:—Sodium bicarbonate, 22; glycerine, 85; gum arabic, 20; nitric silver, 11; solution of ammonia, 20; Venice turpentine, 10; mix according to art. For ribbon ink:—Concentrated glycerine and alcohol, of each 15; aniline ½oz. Blacking of excellent quality can be made by means of a judicious combination of soot, glycerine, oils, &c.

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* By F. H. ALCOCK, in the *Chemist and Druggist*.

A good "graph" is readily made from Russian glue, 2; water, 1½; glycerine (1·260), 5 parts by weight. As these sometimes go mouldy, we may mention a wrinkle which will prevent the proneness of gelatine to this trouble. It is simply to dissolve a few grains of boracic acid in the glycerine before incorporating with the other materials.

In the process of vulcanising indiarubber glycerine is found to be of service. It appears that the indiarubber acquires properties which protect it from oils and fats without interfering with its other properties.

For silvering and gilding glass we find our subject again in request by reason of its reducing action on the salts of silver and gold, and also because the deposit thus produced is of a brilliant metallic lustre. An ammoniacal solution of nitrate of silver is first prepared, and in it is poured a little of caustic potash, and then a few drops of glycerine. It is then ready for immediate use, since reduction begins at once, which process is accelerated if a little ether or alcohol be also added to the mixture. The result is said to be most brilliant when a moderate heat is used, and darkness is said to favour the adhesion of the deposit to the mirror.

A polish for leather is thus made:—Shellac, 200; spirit, 1,000; Marseilles soap, 25; spirit, 25 per cent., to dissolve soap, 375; glycerine, 40; to which is finally added 5 nigrosin in 125 spirit.

Mineral water manufacturers are now availing themselves of the advantages to be derived from the use of glycerine in the preparation of the liquors and flavours, &c., which are much in request as beverages.

Glovers use large quantities of yolks of eggs in certain processes involved in the manufacture of kid gloves. An addition of a few per centums of glycerine is said to be a decided advantage. Glycerine preserves the yolks for a long time.

In the preservation of anatomical and other specimens its value is well established, but a little point will perhaps be useful to bear in mind. About six years ago a friend presented me with a nice specimen of the ripe fruit and fresh leaf, with tendrils, of the *Bryonia dioica* which I placed in a bottle with some glycerine and water, but now, although in good condition as far as preservation goes, I find the berries have become wrinkled and some have collapsed, which, I believe, is probably due to a process of osmosis, the liquid within the fruit being of a different gravity from the preservative fluid. If I had first ascertained the gravity of the juice, and made my glycerine solution of a similar gravity, if such had been possible, I think the shape of the fruit would have been retained.

For the preservation of cider, glycerine of salicylic acid is admirable, a very small quantity keeping it good for over twelve months.

A solution of alum, arsenic, and nitre in glycerine is said to be an admirable preparation for "curing" animals' skins. I have a cat's skin which has been successfully prepared with this combination.

To render corks impervious, soak them several hours in a solution composed of ¼oz. glue or gelatine, ¼oz. glycerine, and a pint of water heated to 50° C. After such a treatment they are nearly proof against many corrosive liquids, but are more competely so if they are at first well dried and then dipped in a mixture of 4 parts of paraffin and 1 of petrolatum, or simply ordinary petroleum oil.

The easiest and safest method of preparing this explosive is that which was first introduced by Messrs. Boutmy and Foucher, and which, as a new and safe method, obtained the prize of 2,500f. offered by the French Academy of Sciences. First by converting the glycerine into sulpho-glyceric acid, and in this form bringing it into contact with the nitric acid, to which an equal weight of sulphuric acid has been previously added.

The details of the process are as follows:—

One part by weight of pure glycerine (1·260) is thoroughly mixed with 3 parts of strong sulphuric acid (1·842); there is at once a considerable evolution of heat, and the glycerine is slightly discoloured. In a separate vessel a mixture 3 parts (also by weight) of sulphuric acid and 3 parts of nitric acid (1·4) is made, and both mixtures are then allowed to cool down to about 15° C. The next step is to transfer the two cooled liquids to a tall cylinder, and well stir them together, when a slight rise in temperature (to about 20° or 25°) takes place, followed, after the lapse of half an hour or so by a cloudiness of the acids, due to the separation of minute drops of nitro-glycerine. After standing for about twenty hours the formation of the oil is complete, the whole of it having risen to the surface of the acid mixture; it may then be siphoned off, dissolved in an equal volume of ether, to facilitate its separation, shaken up with successive portions of water until the washings fail to redden blue litmus, and finally heated on a water-bath until its weight remains constant. The nitro-glycerine will now be light-brown in colour, and should have a specific gravity of 1·6, and should detonate readily and powerfully when fired by percussion or by means of a fulminating charge. This substance may be easily recognised by the violent but transitory headache which is experienced on placing an exceedingly small quantity (1-1,000th of a grain or thereabouts) on the tongue.

In the old processes the nitro-glycerine separates almost instantaneously, and rises in part to the surface, thus rendering washing difficult. In the process above described its formation is gradual and extends over a long period of time.

The barometric records made for the *Times* newspaper are from a glycerine barometer. In place of the column of mercury of about 30in. length, a tube about 27ft. long is used containing ¾ of a gallon of glycerine coloured red with aniline. The great advantage of this fluid is that readings can be taken more accurately, for, when subjected to the weight of the atmosphere, while mercury would move 1-10in., the height of the glycerine column would be moved through a space of 1in. One objection has to be provided against, i.e., the hygroscopic nature of glycerine, its powers of absorbing water from the air being very great. This is remedied, however, by putting a layer of heavy petroleum oil in the cistern of the barometer. There is a glycerine barometer at the Kew Observatory which also required for its construction ¾ of a gallon of glycerine, and, in order to obtain the correct height, the tube passes through two rooms, the cistern being in one and the column read off in the one above. This fluid, on account of its high boiling point and low freezing point, is of constant use in scientific experiments. Carbolic acid is said to be an adulterant of ordinary or wood-tar creasote. The former is well known to be soluble in glycerine (glycerinum acidi carbolici), and on the addition of water forms a clear solution. Creasote forms a nearly clear solution with this liquid when of sp. gr. 1·260, but on dilution with water it separates out again.

When gallic acid is warmed for a long time with glycerine, even at a low temperature, pyrogallol results, and this process is taken advantage of by photographers, who use a combination of glycerine and pyrogallol, or pyrogallic acid, in some of their operations.

A delicate test for glycerine is to take two drops of carbolic acids with 3,000 to 5,000 drops of water, and add one drop of solution of ferric chloride; in the absence of glycerine a blue colour results, but if it be present the colour does not form. If colouring matters or sugar are present in the suspected liquid they must first be removed. To do this calcic hydrate is added to the liquid to be tested, with some powdered marble, and evaporated, and the mass then exhausted with a mixture of alcohol and ether; the alcoholic solution evaporated to remove ether and alcohol, and the residue mixed with water, and the test applied, first neutralising any alkali, should any be present. This may be available as a qualitative test for the presence of glycerine in beers, wines, beverages, &c.

The value of glycerine jelly for mounting microscopic objects needs only a passing comment; its manipulation is very easy, and well suited to the tyro embarking in the study of histology of animals and plants.

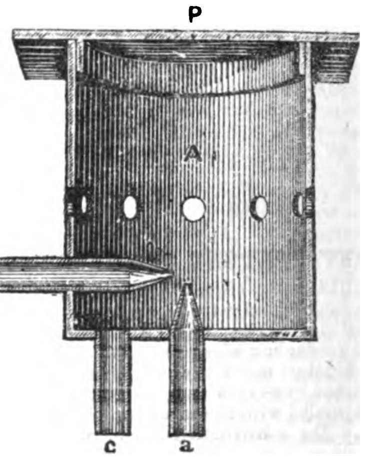
The fact that glycerine when present in a solution often greatly interferes with the usual chemical reactions should always be borne in mind. Thus ferric bromide mixed with glycerine, and then sulphocyanide of potassium added, gives the usual red colour, but ether does not remove that colour and impart it to itself. Again, if ferric bromide be added to sulphocyanide of potassium, and then ether added, we get all that we expect, but on the addition of glycerine the ether becomes colourless again. Glycerine also removes auric chloride and uranium nitrate from their etheral solutions; so, too, an etheral solution of mercuric chloride, when agitated with glycerine, is found to hand over the greater part of its solvent to the latter solvent.

Glycerine has very recently been used in a process for the preparation of chemically pure metallic bismuth. Ordinary commercial bismuth is dissolved in dilute nitric acid, and the solution mixed with water until turbidity begins to appear; then a sufficient quantity of fixed alkali is added in solution to precipitate the bismuth and render the solution alkaline; twice the volume of the alkaline solution is now added, and glycerine in sufficient quantity stirred in to redissolve the precipitate; filter if necessary. The filtrate is now mixed with a solution of blue glucose (1 : 6 or 8) and laid aside for some time in the dark; filter again. The filtrate is now boiled and well stirred, when finely-divided bismuth is deposited, which must be filtered away, washed, and dried as rapidly as possible.

## ETHER FREEZING APPARATUS.

A SIMPLE and convenient ether freezing apparatus for microscopists has been described recently by W. Emil Boecker in the *Zeitschrift für Instrumentenkunde.* Following the principle of the Lewes and the Roy instruments, the ether spray is thrown on the under side of the object-plate instead of on the object itself.

The apparatus consists of a short cylinder (Fig. 1, A), closed by the plate (P), on which the object is placed for freezing. A metallic tube (*a*) drawn to a fine point penetrates the base of the cylinder, and another (*b*) its side. The vertical tube (*a*) is connected by rubber tubing with a small bellows, while the horizontal tube (*b*) is similarly connected with a glass tube which passes through the stopper of a bottle containing ether, reaching nearly to the bottom. When the bellows is set in motion, the current of air throws the ether spray against the plate (P), and the rapid evaporation thus produced soon lowers the temperature sufficiently to freeze the object. The ether vapor and the air escape through a series of holes in the side of the cylinder. A third tube (*c*) connects with a second glass tube that extends barely through the stopper of the bottle of ether, and thus provides for the admission of air into the bottle and for the escape of the excess of condensed ether. The cylinder is small enough to be received by the holder of the microtome.



## AMATEUR LENS MAKING.*

TO make an ordinary lens requires a certain degree of manipulative skill, but when compared with a fine job of filing, fitting, or even turning, it is easy, and there is a charm about making a nicely polished lens which is not found in metal working. The tyro should commence with small plano and double convex lenses, which he may mount singly or in pairs. After attaining a fair proficiency in making these, he may proceed to larger work, and afterwards, by coupling study with practice, he will be able to make fine work, such as the achromatic objectives of microscopes and telescopes, eyepieces, lantern objectives, &c.

The first thing to be done in the way of the preparation of tools for lens grinding is to make gauges or patterns with which to gauge the convexity of the grinding tools. These may be made from pieces of sheet brass, about $\frac{1}{32}$in. in thickness, the plates for gauges for convex tools being chucked on a plane board secured to the face-plate of the lathe, and the circular aperture turned out. The plate should be bevelled each way from the aperture, forming a knife edge, and it should be separated by a saw into two or four parts, according to the size of the lenses to be ground, as shown in Fig. 1. The radius of the circle so formed will be approximately the focus of a double convex of this curvature, and the diameter of the circle is approximately the focus of a plano-convex lens of the same curvature.

Gauges for concave tools or concave lenses are made by turning discs of brass with V-shaped edges, as shown in Fig. 2, and an instrument for shaping small concave grinding tools is shown in Fig. 3. It consists of a sharpened steel disc attached to or formed upon the end of a bar, and used as a scraper, for giving the final shape to the concave grinding tools. For grinding convex lenses it is well to have two concave tools like that shown in Fig. 4. This, as well as other grinding tools for small work, should be made of brass. Drawn brass is preferable, as it is usually better metal, and more homogenous than castings, and needs no external turning.

Having determined on the focus of the lens to be ground, the brass is chucked in the lathe, and hollowed out as nearly to the correct form as possible, the gauge shown in Fig. 2 being used from time to time to determine when the proper concavity is reached. The grinding tool is finally scraped with the cutter shown in Fig. 3. The counterpart of the concave tool shown in Fig. 5 is now turned as nearly to the gauge shown in Fig. 1 as possible,

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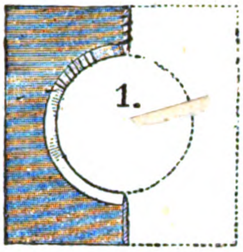
* By "M.," in *Scientific American Supplement.*



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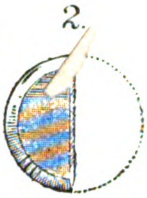

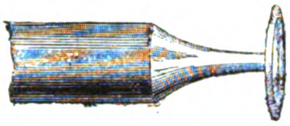

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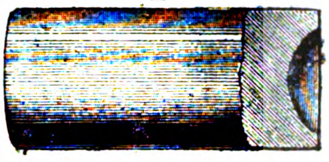

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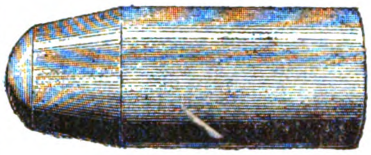

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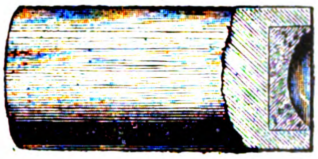

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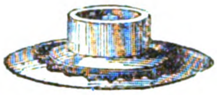

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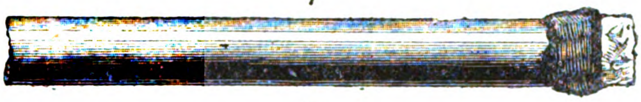

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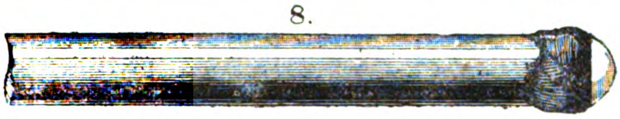


and is finally ground into the concave tool with washed flour emery and water.

A tool like that shown in Fig. 6 is necessary for finishing small lenses. It consists of a cylindrical piece of brass, having a chamber turned in the end for the reception of a mixture of pure hard beeswax and fine rouge. This mixture should contain sufficient rouge to make it rather hard, but not so hard as not to yield under strong pressure.

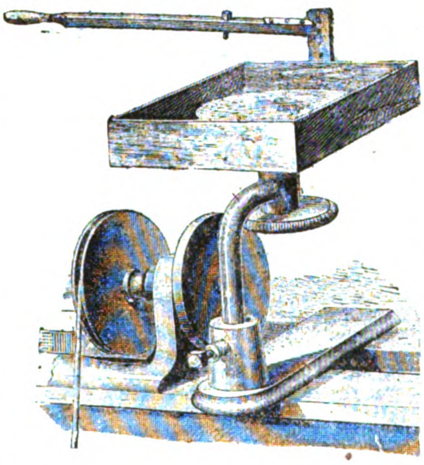
The glass for small lenses may be clipped from bits of plate (crown) glass and roughly shaped by means of an ordinary pair of pliers. It may then be cemented with pitch to the end of a round stick, as shown in Fig. 7. The glass is then ground on a common grindstone until it approximates the required shape. It is then polished with fine emery and water in one of the concave brass tools until a truly spherical surface is secured. It is then transferred to the other brass tool, and ground with fine washed flour emery until the surface is fine and entirely free from scratches. During the grinding, as well as polishing, the stick to which the glass is cemented must be turned axially, and at the same time its outer end must be moved about the prolongation of the axis of the grinding tool so as to present the glass to every portion of the grinding tool as nearly as possible.

The final polish is secured by pressing the smoothed glass into the wax in the end of the tool shown in Fig. 6, as the tool is revolved, and at the same time applying fine rouge and water from time to time. When the polish is nearly perfect the tool should be allowed to work nearly dry.

For a plano-convex lens the plane surface of the plate glass will answer very well for the plane surface of the lens, and the glass will be ground down as shown in Fig. 8. If the lens is to be double convex, the finished spherical surface should be cemented to the end of the stick, and the opposite side proceeded with as before described. There are two methods of finishing the edges of plano-convex lenses: first, by holding the plane surface in a concave tool charged with emery and water until the edge is bevelled to the required degree; and, second, by chucking the lens on the end of a spindle projecting from the lathe mandrel, and centring it while the pitch or cement which holds it is still warm. Then a piece of brass, which is concaved to conform nearly to the periphery of the lens, and charged with emery and water. This tool is held against the edge of the lens after the manner of turning. The lens will soon assume a perfectly circular shape, and may be readily reduced to any desired size. In making concave lenses the convex tools will be used, and the final finish will be given by a piece of silk cemented to the tool with pitch and charged with rouge and water.

For grinding larger lenses of longer focus an attachment like that shown in Fig. 10 will be required. It consists of a wooden box supported by a curved arm inserted in the tool-rest support. A vertical journal box passes through the bottom of the box, and contains a shaft, having upon its upper end a socket for receiving the grinding tool, and on the lower end a grooved wheel surrounded by a rubber friction band, which is revolved by contact with the face plate of the lathe. The speed of the wheel relatively to that of the lathe may be varied by raising or lowering the box support in the tool port.

The glass to be ground is cemented to the face of a flanged casting as shown in Fig. 9, and is held down to the grinding tool by the lever attached to the box. The tool for large work may be made of cast iron. The centre of the lens should be eccentric to the centre of the grinding tool, so that the lens will be revolved on the face of the tool. The point projecting from the lever enters a small cavity in the centre of the casting, to which the lens is attached, and insures an equal distribution of pressure over the entire surface of the lens.



Grinding and finishing a large lens is substantially the same as in the case of the smaller ones, the only difference being in the method of giving the final polish. In the case of a large lens, after the fine grinding, the tool is heated, covered with a thin coating of pitch, and a piece of thin broadcloth is pressed down on the pitch. The broadcloth surface is charged with fine rouge and water, and the lens is pressed down on it with considerable force as the tool is revolved. The cloth should be worked rather dry, and so much so at the end of the process as to offer considerable resistance to the rotation of the tool.

## THE ELECTRIC RAILWAY IN PHILADELPHIA.

THE electric railway soon to be constructed along Belmont Avenue, Philadelphia, will present the novel sight of cars running without any apparent propelling force, free from annoyance of noise, smoke, and dust. The motive power for the cars, which are to be run according to the Bidwell system, will be furnished from a station located somewhere on Belmont Avenue, outside the park. It could, if necessary, be carried over an indefinite distance. This system differs from other systems of electric railways in not passing the current through the rails. Guards made of lumber run along the inner side of the rails, and a broad covering projects toward the centre, leaving a narrow slot in the middle of the track. Beneath this cover, and parallel with the rails, properly insulated copper conductors of a semitubular shape are placed. The current is conveyed from the dynamos supplying the power through wires to the terminus of the railway, where connection is made with the copper tubes, and a current is thus sent through the whole length of the road.

To propel the car, a receiving dynamo or electromotor is placed in the centre of the car. Connection with the current is made by means of an iron tube passing down through the slot, with branches in either direction in the form of an inverted T. On the end of each branch a small wheel, so placed as to run against the copper conductors, completes the connection, wires being run through the tube from the electromotor in the car to the wheels. The electricity being passed through the circuit of the track, the operator has but to turn a lever to receive the current in the motor, which immediately revolves, and by an attachment with the wheels of the car propels it in either direction, according as the current is reversed or not. Through the reversal of currents the need of brakes is dispensed with. If necessary, the car can be brought to a sudden standstill, but the change can be effected as gradually as may be desired. There will, therefore, be no danger of running over persons on the track.

The avenue will be lighted with the same current by running wires from the tubes to the lamps, as in ordinary street lighting, while the cars will be illuminated by running a wire from the motor to the incandescent lamps in the interior of the car, the whole power coming from the single current supplied by the stationary engines some distance away from the track. If it is desired to heat the cars, another draught is made on the current by passing the electricity through some poorly conducting substance, as German silver, the electrical energy being thereby dissipated in the form of heat. These connections are made by means of switches, so that no current may be made through the branch wires when the light or heat is not wanted.

An important feature of this railway for the park is the utter impossibility of trifling with the conductors and receiving injury from a shock. They are placed beneath the board flooring near the rails, and the only opening is the narrow slot, more than a foot distant, the whole being concealed from view. The road will be about a mile and a quarter long, and ten cars, carrying from fifty to sixty passengers, will be run. To furnish the power for these, and to light both the avenue and the cars, about 100-horse will be required. — *Scientific American.*

## HERZOG'S PROCESS OF RAPID OIL BLEACHING.

THE *Organ für Oelhandel* describes the following process, invented by Dr. Herzog, for the bleaching and clarifying of oils and fats, both for domestic and industrial purposes. The solid fatty substances are treated in the same manner as those which are liquid. In order to prepare cottonseed oil, rape oil, as well as all fatty oils, for ulterior treatment, they are first mixed in large receivers with 2 to 3 per cent. of common salt, and then thoroughly stirred for five or ten minutes with 25 to 30 per cent. of cold water. After a rest of twenty-four to forty-eight hours a part of the impurities have been deposited at the bottom with the water and salt. The oil on the top is then drawn off and is thoroughly washed in another vessel with cold water by means of crank-shovels. After six to twelve hours the oil has again accumulated on the top and is drawn off for further treatment. This treatment with common salt is particularly useful in the preparation of fine culinary oils, but can also be employed with linseed oil, fish oil, &c. If an electric stream be conducted through the mixture during the mechanical treatment, the oil is at the same time bleached as the salt becomes decomposed under the influence of the electric current, and secondary combinations effect marked bleaching results. For many oils and fats which would otherwise become rancid and be spoilt, it is recommended in the above process to add 2 or 3 per cent. of bicarbonate of soda, which exercises a preservative influence.

In addition to the second washing with cold water in the second vessel, the oil can likewise be treated with steam, which is conveyed through the oil in a fine state of division. For cottonseed oil it is recommended for the process to be continued for five or ten minutes. By this treatment the rancid particles are removed while the slimy portions sink to the bottom. In place of steam, heated air may be sent through the oil, which is mixed with 25 to 30 per cent. of hot water. This operation should last five minutes, and might be repeated at intervals of two or three minutes. If the cottonseed oil, rape oil, or similar quality is filtered and left in store a certain time, a pure product is obtained of pleasant sweet taste and pale yellow appearance. For filtering it is recommended to use endless filtering paper, with which the sides and bottom of the filtering vessels are covered. After being used, pressed, and washed out the paper can be again used in flake-form in the preparation of filtering grounds. For the preparation of varnishing, burning, and lubricating oils the oil is mixed with 2 per cent. of common salt, dissolved in 15 to 20 per cent. of water, at 176° to 212° Fahrenheit, which is heated by steam introduced during the stirring. Then during the continued stirring there are added 1 to $1\frac{1}{2}$ per cent. of muriatic acid diluted in 15 to 20 per cent. of water, and steam is afterwards introduced at intervals of five minutes. In many cases Dr. Herzog considers very useful an admixture of permanganate of potassium, or chlorate of potassium, or bicarbonate of potash with muriatic acid. For 2cwt. of oil there are taken in the proportion of one-tenth pound of the last-named salts and $1\frac{1}{2}$lb. to 2lb. common salt.

## EXPERIMENTS WITH GELATINE EMULSIONS.*

### A New Developer with Sulphite of Ammonia.

I HAVE never been adverse to the advantages claimed by the advocates of the potash developer, especially when used for very rapid plates, or with very short exposures, and have even described a modified method of developing with potash, and published my own formula for it. Nevertheless, I now call attention to a new pyro developer with ammonia, and sulphate of ammonia, which has given splendid results with the ordinary commercial plates, equalling in every way negatives developed with ferrous oxalate, and even surpassing them.

The formula is:

| | | |
|---|---|---|
| A— | Pyrogallic acid | 10 parts |
| | Sulphite of ammonia | 30 parts |
| | Water | 100 parts |
| B— | Bromide of ammonium | 5 parts |
| | Water | 150 parts |

Immediately before use mix 100 parts of water with 4 parts of A and 4 parts of B. With this developer the image will appear quite rapidly. If it is desirable to prolong the developing process, 150 parts of water instead of 100 can be used. The negatives will be softer with a diluted developer, while more vigour, strength, and contrast is given by a few minims of a bromide of ammonium solution (1 to 10). Sulphite of ammonium developer makes brilliant and well-detailed matrices, representing perfectly the whites and high lights. They are of an agreeable, dark brownish colour, far superior to that obtained by a glycerine or potash developer. The use of the alum bath before fixing is admissible, but not necessary before fixing, but is wanted afterwards. No acid is needed with the alum. Pyrogallol, mixed with a solution of sulphite of ammonia, is more durable than with sulphite of soda, and prevents fogging of the plate more effectually than the corresponding soda salt. Sulphite of ammonia should not be used in combination with either the carbonate of soda of potash, with either of which carbonate of ammonia and the respective sulphites would be formed, resulting in but feeble action upon the bromide of silver emulsion, and rendering the negatives weak.

### Developer with Lime Water.

As early as 1877, Daranne recommended in "Progrès de Photographie," the use of lime water with pyrogallol, in developing bromide of silver collodion films: the process has, as far as the colour of the negative is concerned, proved also to be satisfactory with gelatine emulsion. Lime being sparingly soluble in water, a solution of sugar, one to ten, is prepared and shaken well, with lime in excess. The mixture assumes a violet or brown colour, and soon becomes turbid. With it I have obtained but very thin negatives, and for that reason can hardly recommend its use.

### Mixed Hyposulphite of Soda and Alum Baths,

so often favourably spoken of, should not at all be used. They fix much slower than pure hypo, separate constantly finely divided sulphur and alumina, and exhale an odour of sulphurous acid. The negatives assume a milky whiteness, which disappears when being varnished, and although it offers no obstacle to the printing, injures the appearance of the negative. When gelatine emulsion plates show such a marked tendency to frill as to expect their entire loss in a plain hypo fixing bath, they may be used to advantage, and possibly save and solidify a film, which otherwise might be destroyed. One part of ordinary fixing bath with one-half to two parts of saturated alum solution are proper proportions. Besides the tanning of film, the elimination of the fixing soda is retarded, which reduces the rapidity of diffusion, and prevents, consequently, the tendency to form blisters.

### Transforming Silver Deposits into Chloride of Silver.

To remove yellow stairs from negatives, as recently recommended by L. Betitsky, is nothing new. A method of using potassium bichromate and hydrochloric acid for the same purpose, and as a toning bath for bromide of silver, gelatine emulsion plates has been recommended by Eder and Toth in 1882.

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* By Dr. J. M. Eder in *Correspondenz.*

## OIL ON TROUBLED WATERS.

THOSE of our readers who are interested in the question of the effect of pouring oil on the waves, will be glad to learn that the United States Hydrographic Office has been collecting data to determine under what circumstances its use is most efficacious in diminishing the danger of breaking seas during gales of wind. Masters of vessels are requested to make experiments in this matter whenever the opportunity occurs, and report the results to one of the Branch Hydrographic Offices, or directly to the Central Office at Washington. When sufficient data have been collected a pamphlet will be issued giving such directions in regard to the use of oil as the common experience of seamen may determine to be the best. The following accounts have been received lately:—Capt. R. S. Thompson, ss. *Sacrobosco*, reports using oil in 1880, and twice during the month of February, 1885. In each instance, after getting his ship before the wind, he put over oil bags with the best results. In the first case the engines were slowed so as not to lose too much to leeward, and it was proved clearly that with the use of oil it was not necessary to run as fast as is generally supposed. Captain Smith, of the English barque *Emma*, used refined petroleum during the gale in which his vessel was abandoned. He found it entirely useless, although barrels of it were emptied to windward, and seven or eight bags of it were towed alongside. About five gallons of crude turpentine or pine oil was used with good effect as long as it lasted. Captain Geddes, of the s.s. *Erato* in February, 1885, instead of heaving-to during a favourable gale, concluded to run. He shipped some very heavy seas, which did great damage until the oil bags were put over, when the ship ran comfortably with the decks perfectly dry. Captain Daniel Thomas, of the British barquentine *Corisande*, in January, 1885, during a gale, while lying-to, was boarded by a heavy sea which washed one man away and disabled the vessel, which lay in the trough of the sea. Men were stationed immediately to pour oil overboard until bags could be prepared and the vessel secured. When this was done she was easily got before the wind and ran very comfortably. Captain Johnson, of the English steamer *Emerilda*, reports using oil bags with excellent effect, during a heavy north-west gale, on his last voyage from Port Royal to Liverpool. Captain Moore, of the British barque *Siddartha*, says that during the last four years he has frequently used oil bags when hove-to or running, and has invariably found they made a wonderful change in the nature of the sea. His system is to fill a coarse bag with oakum, thoroughly saturated with oil, and to hang it over the weather bow, if hove-to. or to the bumkins, if running. Chief-officer John Matson, of the English steamer *Edinboro'*, in 1881, while lying-to in a mountainous sea in the Bay of Biscay, placed two oil-bags overboard forward with the best results, the oil effectually preventing the sea from boarding the ship. Captain Scott, of the English s.s. *Briscoe*, during a recent passage from Baltimore to London, experienced heavy gales from W.N.W. to W.S.W., with high seas sweeping over the ship. He filled two canvas bags with oil and towed them over the stern with excellent effect, as they prevented the seas from boarding the vessel. Captain Mumford, of the British s.s. *North Anglia*, in October, 1884, during a hurricane, had his main wheel gear carried away, and was obliged to steer aft. After the men had been washed away several times, he tried oil and had no further trouble. Again, in February, 1885, while hove-to, he poured oil through a pipe on each side of the forecastle. Oakum was put loosely into the pipes to prevent the oil running too quickly. After commencing the oil no dangerous water was shipped. Mr. G. Foster Howell, of New York, sends a very interesting account of the use of oil while off the Horn in the ship *Cavalier* in 1876. The ship had been run too long, and heavy seas were constantly boarding her. At last one more powerful than the rest rushed upon her with awful violence and started the deck. At the writer's suggestion oil bags were towed overboard with about 25ft. of line, one on each quarter and one amidships. "No sooner had the oil commenced to leak than the sea ceased to boil and rage, and the waves became so harmless that they no longer broke upon us."

## SCIENTIFIC NEWS.

FROM Dun Echt Circular, No. 94, we learn that a new comet was discovered by Mr. E. E. Barnard, of the Vanderbilt Observatory, Nashville, Tennessee, on July 7. The comet was observed at Harvard College on July 9, 17h. 17m. 31s., G.M.T., when it had R.A. 17h. 17m. 48·4s., and S. Dec. 6° 1′ 8″. The daily motion was — 2m. in R.A. and 35′ towards the South. It is described as not more than 1′ in diameter, 11th mag., or fainter, and as having some central condensation, but no tail. The comet was sought at most European observatories on Saturday and Sunday evenings; but the only observation of which intelligence has been received was made at the Strasburg Observatory 57 minutes after midnight on Saturday, the observed place being R.A. 17h. 14m. 24·3s., N.P.D. 97° 2′ 31″. At Greenwich the comet was traced with the help of the $12\frac{3}{4}$in. equatorial about 10h. 30m. on Saturday, but clouds intervened before an observation could be secured.

Prof. Adams's report to the Senate of Cambridge University was issued last week, and shows that a large amount of routine work and many special observations have been undertaken during the year ending May 26th. The observations of Clock Stars and those of Polaris are completely reduced, and the mean places for January 1st obtained up to the end of 1884. The true apparent place of all the other stars observed in 1884 is also obtained both in R.A. and N.P.D. As regards the observations of former years:—The mean R.A. and N.P.D. of the Zone Stars are obtained up to December 12, 1877, and the true apparent R.A. and N.P.D. to the end of 1882, and the reductions are far advanced in 1883. The reductions from mean to apparent place at date are calculated to the end of 1882. The means of transits and microscope readings are deduced up to the present time. The intervals of R.A. wires used in the reductions for 1884 were obtained from 63 observations of Polaris made 1884, January 18—July 10 (1), by taking the mean of the intervals for Polaris and the mean of the declinations, and using the formula $\sin. E = \sin. P \cos. \delta$; (2) by deducing the equatorial intervals from each individual observation, and taking the mean of the results. The intervals by the two methods almost exactly agreed.

Nos. 2665-6 of the *Astronomische Nachrichten* contain a complete list of recent determinations of cometary orbits by Prof J. G. Galle. It appears that five comets passed perihelion in 1880, eight in 1881, three in 1882, two in 1883, and three in 1884.

It is rumoured that the professorship of biology at South Kensington, resigned by Prof. Huxley, will be superseded by the creation of two lectureships of £300 a year each.

Dr. Boverton Redwood, retired as Emeritus Professor of Chemistry to the Pharmaceutical Society, has been succeeded by Mr. W. Dunstan, of the University Museum, Oxford, as professor of chemistry.

Mr. E. Thurston, curator of King's College Anatomical Museum, has been appointed director of the Central Museum at Madras.

The excursion of the Geologists' Association will this year be to Belgium, the members meeting in Brussels on August 10, and proceeding the same evening to Charleroi. M. Ed. Dupont, Prof. A. Renard, Dr. E. Purves, and Prof. J. Gosselet will act as guides. The excursion will last five days.

The Essex Field Club is desirous of founding a local museum, and proposed to establish it in Queen Elizabeth's Lodge at Chingford; but a "high official of the Corporation" objected, and the club, which has done excellent work, especially in connection with the natural history of the Forest, is in want of a suitable locale and a habitation for the collections, which would no doubt speedily increase if a museum were established.

The study of natural science is prosecuted with vigour in New South Wales, and the Hon. William Macleay, a member of the senate of Sydney University, and president of the New South Wales Linnean Society, has established and endowed four fellowships of £400 a year each, for the encouragement of study and research in natural science. The fellowships can be held only by graduates of the university who are without other lucrative employment, and are actively engaged in research. They are renewable annually, in order, we suppose, that the appointment may approximate as nearly as possible to "payment by results," or, as has been suggested, to give "an opportunity for correcting any abuse."

At the meeting of the Royal Society of South Australia, on June 2, Mr. W. Howchin, F.G.S., exhibited a specimen of Astrorhiza angulosa as a fossil found in the Miocene strata of Victoria. The specimen was stated to be of more than ordinary interest, inasmuch as it was the first instance in which the genus had been found in the fossil condition in the recent slate. The species submitted was very rare, having been hitherto known to occur only at two localities—one of these being at a *Challenger* station to the east of the Azores, at a depth of 1,000 fathoms; and the other at a point in the North Atlantic, dredged by the *Porcupine*, at 630 fathoms—where only a single specimen was taken. There are five species in the genus, but with the exception of a single specimen of an allied species taken by the *Challenger* off the Cape of Good Hope, the genus is only known as a North Atlantic type. The species discovered in the Victorian rocks is one of the rarest; its occurrence, therefore, in the fossil condition in the Australian tertiaries is a matter of some interest. The speaker stated that his researches with regard to the microzoa of the Australian formation led him to believe that many of the rarer arenaceous forms of foraminifera recently discovered in the deep seas, and which have been so beautifully illustrated by Mr. H. B. Brady in the "Scientific Results of the *Challenger* Expedition," occurred as fossils in Australian geology from the Cretaceous formation downwards.

At the same meeting Mr. C. L. Wragge read a portion of his paper entitled "Scientific Results of a Voyage in the *Maronoa*," dealing with that part of the voyage between England and the Suez Canal. Some singular facts in connection with winds and tides have been discovered by means of the bottles which Mr. Wragge threw overboard with requests for particulars of where they were found and when.

Some important telephone experiments were made between Uxbridge and Liverpool last week, on one of the new lines of telegraph wire recently erected. The distance is about 200 miles, and it was doubted whether satisfactory results could be obtained in this country over such a length of wire. The Gower-Bell transmitter was employed, and the tests applied satisfied the experts that it would be possible to speak with sufficient clearness over double the distance. Two line wires were used.

Prof. E. Stebbing, of Paris, informs the *British Journal of Photography* that "a great hope is felt here that MM. Hembert and Henry have succeeded in a practical manner in producing hydrogen from water by decomposing steam." The latest experiments of these savants have, it seems, been highly satisfactory. Steam is generated, and it is then superheated to "dissociation" by making it pass through a retort filled with incandescent coke. The steam is decomposed, and two gases are formed—hydrogen and carbonic oxide—in equal volumes. This mixture passes into another red hot retort, where a jet of steam mixes with it, and acts upon the oxide of carbon, and transforms it into carbonic acid. The hydrogen produced by this second operation added to the other makes about 3,200 cubic metres per ton of coke. The hydrogen is purified by passing it through lime-water—just, in fact, as is described in most textbooks of chemistry, the process being that of Deville and Debray, who seem to have been forgotten by their own countrymen, MM. Hembert and Henry. Prof. E. Stebbing thinks that, sooner or later, "we shall have a purer and more uniform gas to light up our dwellings."

The Cunard liner *Etruria* has accomplished the quickest eastward passage of the Atlantic, having arrived off the Fastnet on Friday last in six days, seven hours, and forty minutes from New York. Unfortunately fog came on, and her time to Queenstown was six days thirteen hours forty-five minutes. It is said to be the fastest passage on record to the Fastnet, but scarcely, we should think, comes up to expectations. The *Umbria* and the *Etruria* ought both to do better than that.

The *Arawa*, of the Shaw-Savill-Albion line, reached Plymouth last Sunday, thirty-six days seven hours out from Lyttelton, New Zealand—the fastest passage on record. This voyage is the quickest ever made round the world. The *Arawa* left Plymouth on March 28 and arrived in New Zealand on May 7 (40 days); she left Lyttelton on June 6 and made a splendid run of 20 days to Rio, and having coaled, left again on June 27—the actual steaming time on the run home being only thirty-five days thirteen hours ten minutes. Her steaming time for the round voyage was 74 days!

A statue is to be erected in the Conservatoire des Arts et Métiers to Leblanc, the French chemist who introduced the soda process which bears his name. The proposal has been a long time before the world; but by the aid of the principal soda makers of Belgium, Germany, and the United Kingdom, sufficient funds have at last been collected, and the statue will be placed near that of Denis Papin.

Dr. G. Brown, of Edinburgh, in company with Drs. Roy and Sherrington, has left for Spain, to carry on further investigations upon the etiology of cholera.

The fifty-second annual report of the Royal Cornwall Polytechnic Society is, as usual, full of a variety of useful notes on new inventions, to which prizes have been awarded, and of papers of special interest, mainly to miners.

The *South Wales Press* announces the death in London of Mr. F. T. Williams, for 25 years manager of the lead and silver works, Llanelly, and of whom Col. Ross spoke in these columns recently "as an old Freiberg student, and a man of first-rate ability."

**The Exploration of Africa.**—Last week an address was delivered in the Merchants' Hall, Edinburgh, before the members of the Scotch Geographical Society, by Mr. Henry O'Neill, Her Britannic Majesty's Consul at Mozambique, on the subject of African exploration. Sir Donald Currie occupied the chair. Mr. O'Neill, in the course of his address, said that the ground he had passed over in Africa had been done in 12 journeys, and had occupied nearly six years. He had covered about 4,000 miles, and nearly one-half of these had been over previously unbroken ground. Briefly, the chief results of those journeys had been to open up three new routes between the Nyassa district and the coast:—1, between Mozambique and Lake Shirwa and Blantyre; (2) from Blantyre to the Portuguese coast settlements of Angoche and Parapato; (3) from Quillimane to Blantyre. The Nyassa might now be reached by the longest of the three routes opened up by him in 30 days, and that from Quillimane to Blantyre in 14. The country was well populated, food was fairly abundant, and the people were peaceable, helpful, and industrious. There was no reason whatever that any or all of the three routes he had laid down might not be constantly traversed by Europeans and become most valuable channels for the development of the trade and agricultural riches of the country. In his journeys he had been fortunate enough also to discover three minor lakes, one, Lake Lidedi, which was just south of the Rovuma, and close to the Lake Nangadi, of which Livingstone first heard as he passed up north of that river when upon his last travels. The others were Lakes Amaramba and Cheuta, which had their outlet in the River Lugenda. About 5,000 observations had been taken by him to fix the positions of 57 of the most conspicuous points and principal features of the country, and nearly all these observations had been reported to be completely satisfactory by the scientific staff of the London Geographical Society.

# LETTERS TO THE EDITOR.

*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, *332, Strand, W.C.*

*All Cheques and Post-office Orders to be made payable to* J. PASSMORE EDWARDS.

**** In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

## THE POST OFFICE AND THE PRESS—MAKING HAZE WHILE THE SUN SHINES — LUNAR GLACIATION — MAGNETIC DECLINATION IN YORKSHIRE—THE NEW TIME—THE "NAUTICAL ALMANAC"—WHAT IS "CREATION"? — POWER FOR AN OPERA-GLASS.

[24472.]—AN idiotic piece of Post Office red-tape has just been brought to my notice in connection with these letters of mine. Being, of course, intended to be printed, they go by book post, under paragraph 2 of the regulations on page 3 of the "Official Guide." I learn, however, from our editor, that, while they reach the office between 8 and 9 a.m. on the Saturday morning if posted as letters with a penny stamp, *they are delayed until noon* if they only bear a halfpenny one. Paragraph 5 of the regulations to which I have just referred does say, it is true, "When, owing to an unusually heavy influx of letters, books, &c., the transmission or delivery of the letters would be delayed if the whole mail were dealt with indiscriminately, book-packets may be kept back till the next despatch or delivery," and it is not difficult to see that a number of octavo volumes weighing 3lb. or so a-piece might delay the delivery. Why, though, a letter—for so it is—in an open envelope, weighing perhaps a quarter of an ounce, should be detained, simply because it legally has a halfpenny stamp instead of a penny one upon it, I wholly fail to see. I suspect that this is the doing of some under-strapper in the department, who thinks by such conduct to drive everybody into the use of penny stamps for literary MS.; much as some of the idiots of railway managers, in their frantic efforts to compel everyone to travel first-class, drive their customers out of the second—into the third! This most trumpery system of conferring a seeming boon with one hand, only to take it away with the other, is wholly unworthy of a Government office which is the source of a really considerable annual addition to the revenue.

Every one, and certainly every astronomer, must be familiar with the fact that the odd and remarkable haze which has now perpetually surrounded the sun for more than two years still persists; in fact, as I have said on a former occasion, the observer has only to hide the orb of the sun itself with his hand to see this strange pseudo-coronal glare in his immediate neighbourhood, and to note where the blue sky proper actually begins, and how comparatively sharp is the line of demarcation. I am anxious to emphasise this because news reached Holland a week or two ago of a violent eruption of the volcano Smerdu in Java, and, in fact, of great volcanic disturbance over the whole of the west of that island; and that most valuable and trustworthy body, the "Krakatoa Committee" will almost certainly point to this circum-solar haze as the result of this last eruption.

I may say, very briefly, with reference to letter 24418 (p. 389) that I cannot myself understand aqueous vapour being transported by actual translation. My own view is that if any heated lake or sea emitted steam, this would be diffused in the atmosphere generally, and by no means condensed and deposited in the form of snow or ice in the immediate neighbourhood of the point of its genesis. I shall be very curious to hear what Professor Darwin thinks of Mr. Peal's theory.

Premising that magnetic declination is an element not susceptible of rigid predication, I may say (in reply to query 56952, p. 397) that at Hull (the nearest point to "Streetgate's" station at which it has been determined) the needle at present points 18° 21′ west of north. In the year 1881 the magnetic declination was 18° 47′ in the same locality.

I should like to make two remarks with reference to letter 24445 (p. 411). The first is that I did not (*loc cit.*) adduce the case of the commencement and conclusion of a solar eclipse, before and after noon of the same civil day, as presenting any special difficulty. All I did say (in reply to Mr. Hopkins), was that it was cognate with the one which exercised him in connection with the phenomena of Jupiter's satellites. In the second place, I have never advocated the adoption of the new mode of reckoning time until the alteration shall have been made in the *Nautical Almanac.* The hideous muddle it would introduce into the calculations made by the Mercantile Marine would, in all human probability, lead to grave disaster. How far such alteration is probable Mr. Franks can judge as well as I can. No more conservative institution exists on the face of the earth than that which has its headquarters in Verulam-buildings. Look at the Tables of Jupiter's Satellites, the grossly erroneous data given of the relative dimensions of the Saturnian System, and (until quite recently) the Ephemerides of Uranus. When very strong public pressure is applied from the outside somebody wakes up, and by the kind aid of the Americans, or the French, rectifies what is most glaring—and then goes fast sleep again.

I cannot answer the query propounded by "H. B. F." in letter 24452 (p. 412), for the simple but sufficient reason that I have not the most distant idea what "selective creations" are. Your correspondent must forgive me for expressing the opinion that he uses the word "creation," as a great many people employ the one "electricity"—i.e., as a quasi-scientific way of hiding the fact that they know nothing at all about the phenomenon they adduce it to explain! Creation, if rigidly defined, means the bringing into existence *ex nihilo.* A man does not "create" a new type of clock by adding a striking-train to the going movement of an old one. Moreover, unlike "H. B. F.," I do not profess to "account for the first appearance of such abnormals." All I can certainly predicate is that there seems to be a tendency to variation in Nature. Whence it arises, I am in humble ignorance.

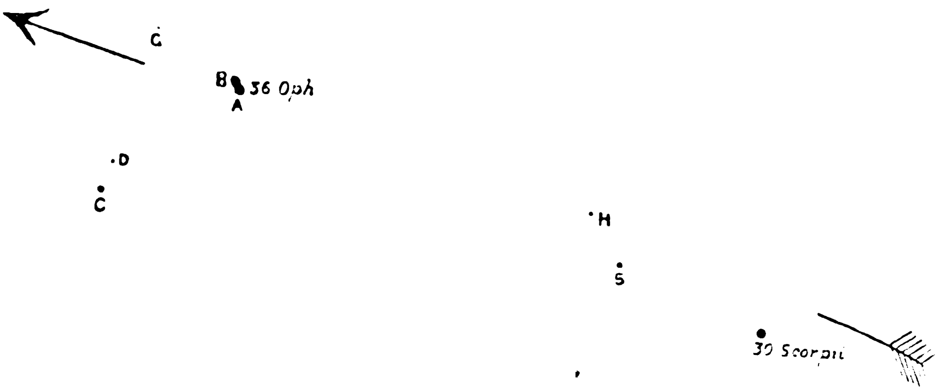
I reply to the question asked by "Experience" (letter 24462, p. 413) because it would be discourteous not to do so; but it really seems what our Roman Catholic brethren call "a work of supererogation" to say that it is a most utter "delusion that increase of power in an object-glass of given size can be obtained without sacrifice of light or field"—always, of course, supposing that (as Mr. Nelson points out in letter 24460) the emergent pencil is not bigger than the pupil of the eye. As for the power most suitable for *opera*-glasses, I regard 3 as ample, always supposing that you wish to get a general view of an actor or actress, and not to examine him—or her—piecemeal. For outdoor work, though, a higher power tells wonderfully.

**A Fellow of the Royal Astronomical Society.**

## DOUBLE STARS—36 OPHIUCHI—53 OPHIUCHI.

[24473.]—It has long been known that 36 Ophiuchi (itself a binary pair) is physically connected with 30 Scorpii, notwithstanding their immense distance, the large annual proper motion of both being about 1·230″ in the direction of 203·0°, and there is an intermediate star mentioned in "Celestial Objects," which was thought by Flammarion to partake of the same proper motion. I have observed the group very carefully during the past month, to determine this point if possible; but cannot say the result is quite conclusive. There is a considerable discrepancy between the MS. and "Cycle" diagrams of Smyth in 1835, Flammarion's drawing in 1877, and the apparent place of the star. Smyth represents it in the "Cycle" and MS. diagram, from which it was written as decidedly S. of the line joining 36 Ophiuchi and 30 Scorpii. Flammarion shows it in 1877 about 20″ N. of the line, and the present place of the star appears to be almost exactly between A of 36 Ophiuchi and 30 Scorpii; if anything, a little N. It is difficult to understand how such a difference can have arisen, for the star is most conspicuous with 120, which includes the whole field, thus rendering comparison very easy; it was rated at about 11th mag. The star G discovered by Challis in 1839 is no longer in the place described in the Cycle, viz., "where lines through A B—C D meet," a change no doubt due to the proper motion of A B, and which would seem to indicate it is not connected with the system. There is a very faint star H a little *s.p.*, the "stranger" S., which probably is one of the other stars referred to in Challis's note in 1839. This would form an excellent point for a series of measures of the P. A. and Dist. of S, when any change (supposing S to be connected with 36) would speedily be detected. The following are some of the principal measures of the group:—

A B = 202·0° 4·2″
A C = 306 0° 198·1″
A and 30 Scor. 75·0° 725·2″



C is about 8 mag., and D 10·5, S 10·3, G 10·8, and H 11·0 of Σ.'s scale. There is also another glimpse star in the group, but it is too near the limit of my aperture to hold steadily. For the above measures and tracings of Smyth's and Flammarion's diagrams, I am indebted to the kindness of Mr. Sadler, at whose suggestion the object was looked up; it requires very careful watching. and opportunities must not be lost, as its great S. declination renders it peculiarly liable to be obscured by mist and radiation from the earth. Since sending my note on 53 Ophiuchi, I find there is a slight error in it, the star mentioned as "N. a little *f.*" being really *n. p.* 53. There are six more small stars in the field (found since the drawing was made), and a faint *comes* to C (the 8th mag.) at about 40″± constituting it a double star in the same sense as 53 itself.

**Kenneth J. Tarrant.**

Letchford House, Pinner, 7th July.

Erratum.—I find in to-day's issue that an error has been made in line 11, of letter 24440, which renders the sense rather obscure, a plus sign having been inserted instead of the word "and." It should read "and *s.p.* AB at about 75″ ±."

July 10. **K. J. T.**

## DOUBLE STARS—TO MR. GAUDIBERT —THE TERRESTRIAL TELESCOPE.

[24474.]—The pair in Corona Borealis, you mention in letter 24439, p. 410, is apparently new, and is an interesting object. It is evidently Bode (Lalande 28500), and its approximate place, brought up from Weisse's "Bessel" to the commencement of the present year, is

XVh. 31m. 51s. + 36° 5·3′.

It is rated 7·5 mag. by Argelander in the "Durchmusterung," and the mean of Bessel's two observations gives the same value; Bode and Lalande call it 7 mag. It is strange that so bright a pair was missed at Dorpat and Pulkova, and by modern double-star observers. Have you not rather overrated the brightness of A, as the star does not appear in any naked-eye catalogue? I have endeavoured to find some recent meridian observation of it, for the purpose of ascertaining its proper motion, if any exists, but have failed to find any modern determination of its place in any prominent catalogue. There is a little difference between the respective declinations of Lalande and Bessel, but probably no greater than would be accounted for by the probable errors of the two catalogues. The pair Σ. 1959: 8·7, 10·2 mag.: 241·1°: 1·7″, is 1m. 35s. preceding, and 1° south of your pair.

The following are some of the most recent observations of the stars you mention:—

ζ Boötis. Eng. 300 9°: 0·670″ (seven nights): 1883·3.

η Coronæ. 173·9°: 0·61″, 1885·5; calculated from Doberck's elements.

Gl. 435 (O. Σ. 273). De. 110 6°: 1·0″: 1871·1; distance increasing.

Gl. 487 (Σ. 1944). Hall 333 9°: 1·25″: 1879 5.

Gl. 488 (O. Σ. 296). Seagrave 312 5°: 1·47″: 1882·4.

Gl. 510. (O. Σ. 306). De. oblong in 60°, but not easily measurable. 1865.

Gl. 522. (Σ. 2049). Distance constant at 1·1″.

Gl. 525. (O. Σ. 313). Pe. 151·6°: 0·99″: 1883·5.

Gl. 530. (O. Σ. 315) β. 166·4°: 0 97″: 1881·6; Pe. 161·7°: 1 00″: 1883·5.

Gl. 536. (O. Σ. 321). Probably no change since O. Σ.'s measures in 1848.

Gl. 566. (O. Σ. 338). Pe. 20·1°: 0·62″: 1883·5.

Gl. 572. (Σ. 2275). De. "L'Angolo di Σ. corrisponde, ma la coppia non è misurabile." 1866.

Gl. 494. (O. Σ. 298). Schiaparelli's angle agrees well with the one computed from Dolgorukow's elements for that epoch, but, of course, the angle is not 7·5° *now.* It is not 130° either, in which direction you observed the doubtful elongation. You showed this object again, with higher powers than 370 or 208.

You will find the following pairs in Cygnus beautiful objects, and fair tests of the defining power of your telescope and eye on moderately close unequal pairs. All the small companions seemed blue (in two cases deep blue) to me some ten years ago when I looked at them, but I have not seen them since. The places are for 1880, and the stars are prominent ones, though not in Webb. The mags. are in Σ.'s scale:—

B. A. C. 6959 Cygni. (A. C. 17). XXh. 9m. 10s. + 51° 6′. 6·0, 11·0.

60 Cygni. (O. Σ. 426). XXh. 57m. 0s. + 45° 41′. 5·4, 9·4.

44 Cygni. (A. C. 18). XXh. 26m. 26s. + 36° 32′. 6 3, 11·0.

75 Cygni. (A. C. 20). XXIh. 35m. 28s. + 42° 43′. 5·2, 10·5. A distant 9 mag. is *h* 1678.

P. XXI. 215 Cygni. (β. 167). XXIh. 31m. 1s. + 29° 31′. 7·0, 11·3.

The distance of the widest pair of the five, B.A.C. 6959, is only 4·0″. The pair of somewhat similar character (Dawes 13), alluded to in "Celestial Objects" under the head of δ Cygni, is 12′ *south*, and not north of that pair, as printed. It is 15 seconds of time preceding δ.

Mr. Nelson, "Montmartre," and others, writing about the aperture of telescopes for terrestrial use, will find a short article by Prof. Holden on the "Light of Telescopes used as Night-glasses," in the *American Journal of Science and Arts* for August, 1881, of interest. It refers to some observations on distant terrestrial objects made with the 15½in. refractor of 20ft. focus in twilight and by night. **H. Sadler.**

## THE DAYLIGHT OCCULTATION OF ALDEBARAN.

[24475.]—This occurrence was observed here under the most favourable conditions; the sky was almost cloudless, and the sun shone with all its summer brilliancy. Aldebaran was bright and clear, and the moon's limb well defined, the star being snuffed out instantaneously without the least hanging on the limb or lingering light. At the reappearance, the moon's dark limb was invisible, but the driving clock carried the telescope steadily during the interval, and the star flashed out near the centre of the field, shining at once with its accustomed brilliancy. The power used was 64 on the 6 4/10in. Merz achromatic telescope and the times as taken by the sidereal chronometer by Dent were:

| | | | h. | m. | s. |
|---|---|---|---|---|---|
| 1885. | July 9th. | Disappearance | 6 | 20 | 25 |
| | | Reappearance | 7 | 9 | 44 |

The chronometer error had been determined by star transits the previous evening.

**C. Grover,** Assistant Observer to C. E. Peek, M.A., F.R.A.S.

Rousdon Observatory, Lyme Regis, Dorset.

[24476.]—The occultation of Aldebaran by the moon in the forenoon of the 9th inst. was well seen here in bright sunlight. The sky was very clear, and about 11 a.m. I observed Aldebaran shining brightly near the illuminated edge of the waning moon, which had southed at 9h. 14m. a.m. The reddish-colour of Aldebaran was very noticeable, and, as the moon approached the star, the latter appeared more brilliant by comparison—it disappeared instantly on contact. There did not seem to me to be any projection on the moon's disc, as is said to have occurred previously. Time of disappearance at Greenwich stated to be 11h. 23m. 26s. The dark portion of the moon was quite invisible; but using a somewhat low-power eyepiece, I had no difficulty in placing the estimated position of emersion in the centre of the field of view, shortly before the calculated time, and had the satisfaction of noting the sudden reappearance of the star. Telescope used: A 6½in. Calver, silver-on-glass, with an eyepiece of a power of 60. **A. H. S.**

Southampton, July 10.

## 100 TO THE INCH ON TELESCOPES

[24477.]—There seems a veritable paradox about telescope powers. Bearing in mind the conventional 100 to the inch, we yet know that Herschel applied to his 6¼in. reflector powers as great as 6,000 – nearly ten times the limit by the rule just referred to. Kitchener, in his "Companion to the Telescope," which I have by me, speaks of some reflectors of his, 7in. in aperture, "magnifying from 50 to 2,000 times." Further on he relates an observation of Polaris through a 3⅝in. o.g. with powers up to 700, and even 1,123, and with the latter "the small star was still visible." Advising students as to a battery of powers for a 2¾in. o g., he mentions 300 for close doubles, and says that an optician made him one of 425, with the performance of which he was quite satisfied. Were there "giants in those days," or what is the explanation? I appeal to "F.R.A S." and Mr. Franks.

**Arthur Mee.**

## 100 TO THE INCH.—TO MR. SADLER.

[24478.]—Allow me a few words of explanation in reply to those correspondents who are at issue with me on the question of 100 to the inch of aperture. To begin with, I never said that my illustration was intended for *planets*, or other objects having a sensible disc—indeed, I should have thought that, in speaking of 100 *to the inch*, no one would have supposed it to be meant for anything but *stars*. Confined to the latter objects, my remarks were justified by the facts of the case. And, with regard to what "An F.R.A.S." says concerning a 2¼in.—on which he frequently uses *more than* 100 *to the inch* on lunar craters, Saturn's ring, &c.—well, all I can say is, I should like to see *Saturn* with such a miraculous glass. I have a lingering suspicion that with such an abnormal magnifying power and so little light, I should see no detail at all.

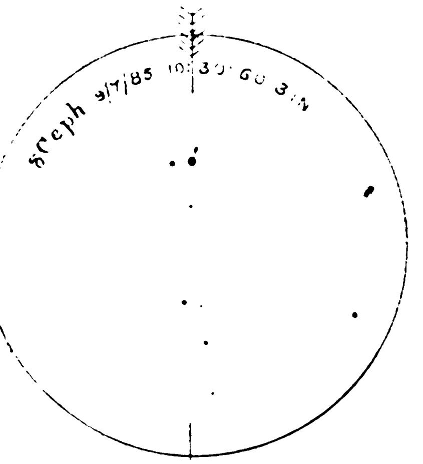
I am obliged to Mr. Sadler for his remarks on the red star B. Add 27. As the mags. of 10, 11, and 12 Gem. are all below 6 in the B.A.C., they were not included in my observations during 1877-8. I find an entry, however, of B. 607 (P. xxii. 36) Lacertæ, as follows:—"Oct. 17, 1877 : 5·5m. : bright yellow : < 1 Lacertæ." I fancy that $\alpha^2$ Cancri was added by Mr. Sadler himself in the appendix to "Cel. Objects"; and, therefore, in reading the proof, I should take his accuracy in such matters for granted. The date of my observation of 70 Ophiuchi, mentioned in "Cel. Objects," is July 29, 1876, with 5in. o.g. A recent observation of the same object was made on June 3, 1885, with the 11¼in. speculum, thus:—"70 Oph.: yel., deeper yel.: ang. lat. 40° ±: very neat."

**W. S. Franks.**

## $\delta$ CEPHEI—VEGA.

[24479.]—I am indebted to Mr. Sadler for kind answers to inquiries so long since as December 5, 1884. Will he please accept my best thanks, and may I now beg a little more information from him?

$\delta$ Cephei.—The field, as seen with a power of 60 on a 3in. Wray, presents a most interesting view. I am not, however, concerned so much with the primary pair (though "Celestial Objects" says, "especially fine, somewhat like $\beta$ Cygni"), as with the coarse *n.p.* triple, shown in the following diagram:—



I should be very much obliged to Mr. Sadler if he would kindly give me some details of this *n.p.* triple from the list of Herschel or Struve, the magnitudes, P.A., and distances.

Vega.—I believe Mr. Sadler is of opinion that the *comes* 159° 43″ is variable. It seems to me more distinct now than the *n.f.* and more distant one, 40° 140″.

I suppose, generally speaking, this latter is the plainer of the two; but with 240 on 3in. Wray the former one has of late seemed more distinct to me. Am I in some error here, or is my observation worth anything in corroborating the statement of variability? Is the 140″ 40° *comes* variable too?

July 10. **H. D.**

## SUSPECTED VARIABLE STARS IN FIELD WITH B 464—STAR MAGNITUDES—$\pi^1$, $\pi^3$, &c., ORIONIS—60 LEONIS—B 135—B 148—B 437—B 448—$\phi^2$ AND $\upsilon^1$ CANCRI—STARS IN FIELD WITH $\gamma$ LEONIS—B 607—ALCOR.

[24480.]—In the first place, I would like to be allowed to correct two small misprints which have crept into letter 24390 (p. 364). In second par., line 8, "$\beta$ 212," should be "B 212"; and in sixth par., third line from end, "$\beta$ 279" should be "B 279."

In speaking of the beautiful red star B 464, Birmingham says, "forms preceding angle of a beautiful triangle containing seven principal and several smaller stars." When observing B 464 on the 28th August last, I found that although the triangle *was* composed of seven stars, one of them was much fainter than the rest. This star was situated in the south face of the triangle, and is the next star *following* B 464. On the 7th November I confirmed my previous observation of this star, and made a rough sketch of the field. On the 9th ult. I saw the field again, and made the following rough sketch. The stars are numbered in order of brightness, 1 being B 464 itself. The stars which, so far as I can make out, make up the "triangle," are those numbered 1, 2, 3, 4, 5, 6, 9—for 8 is too far to the right to form part of the *n f.* face, and 7 is not in this triangle at all; 9 is the star referred to above. It was found to be much fainter than any of the other stars; in fact, the "triangle," the figure of which was obvious when the field was looked at, was only made up of six stars. If Birmingham did not, which I do not very well see how he could, reckon 8 as one of the triangle itself, and if the seventh star was 9, the latter must be variable, for it is in no sense one of the "principal stars" now. The star numbered 5 may also be variable, for I notice that in the sketch made on Nov. 7 last I have numbered it 3. Perhaps some of those who have made observations upon this exceedingly beautiful group of stars may be able to furnish further particulars. The whole region is well worthy observation.

Mr. Espin's letter in "Ours" for June 12 (24339, p. 322) is very interesting, and I would like to make one or two remarks upon it. Would Mr. Espin give some further particulars respecting Heis 121 Persei, and the suspected confusion between it and another star by Heis and Peirce. Objection may, I think, be taken to an expression which appears in the first paragraph of Mr. Espin's letter, assuming it not to be a misprint. He says, "which is a bright 6·0." The expression "a bright 6 magnitude" is quite correct, for the phrase "6 mag." is necessarily indefinite; but there can be no such thing as a "bright 6 0," or a "faint 6·0" either, for "6·0" has an exact and definite meaning. No star rated "6 0" can be supposed to be brighter or fainter than another rated the same, unless the scales employed in the two estimates be different. Again, as to $\pi^1$ Orionis, I would like to know how Mr. Jackson made his observations, that he can give them with such precision to the second place of decimals. It would be well if observers would content themselves with giving the magnitudes to the first place, for when given to the second place they have an appearance of minute accuracy which is only misleading, for such accuracy is quite unattainable. I have only got a few observations of $\pi^1$ Orionis; but I give them, and such observations as I have of the stars $\pi^1$, $\pi^2$, &c., Orionis, below. I may here note, what is important in this connection, that the numeration of the stars lettered $\pi$ in Orion followed in Mr. Espin's letter, and below, is the numeration in Proctor's "Atlas."

| | | | | | | |
|---|---|---|---|---|---|---|
| 1883. | Dec. | 3 | $\pi^5$ | Orionis | 3·9 | Conditions pretty good. |
| ,, | ,, | 3 | $\pi^3$ | ,, | 3·9 | |
| ,, | ,, | 3 | $\pi^1$ | ,, | 3·8 | |
| ,, | ,, | 3 | $\pi^2$ | ,, | 4·3 | |
| ,, | ,, | 3 | $\pi^4$ | ,, | 4·5 | |
| 1884. | Nov. | 12 | $\pi^1$ | ,, | 3·5 | |
| 1885. | Jan. | 11 | | — | — | ($\pi^5$ = 4·0) |
| ,, | ,, | 11 | $\pi^6$ | ,, | 4·9 | Light orange. |
| ,, | ,, | 11 | $\pi^3$ | ,, | 4·1 | Light yellow. |
| ,, | ,, | 11 | $\pi^1$ | ,, | 3·8 | Light yellow. |
| ,, | ,, | 11 | $\pi^2$ | ,, | 4·7 | White. |
| ,, | ,, | 11 | $\pi^4$ | ,, | 4·8 | |
| ,, | ,, | 11 | 5 | ,, | — | Deep orange. |
| ,, | ,, | 12 | $\pi^1$ | ,, | 3·7 | Standard $\pi^5$ Orionis = 4·0. |
| | | | $\pi^3$ | ,, | 4·1 | |
| | | | $\pi^2$ | ,, | 4·7 | |
| | | | $\pi^4$ | ,, | 5·0 | |
| | | | $\pi^6$ | ,, | 5·0 | |

The observations of magnitude were made mainly with opera-glass; those of colour always with 45 on 3¼in.

60 *Leonis*. Mr. Espin has drawn attention to the fact that the colour of this star is now no more than yellowish-white. I had intended to draw attention to this fact. The following are my observations of this star.

1883, February 18 4 3 $\alpha$ = 1·6
1883, May 2 .... 4·1 $\alpha$ = 1·4

Of course, these observations are practically the same, the difference being due to difference in estimate of $\alpha$, which headed each sequence.

| | | | | |
|---|---|---|---|---|
| 1883, | May 26, | 4 4 | $\delta$ = 3 0 | |
| 1884, | March 17, | 4·2 | $\delta$ = 3 0 | |
| 1885, | April 8, | — | | Straw colour. |
| 1885, | May 7, | — | | Yellowish. |
| 1885, | May 9, | 4·3 | $\delta$ = 2·9 | |
| 1885, | June 4, | — | | Yellowish. |

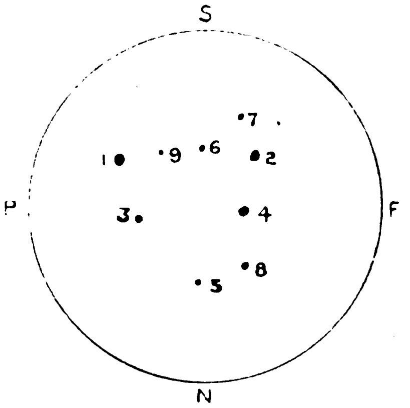
So far as these observations go, they show that 60 Leonis has not fluctuated in light, for the discrepancies are apparent only, being due to differences in rating of standards. I think the magnitude may be taken as 4·3. This is, practically, Argelander's magnitude. Heis, however, gives 5 – 4. I may add, moreover, that Mr. Gage, in the L. A. S. *Journal* for January (p. 61), calls it "light yellow."

B. 135. I observed this star on the 19th of February last, and noted it as "deep red orange."

B. 148. This is a very fine star, and is beautifully situated. I have the following observations of it:

1884. April 13: Fine orange.
1885. February 9: Fiery orange; a fine tint.

B. 437. Speaking of this star, Mr. Espin says: "The star D.M. 24·3395°, which Birmingham believes to be same as Secchi's star." I do not find this identification in the "Red Star Catalogue"; but as "Birmingham" in the "magnitude" column assigns a mag. from "D.M.," I presume it is the mag. of D.M. + 24 3395 he has there given? If so, it may be noted that it is 7·5, thus agreeing with Mr. Espin's 7½, I suppose.



Would Mr. Espin or Mr. Gore mind giving a little map whereby B 448 may be readily identified?

In "Ours" for June 27, 1884, I gave some observations and particulars concerning $\phi^2$ and $\upsilon^1$ Cancri. On the 7th of April last I observed them again. As regards $\phi^2$, I found the components to be practically equal, "if any difference, B the brighter." Concerning $\upsilon^1$ I noted, "At least one magnitude between the components. The colours differ." These observations practically agree with those I gave in my letter referred to above. They are both beautiful objects. In "Ours" for August 15, 1884, Mr. Stanley Williams gives some observations of his own, made with 5¼in. Calver, on January 3, 1881, when B of $\phi^2$ Cancri was found to be 0·1 brighter than A, and the components of $\upsilon^1$ were found to differ a magnitude; thus confirming my own observations, and showing that the relations in brightness existing among these stars was the same in 1881 as it is now. Both of these pairs are interesting, and worthy of further observation. From the observations given in "Celestial Objects," it appears that Struve found a difference of 0·5 in 1826; but that Webb found them "much less unequal 1849, nearly equal 1856." In the interval between 1849 and 1856, however, Dembowski had, in 1854, rated them as equal. Again, we find that while in 1871 and in 1874 Duner found "∓ 0·1 mag. difference"; in the year 1872 Webb found "¼ or ⅓ mag. difference" between the components, with his 9⅓in. reflector. There is, therefore, good ground for thinking the stars which comprise this pair to be variable in some way; but it may be noted, in addition, that in the observations given in "Celestial Objects," there is no word of B (the preceding star) being the brighter. The observations read as though A had always been found to have the superiority, whereas B certainly seems to be the brighter now.

In "Ours" for Aug. 1, 1884, I drew attention to the two small stars *p.* in field with $\gamma$ Leonis. I there said that I had found C to be about 9 6 and D about 10·3, and that on March 31 Mr. Franks had estimated them for me and made C 9·7 and D. 10·5. In the "E. M." for Aug. 15, Mr. Sadler gave a number of comparative estimates of the magnitudes of these stars, showing that they had been most variously estimated. C, he said, is 9·2 in D.M., and D is 9·5. Of D he remarked that "it was certainly not so low as 10·3 or 10·5 in 1882 and 1883, or in 1874—1877, according to my estimate." On May 11, when definition was pretty good, I examined these stars, using stops, and made C 9·7 and D 10·4 Arg. Perhaps some other observer can furnish notes on the magnitude of these stars.

In reference to Mr. Gore's very interesting note on B 607 (letter 24417, p. 388), I would like to know whether he has any other authority for the observation quoted from Burton, giving the magnitude in 1876 as 7·5, beyond the entry in the "Red-Star Catalogue"? I ask, for it seems to me to be possible that there is a misprint here in Birmingham. The "Red-Star Cat." says "Dublin Obs.: Copeland, 1875, Sept. 11, orange, 5·4. Burton, 1876, red, 7·5; Aug. 20, yellowish, 5; Oct. 10, yellow, 5·5." It will thus be seen that the change of magnitude, if the star was ever really observed in 1876 by Burton as being 7·5, must have been, at least, comparatively rapid; and that being so, it is strange that Birmingham does not draw attention to the circumstance. Neither in the text, on p. 297, nor in the list of stars to which, on the ground of their being perhaps variable, he "would specially direct the attention of observers," which occurs on p. 300, does he mention No. 607. It is noteworthy, too, that although he points out on p. 300 that variability was "observed . . . by Mr. Burton in 502," he does not say that he observed it in 607, though we might have expected that had Burton actually observed the variation mentioned under 607, he would have drawn attention to it. Variability might certainly be, I think, inferred from the statement quoted by Mr. Gore from Sir W. Herschel, and might be, perhaps even ought to be, also inferred from the observations of Secchi, given in Appendix I. to the "Red Star Catalogue." These observations of Secchi's strongly suggest variability in the spectrum as well. B 607 is a beautiful star in colour. The following are the only two observations of it of my own I can find:—

1884, Sept. 21 ...... Ruddy gold.
„ Nov. 27 ...... Orange; in moonlight.

I would like to direct attention to Alcor, for it seems to me to be unusually bright at present. I had observed it on previous occasions to be about 4·6 or so; but I thought the other night that it could not be much less than 4·0, and last night (8th July) I compared it—but roughly though, I must say—with λ Boötis, which star I have found constant at 4·0, and made it 4·3. That Alcor must be at present a good deal brighter than it was once, must be, I think, taken as certain; but I have a fancy that its present brightness is not constant, but subject to fluctuations.

Allow me to thank Messrs. Sadler and Tarrant for the large amount of information they supply in answer to my queries in letter 24390 (p. 364), in to-day's "E.M." Mr. Sadler will see from par. 1 above that I *did* write "B.," and not "β." I must say, however, that I have often thought that "β" is an inconvenient symbol to adopt for "Burnham," and that it would be much better to always employ the contraction "Bu" used by the late Mr. Webb throughout the whole of "Celestial Objects."

Glasgow. **S. Maitland Baird Gemmill.**

## ASTRONOMICAL.

[24481.]—I think we may accept it as a fact that an elongation of γ Coronæ exists towards 135° or 140°, since independent measures by M. Gaudibert, Mr. Tarrant, and myself all give the same angle, but the elongation is very slight, and I am told the present distance is less than 0·3″.

I think "M. G." (24439) will find his measure of η Coronæ 5° too large. 70 Ophiuchi I have measured twice as 28°.

Mr. Kershaw (24458) asks about paraffin covered vessels for silvering. My silvering vessel is made from a piece of plate glass with a glass ring cut from a glass shade upon it. This ring is about 2in. deep and is united to the slab of plate by brushing hot paraffin wax round. I have noticed that less silver deposits upon the wax than upon the glass, and have not noticed it affect the film in any way. An ordinary wax candle melted down seems to do just as well as pure paraffin.

Mr. Franks, letter 24459, in remarking that while a 4in. o.g. with a power of 200 gives a brilliant image of Jupiter, "I have never seen a 2in. yet that I should care to observe the planet with when charged with a power of 100," forgets that a 2in. does not collect enough light to make the features of Jupiter observable at all. He is also accustomed to a much larger aperture, and therefore dissatisfied with small instruments. But evidently the first necessity of the case in any comparison is that the instrument shall not be too small to show anything. It is not the comparative quantity of light, but the total quantity that is in question here. A 4in. may, with a power of 200, show a lunar crater distinctly, while a 2in. with 100 fails to show any crater at all. Does this prove that the 200 on 4in. is borne better than 100 on 2in.? I think not. It only proves that the total amount of light collected by 2in. is insufficient to affect the retina. If we look at a bright star with a faint companion, the disc of the larger star will be as sharp and well defined with 200 on a 2in. as with 400 on a 4in.; but the faint *comes* visible in the one is invisible in the other, not from want of proportionate, but for want of absolute, power. Again, when Mr. Franks asks if a 26in. would bear 1,300 diameters on Jupiter, and opines it would result in a "fearful and wonderful illustration of what the atmosphere can do in setting optical theories at defiance," does he not see he is discussing an entirely different question? That our atmosphere might render such a power useless may be quite true without affecting the truth of optical theories in any manner. His first proposition relates to the comparative light; but this is a question of the comparative effect of atmospheric disturbances on various apertures.

I think he will see there is an inherent defect in his quotation from his private correspondent. He, in effect, says that the brightness of the object will be the same in a 2in. with a power of 100 and a 4in. with 200. If this were correct, it would go to prove that a faint *comes* would be just as easily seen in one telescope as another, provided proportional powers were used. I am sure I need not waste space in refuting this, although Mr. Franks has inconsiderately indorsed it.

It is the total quantity of light collected that enters into this question. Again, and as in the larger instrument, the actual image of any point is identical in size with corresponding powers (that is the image of a point in a 4in. with 200 is exactly the size of image in a 2in. with 100), then, as the 4in. collects four times the quantity of light, and delivers it in the same space, the image in the 4in. is four times brighter than in the 2in. This is just as true of any larger aperture.

With regard to the question he puts further, I should regard the failure of a 26in. to stand 1300 on a steady night as a proof it was defective. I have found a 9in. stand 900 easily enough on stars, and 600 on planets. **E. Holmes.**

## HIGH-POWER GLASSES.

[24482.]—Replying to "E. C. J." (24461), the difficulties raised by the A. and N. Stores are now surmounted as regards non-members. I had to go myself for a 7-power glass for another "E. M." reader since Dr. Dickson's, and when there I saw another 7-power which yet another reader had succeeded in ordering to his special width of 65mm. in aluminium, but which the authorities had since refused to deliver to him. To stop this I wrote, acting on the Editor's late suggestion, to Mr. William Whiteley, of Westbourne Grove, who has consequently to-day agreed to order samples of 4, 7, and 10-power glasses from the maker in Paris, and to execute orders for the same to all applicants, at the same prices as those already quoted by the A. and N. Stores. Answering "E. C. J.," why 10-power should be so much more costly than 7, ten diameters cannot be achieved under a focal length of 10¾in.; this will not allow less than 8¼in. as length closed, unless double draws are resorted to, which is bad in principle. Hence the amount of material needed. Then the object-glasses are 2⅜in. aperture. It is a really valuable instrument. The glasses in their cells weigh 9oz. out of the total weight 20oz. Substituting brass for aluminium would greatly decrease the price, but increase the weight. For some years these glasses cost £12, and it was only on my holding out prospects of the present demand that the maker went afresh into the figures, and reduced the tarif to the present price, 181s. "E. C. J." also asks if it is not the fact that all glasses are made in France? I believe he is right in his assumption. It is not disputed that all the aluminium work is done in France exclusively, and the efforts to assert that *soi-disant* English glasses are made in England are feeble, and I doubt if they would stand cross-examination. I regret it is so. I would much prefer to see both the lens trade and the aluminium trade established and prospering in England for England's sake. Till then the best thing for England is to supply her with the best French-made glasses, on the best terms attainable to leave the Paris maker his fair profit and the London agent his fair commission. In this matter I have not interfered: the prices quoted include everything they asked for.

I hardly know whether "Experience" expects replies to his questions (24462), for they are so self-evident. He reads of my taking the bin. telescope and 10-power Galilean to Albert Hall to try their respective capabilities, and that at 5 p.m. by daylight the former could hardly distinguish features across the hall, while after night came on, and the evening performance was conducted before 6,000 spectators by gaslight, "the telescope could show nothing, while the 10-power showed everything equally well as by day." To this he asks, "What can 'Montmartre' mean?"

Then he proposes to ask "whether increase of power can be obtained without any sacrifice of light *or field?*"—a question which is itself a contradiction in terms as regards field. (Mr. E. M. Nelson, in our current issue, 24460, brings the weight of his opinion to the effect that there is no loss of light in a 10-power on a 2in. aperture.) The one contention of the supporters of the high-power glasses is, that it is common sense and sound practical wisdom to exchange the useless excess of field, with low power—which has so long been pressed upon the market—for the more effective and useful high-power, combined with the correspondingly smaller field, which are the raisons d'être of the 4, 7, and 10-power glasses having been designed and advocated.

I have no doubt that for years past the glass-using portion of the community have been carrying about with them a needless excess in size, weight, and cost in glasses, which is now destined to be revolutionised by the introduction of the present choice of instruments, each of which represents the maximum of effectiveness attainable for its sake, at, apparently, from a half to a third of the cost of the old stocks. **Montmartre.**

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[24483.]—Replying to our two correspondents, Dr. G. Dickson, of Edinboro' (24436), and G. R. Baker (24437), I despatched the former a 7-power at 39s., in brass (the "superior article" at 56s. was a fiction—there is nothing better made), and I can assure the latter that the fears he expresses about the high-power glasses are unfounded. I used myself to have what he terms "a battery" of twelve or fourteen glasses of all makes, but the last ten years' experience taught me that the high powers are worth all the rest put together, and I have given away all the low powers except one, which I keep for sweeping the skies. The 4-power for the ticket pocket companion, the 7 for ordinary theatres and concert rooms, and the 10 for outdoor work, the Albert Hall, and Hippodrome form, I find as complete a range as can be desired for all purposes. Although I have no acquaintance with those occupations myself, I also know that the 10-power has been purchased for use with satisfaction in yachting, duck shooting, and racing. Neither do the fears Mr. G. R. Baker expresses conform with the verdict of the actual purchasers—"Which I have received, and with which I am delighted"—"What I have been wanting for years past"—"I am of your way of thinking—power first, light next, field last"—"The writers who say people do not want to see too much talk bosh; people want to see all they can." These are the types of the remarks of the possessors of the high-power glasses. One of our readers—not Baker—who also went to Paris a few days ago, selecting his 7-power personally at the makers, actually defrayed his first-class fares and bill at the Grand Hotel out of the difference saved between the cost of the 7-power so acquired (though he paid London agency price for it) and that of the 6-power offered by the English advertisers in London! His verdict was "Greatly pleased, the most powerful yet made, for I know those offered by the London firms well."

Dr. Dickson writes to-day from Edinboro': "The 7-power sent has excellent definition, reasonable light, and good achromatism. As to aperture, it should not be complained of when put beside the great advantage of high power. I tried it against a large aperture glass, and could read print distinctly at double the distance with it. I also tried it from Arthur's seat last evening, and, although hazy, could make out the French flag of a vessel five miles away. Accept best thanks for putting in my way what I have sought for for years." Such expressions as these make me feel—thanks to the "E. M."—as comfortable as the party who "made two blades of grass to grow where but one grew before." **Montmartre.**

## PIANOS AND THEIR SHAPE.

[24484.]—So much has been said about the mechanism of the pianoforte in these pages, and so much benefit has resulted, that I crave a word or two on the subject of the form of the instrument. The ordinary upright piano, as made at present, is the most hideous thing in a room, and if we try to get anything of decent design we have to pay prices far beyond the means of common people. Is there any reason why pianos should still be so ugly? Why cannot Mr. Davies, for instance, who makes such good cheap pianos, make us one like the piano I saw recently on view in "Old London" at the Inventions in the room furnished by the "Century" Guild? I wish we had a little more about art occasionally in "Ours." We have become emancipated from the thraldrom of the upholsterer to the benefit of our pockets and the gratification of our sense of the beautiful; but the pianoforte is still a terrible nuisance in a room furnished with any pretensions to taste. **Kappa.**

### EXAMINATION OF MINERALS BEFORE THE BLOWPIPE.—II.

[24485.]—Box No. 6.—Yellowish white, amorphous fragments; compact, but glittering—hard.

| | | |
|---|---|---|
| I. | Powder in B acid. (1.) Transparent ice-like mass, not wholly dissolved. (2.) Green pyrochrome nearly yellowed. | (1.) An alkaline aluminous silicate, with large proportion of silica. (2.) about 5 per cent. of soda. |
| II. | Added CoO. (1.) Cobalt borate nearly all dissolved to purple suffusion over the bead. | (1.) About 10 per cent. alkali (must be potash also here). |
| III. | Added lime. (1.) Calcium borate balls decomposed in part, but milky matter not quite opaque. | (1·) Not very much alumina. |
| IV. | Fragment fused easily before the pyrocone: Powdered, boiled, dried, and treated B.B. in phosphoboric acid. (1.) Semi-transparent undissolved mass. No balls of any kind. | (1.) Large proportion of silica. No lime, iron, manganese, &c. No necessity to try this mineral in P acid. |

What Mineral is this?

Box No. 7.—Compact, white, amorphous fragments, with vitreous lustre; very hard (steel of penknife left on its surface).

| | | |
|---|---|---|
| I. | Powder in B acid. (1.) Strong yellow p.c. from bottom of bead, and green p.c. completely yellowed. (2.) Ice-like mass dissolving. | (1.) Large proportion of soda. (2.) An alkaline aluminous silicate. |
| II. | Added CoO. (1.) Great part of cobalt borate dissolved to purple suffusion. | (1.) At least 10 per cent. soda. |
| III. | Added lime. (1.) Lime balls decomposed; at first with curdy precipitate round them, then completely, to milk-white enamel bead. | (1.) Considerable proportion of alumina. |
| IV. | Original powder in P acid. (1.) Transparent mass after long treatment before pyrocone. | (1.) Large proportion of silica. |

(Did not try for lime, &c., as the mineral is evidently a relative of the preceding.)

Box No. 8. (On opening this box I could see from the iridescent play of colours on some surfaces of the fragments, that the mineral is labradorite, and as I have found this out, and have already given a blowpipe analysis of that in "E. M."—see "Easy Lessons, &c."—I pass it by, and take instead, a small piece of a mineral inclosed in paper in the box, of which someone had sent me one or two small fragments) flesh-coloured, compact, amorphous, soft.

| | | |
|---|---|---|
| I. | Powder in B acid. (1.) Ice-like mass not soluble. (2.) Yellow p.c. at first, but green p.c. not completely yellowed. | (1.) Alkaline aluminous silicate with little alkali and much silica. (2.) Under 5 per cent. soda. |
| II. | Added Co O. (1.) Cobalt borate balls scarcely purpled. | (1.) Little alkali. |
| III. | Added lime. (1.) Only curdy precipitate round lime-balls. Added equal parts of CaO and original powder. (2.) Only milky and opaque in part; but this bead had a trace of P. acid, derived from the wire in it. | (1.) Not much alumina.<br>(2.) Not much alumina; but allowing for the state of the bead, I should say about 15 or 16 per cent. |
| IV. | Fused, boiled, and dried powder in fresh B. acid. (1.) Semitransparent fragments, some giving off faint milky streaks; no balls. | (1.) (1.) No lime, iron, &c; but I had *very* little of this mineral, wishing to retain parts, and was obliged to fuse remains of original powder made into paste, instead of a fragment B.B. |
| V. | Added P. acid and fresh, boiled, &c., powder. (1.) Same as before; no balls. | |

(Unsatisfactory; but think I can guess the mineral from these reactions, and its peculiar flesh colour.)

Box No. 9.—White, opaque, crystalline-fibrous: soft.

| | | |
|---|---|---|
| I. | Powder in B. acid. (1.) Transparent, icelike mass, dissolving to clear bead. (2.) Green p.c. completely yellowed. | (1.) Alkaline aluminous silicate with considerable alkali. (2.) Over 5 per cent. of soda. |
| II. | Added CoO. (1.) Cobalt borate completely but not rapidly dissolved to purple suffusion; not to a blue bead. | (1.) Over 10 per cent. alkali, but under 20 per cent. |
| IV. | Added a mixture of equal parts of lime and original powder. (1.) Milk-white, opaque, enamel bead. | (1.) Considerable proportion of alumina. |
| IV. | Powder of fused fragment (fused easily with strong reddish orange p.c.) boiled and dried in phosphoboric acid; (1.) semitransparent mass with one or two minute colourless balls. | (1.) Considerable proportion of silica, with a trace (one or two per cent.) of lime; no iron, manganese, &c. |

What Mineral is this?

Box, No. 10.—Greenish grey, compact, amorphous; softish.

| | | |
|---|---|---|
| I. | Powder in B. acid. (1) Faint yellow p.c. at bottom of bead, but green p.c. unaltered after. (2) Rusty yellow suffusion over whole bead, with black enamel over wire. (3.) With much fresh B. acid and a trace more powder, many black opaque balls, surrounded by yellow suffusion. (4.) Vesiculated, no ice-like mass or fragments, but one or two larger transparent brown balls, iron borate balls rapidly dissolving. | (1) (2.) Trace of soda, but presence of considerable alkali, by which iron borate balls are dissolved to black enamel, &c. (3.) Large proportion of iron. (4.) Either a large proportion of potash or less of some stronger alkali, not soda, a little manganese. |
| II. | Added CoO. (1.) Cobalt borate balls, with little suffusion, and that pink, not purple. | (1.) Cannot be potash, yet must be considerable alkali present to dissolve the iron borate. |
| III. | Added lime. (1.) Lime balls not decomposed, but take up the CoO as transparent purple balls of cobalt-calcium borate. Almost impossible to vesiculate the bead. | (1.) Either no alumina present or the alkali must be Lithia, probably both. |
| IV. | Splintery fragment before the pyrocone point. (1.) Yellow p.c. but streaks of deep red; more red if the wick of a pyrological candle (!) is touched with the fragment. | (1.) A little soda and more lithia, but still not much of the latter. |
| V. | Boiled powder of the fused fragments, dried, and treated in fresh B acid bead. (1.) The whole powder, black opaque balls with streaks of cohering opaline matter; forming afterwards a peculiar opal bead B.B. | (1.) The whole mineral iron, with (probably) largo proportion of phosphoric acid; a little lithia, and traces of soda and manganese. |
| VI. | Equal parts of boiled powder and lime added to V. (1) A large, black, opaque, conglomerated ball, like that afforded by Gayolinite to B acid. | (1.) Not much information from this reaction, except the probable presence of magnesia. |
| VII. | Added powder of V. to fresh B acid bead containing a large calcium borate ball. (1) Transparent green ball, opaque while hot. | (1.) Iron protoxide with a little magnesia. |
| VIII. | Added potassium pyrotungstate (!) (*a*) in excess to bead I., B.B. (1.) A deep turquoise-blue, opaque bead on cooling. | (1.) Large proportion of phosphoric acid. |

It is pretty plain now what this mineral is.

*Notes.*—*a.* This salt (an invaluable reagent for phosphoric acid) is thus made:—Fuse a portion of potassium carbonate, about the size of a large pea, on clean aluminium plate B B, and add tungstic acid (!) (a yellow powder sold cheaply in small bottles), until all effervescence has ceased. The product, a greyish white mass, is broken into little pieces and kept for use in a small bottle; but I prefer making it "fresh and fresh," as above described. To use it, the supposed phosphate is first thoroughly dissolved in a B acid bead B. B. by the employment of as little potash as possible (a mere trace is sufficient), so as retain a decidedly acid character in the bead. Potassium pyrotungstate is then fused with this bead inside the point of the blue pyrocone; and if it is phosphatic in the least degree, it will turn a pale turquoise blue, and opaque on cooling: if very phosphatic, it will turn a deep blue.

I discovered this test (it is said by some "Ironmasters" to be invaluable in detecting traces of phosphorus in iron, which is then said to be "cold short") in 1874, by a careful perusal of Plattner's celebrated "blowpipe tables" (Probirkunst mit dem Löthrohre," 4th Ed. 1865, p. 138). In them I saw, under the head of "No. 33, Wolframsäure" (tungstic acid), that that substance, added B. B. to borax, affords only a yellow bead; but when added to salt of phosphorus, a "beautiful blue colour." Soda being common to both of these salts, it is evidently phosphoric acid which causes the blue colour.

P.S.—I feel much indebted to "Ex-Blacksmith" and a "Mineralogist" for their kindness in noticing my work in the "E. M."; but I cannot look in the list of minerals yet to see if they are right or wrong, because I should then be unable to help seeing the names of the rest; but I shall be able to ascertain the names after this lot, when I have some remarks to make upon their remarks. **W. A. Ross.**

### FLAMES.

[24486.]—THE old theory as to the cause of luminosity in flames was that solid particles of carbon are deposited, and being heated to whiteness in burning hydrogen, emit light. In support of this theory was adduced the fact that gases, such as hydrogen, whose flames are incapable of depositing solid particles, have but little luminosity when burnt; and it was also argued that the soot formed on a cold surface held in a hydrocarbon flame is the solid carbon to the incandescence of which the luminosity is due. Hydrogen burning in oxygen yields water vapour whose density is only 9, and the flame, though very hot, is of feeble luminosity; if the hydrogen be burnt in chlorine the density of the product of combustion is 18·25, and the flame, though probably lower in temperature, is much brighter. One of the most brilliant flames in existence, that of phosphorus burning in oxygen gas, certainly does not contain solid particles of any kind, for phosphoric anhydride is volatile at a temperature far below that of the flame; and the same remarks apply to the flame of arsenic burning in oxygen, which is very luminous, although solid particles are out of the question. We thus see that we can have luminous flames without solid particles, provided that the vapour density of the product of combustion is high; in the case of arsenic the vapour density is 198, and in the case of phosphorus (probably) 142. We have now to inquire how this theory will fit with the phenomena presented by ordinary gas flames. Coal-gas is of low density, generally about eight or ten, and the flame is much more luminous than would correspond to this density or to the density of the products of combustion. We know, however, that the ignition of gaseous hydrocarbons has the effect of causing the formation of compounds of higher molecular weight. If marsh gas be heated, part of it is converted into acetylene; and, indeed, it is possible, by simply igniting, to pass from the lower members of the paraffins to the more complex molecules of the aromatic hydrocarbons. In an ordinary gas flame, therefore, there are found hydrocarbons of great complexity, whose vapours, intensely heated, emit light.

Soot, which was considered to be merely carbon, in reality always contains hydrogen, which cannot be removed by mere ignition, but only can be got rid of by heating to whiteness in a stream of chlorine. Soot is, in fact, a hydrocarbon of very high molecular weight, which is formed in the flame by the ignition of coal-gas, and which, as vapour in the flame, emits light. It may be asked Why, then, does it not volatilise again on ignition? But these very heavy hydrocarbons will not volatilise twice. The tar in the hydraulic main of a gasworks has been distilled there, but it cannot again be completely sublimed. As a minor argument against the existence of solid particles in a gas flame may be cited the transparency of the flame. A newspaper can easily be read through a flat flame, which would scarcely be possible were many solid particles present, but is quite compatible with the existence of incandescent vapour. Other things being equal, the hotter a flame the greater is its luminosity; but mere temperature in the absence of heavy vapours is useless. It is, however, probable that each density has a certain temperature at which it becomes luminous. The solar prominences consist mainly of hydrogen, and are very luminous; but then their temperature is enormous, and far exceeds any flame we can obtain. If air be admitted to the gas flame, as in the Bunsen-burner, then the combustion is so rapid that the formation of heavy hydro carbons cannot occur, and the luminosity vanishes, being then only that due to the products of combustion—namely, steam and carbon dioxide. The temperature rises considerably, but not enough to render incandescent the light gases produced.

**W. John Grey, F.C.S.,**
Newcastle-on-Tyne. Analytical Chemist.

### LIST OF TRAINS WITH A SPEED OF 50 MILES PER HOUR AND UPWARDS, TAKEN FROM JULY, 1885, BRADSHAW ARRANGED ACCORDING TO COMPANIES.

[24487.]—

| Between | Distance. | Time. | Speed. | Number of Trains. |
|---|---|---|---|---|
| G. N. R. | | h. m. | | |
| Grantham and King's Cross | $105\frac{1}{2}$ | 1 58 | $53\frac{38}{59}$ | 2 Manchester expresses |
| Grantham and Peterborough | $29\frac{1}{2}$ | 33 | $53\frac{2}{11}$ | 3 Leeds expresses |
| *Hitchin and Peterborough | $44\frac{1}{4}$ | 50 | $53\frac{1}{10}$ | 2 Manchester expresses |
| King's Cross and Grantham | $105\frac{1}{2}$ | 2 0 | $52\frac{3}{4}$ | 1 Manchester express |
| | $17\frac{1}{2}$ | 20 | $52\frac{1}{2}$ | 1 Leeds express |
| Finsbury and Peterborough | $73\frac{3}{4}$ | 1 25 | $52\frac{1}{17}$ | 1 Newspaper express |
| King's Cross and Peterborough | $76\frac{1}{4}$ | 1 28 | $51\frac{87}{88}$ | 2 Leeds expresses |
| Huntingdon and Finsbury | $56\frac{1}{4}$ | 1 5 | $51\frac{12}{13}$ | 1 Leeds express |
| Grantham and Peterborough | $29\frac{1}{4}$ | 34 | $51\frac{21}{34}$ | 1 Leeds express |
| Grantham and Doncaster | $50\frac{1}{2}$ | 59 | $51\frac{21}{59}$ | 1 Leeds express |
| Peterborough and Hitchin | $44\frac{1}{4}$ | 52 | $51\frac{3}{52}$ | 1 Leeds express |
| Peterborough and Doncaster | $79\frac{3}{4}$ | 1 34 | $50\frac{85}{94}$ | 1 Leeds and York express |
| Wakefield and Doncaster | $19\frac{1}{2}$ | 23 | $50\frac{20}{23}$ | 3 Leeds and York expresses |
| Finsbury and Peterborough | $73\frac{3}{4}$ | 1 27 | $50\frac{25}{29}$ | 1 Scotch express |
| Retford and Grantham | 33 | 39 | $50\frac{10}{13}$ | 1 Leeds express |
| King's Cross and Peterborough (2) | $76\frac{1}{4}$ | 1 30 | $50\frac{5}{6}$ | 4 (2 Leeds, 1 York, 1 Scotch exprs) |
| Wakefield and Grantham (1) | 70 | 1 23 | $50\frac{50}{83}$ | 1 Leeds express |
| Doncaster and Grantham | $50\frac{1}{2}$ | 1 0 | $50\frac{1}{2}$ | 2 Leeds expresses |
| Wakefield and Retford | 37 | 44 | $50\frac{5}{11}$ | 1 Leeds express |
| Finsbury and Peterborough | $73\frac{3}{4}$ | 1 28 | $50\frac{25}{88}$ | 1 Leeds express |
| King's Cross and Peterborough | $76\frac{1}{4}$ | 1 31 | $50\frac{25}{91}$ | 1 Leeds express |
| Hitchin and Huntingdon | $26\frac{3}{4}$ | 32 | $50\frac{5}{32}$ | 1 North express |
| Peterborough and Grantham | $29\frac{1}{4}$ | 35 | $50\frac{1}{7}$ | 3 Leeds expresses |
| †Peterborough and Hitchin | $44\frac{1}{4}$ | 53 | $50\frac{5}{53}$ | 3 Leeds expresses |
| Retford and Doncaster | $17\frac{1}{2}$ | 21 | 50 | 2 Leeds expresses |
| York and Grantham | $82\frac{1}{2}$ | 1 39 | 50 | 1 Scotch express |
| | | | | 42 |
| L.N.W.R. | | | | |
| Willesden and Rugby | $77\frac{1}{2}$ | 1 28 | $52\frac{37}{44}$ | 1 Manchester express |
| Northampton and Willesden | $60\frac{1}{4}$ | 1 10 | $51\frac{9}{14}$ | 1 Irish Mail |
| Rugby and Willesden | $77\frac{1}{2}$ | 1 32 | $50\frac{25}{46}$ | 2 Birmingham expresses |
| Bletchley and Rugby (3) | 36 | 42 | $51\frac{3}{7}$ | 1 North express |
| Willesden and Rugby (1) | $77\frac{1}{2}$ | 1 31 | $51\frac{9}{91}$ | 1 Manchester express |
| Bletchley and Rugby (2) | 36 | 43 | $50\frac{10}{43}$ | 2 North expresses |
| Northampton and Willesden | $60\frac{1}{4}$ | 1 12 | $50\frac{5}{24}$ | 2 Birmingham expresses |
| Rugby and Willesden | $77\frac{1}{2}$ | 1 33 | 50 | 4 Liverpool expresses |
| | | | | 14 |
| Kettering and Nottingham | $71\frac{3}{4}$ | 1 0 | $51\frac{3}{4}$ | 4 Leeds and Sheffield expresses |
| Kettering and Kentish Town | $70\frac{3}{4}$ | 1 22 | $51\frac{31}{41}$ | 4 Leeds and Sheffield expresses |
| Liverpool and Stockport | $37\frac{3}{4}$ | 45 | $50\frac{1}{3}$ | 1 Liverpool express |
| | | | Total | 9 |
| M.S. and L.R. | | | | |
| Manchester and Warrington | 16 | 18 | $53\frac{1}{3}$ | 13 |
| ‡Manchester and Liverpool | 34 | 40 | 51 | 6 |
| Manchester and Warrington | 16 | 19 | $50\frac{10}{19}$ | 1 |
| | | | Total | 20 |
| G.W.R. | | | | |
| Paddington and Swindon | $77\frac{1}{8}$ | 1 27 | $53\frac{11}{58}$ | 3 Dutchman and Zulu |
| Paddington and Swindon | $77\frac{1}{8}$ | 1 28 | $52\frac{107}{174}$ | 1 Up Zulu |
| Bristol and Taunton | $44\frac{3}{4}$ | 52 | $51\frac{33}{52}$ | 3 Dutchman and Zulu |
| Bristol and Taunton | $44\frac{3}{4}$ | 51 | $52\frac{11}{17}$ | 1 Down Zulu |
| Bristol and Bath | $11\frac{3}{4}$ | 14 | $50\frac{5}{14}$ | 1 Up Dutchman |
| | | | Total | 9 |
| N.E. | | | | |
| Darlington and York | $44\frac{1}{4}$ | 53 | $50\frac{5}{53}$ | 1 Scotch express |
| | | Grand | Total .. | 95 |

* One, the 5 p.m. from King's Cross on Sundays. † One, the 8.20 p.m. from Peterborough on Sundays. ‡ One on Mondays and Wednesdays only. One on Thursdays only.

From this list it will be seen that the G.N.R. is by far the fastest line in the kingdom. It has also the longest run without stoppage. I hope we shall hear no more about the Dutchman being the fastest train.

**D. A. P.**

### GRAVITY BRAKE.

[24488.]—I SEND a short description of gravity brake (letter 24468). I do not know, however, whether it is in use on any railway at present. The construction and action of this brake are simple, and the parts few. There is centrally attached to the underbody of each carriage a vertical cylinder, in which a piston and ram, weighing about 150lb. or so, as required, is free to move; the cross head of ram, connected with and acting through levers, actuates the brake blocks. The ram, when in its normal position, is at the bottom of the cylinder, but not quite touching. Thus, when left to natural forces, the brake blocks are forced against the wheels, and remain on until released. This constitutes the great difference between this and other brakes, there being in the gravity brake no power to leak off, as is the case with air and vacuum system; consequently, the driver must take the whole of the brakes off before he can start a train: this insures it is in good working order.

There is provision made in three different ways if required for releasing the brakes, two for working the brake in actual running, one for releasing brake when required for shunting purposes. This latter is done by means of a manual lever on each carriage. If, however, this lever is accidentally left fastened, and the brake off, the driver can release it from the engine, and thus work the brake as usual.

For taking off and working the brake whilst running, there is the usual length of pipe from end to end of carriage, &c., as is common to all systems of continuous brakes. Primarily this may be used in the ordinary way to maintain a vacuum by means of an ejector on the engine. While the vacuum is maintained the brakes are fully off; when diminished they are partially applied; when destroyed they are applied with full force. A vacuum of 8in. is sufficient to keep the brakes off. A special driver's valve fixed on the engine, enables them to be worked with the greatest nicety. It must be noticed that the vacuum pipe is connected with the upper part of the brake cylinder.

Similarly, compressed air can be used; this pipe must however be connected with lower part of cylinder. As this brake can be worked either by vacuum or air pressure, every individual carriage may be made up in the middle or any part of trains on other lines which may be fitted with either systems as now in use, and the brake will work equally well, which is an immense advantage. This brake is essentially automatic under all conditions. There is also an arrangement on each carriage, automatic in action, for maintaining the levers at their most efficient angle, and perpetually taking up the wear of the brake blocks.

The patentees are Messrs. Cowling Welch and Parker Smith.

July 11. **Nomen.**

### NEW TRAINS, &c.

[24489.]—MR. LAWRENCE (letter 24468) is very wide of the mark when he says: "I think at present the L. and N.W. are running the fastest." The distance from Willesden to Rugby is $77\frac{1}{4}$ miles, not 78 miles, and consequently the speed of the run referred to is below 53 miles per hour.

The following are the only runs in England at a speed of 53 miles and over. It will be seen that the G.N. run 355 train-miles daily at this speed, and the G.W. $231\frac{3}{4}$.

| Company. | From | To | Miles. | Time. | Speed. |
|---|---|---|---|---|---|
| 1. G.N. | Grantham .. | King's Cross | $105\frac{1}{2}$ | 1.58 | 53.64 |
| 2. G.N. | Huntingdon | Finsbury Pk. | $56\frac{1}{4}$ | 1.3 | 53.57 |
| 3. G.W. | Paddington. | Swindon.... | $77\frac{1}{4}$ | 1.27 | 53.28 |
| 4. G.N. | Grantham .. | Peterboro' .. | $29\frac{1}{4}$ | 0.33 | 53.18 |

No. 1 is performed twice daily, 1.47 p.m. and 4.17 p.m.; No. 2, once—viz., at 4.34 p.m.; No. 3 is done three times (twice down and once up); and No. 4, three times, all up.

The number of train miles at 52 miles per hour and upwards are:—G.N., $686\frac{3}{4}$ miles; G.W., 309 miles; L. and N.W., $77\frac{1}{4}$ miles (the run referred to by Mr. Lawrence). None of the other companies reach 52 per hour. The best on the M.R. is about $51\frac{3}{4}$.

Concerning No. 2 run above, it should be noticed that the times given in the tables at Finsbury Park are the departure times, and that two minutes are allowed there.

The N.E.R. time bills agree with Bradshaw concerning the run from Newcastle to Edinburgh. The distance is $124\frac{1}{4}$ miles; and judging from the time allowed, I should fancy that a stop is made on the way, though possibly not for the benefit of the public.

If Mr. Lawrence would make a few journeys between King's-cross and Grantham, he would soon find an explanation for the hitting of the arrival time to such a nicety. The driver simply gets two or three miles in hand, and then runs the last few miles easy.

Undoubtedly, until recently, certain engines on the L. and N.W. did run to Crewe and back on the same day, though whether this is still the case I cannot say. **C. P.**

### THE ACCIDENT AT KING'S CROSS.

[24490.]—WILL Mr. Stretton give such particulars as are available of the accident which occurred at King's-cross the other day, when two trains tried to run up to the King's Cross (underground) up platform at the same time? I understand that a Great Northern goods ran into a Midland passenger, both engines (fortunately) meeting where the lines converge. It is said that the signals were "off" for both trains, but all that is certain is that somebody blundered. If the signals were "off" for both lines, I would ask, Is there any difficulty in so arranging the levers that it would be impossible for the most careless signalman to put one signal "off" unless the other was "on." The accident, fortunately, was unattended with any serious injury to passengers, the two engines obligingly coming together as before (p. 386, No. 1032); but whose fault was it? **Nun. Dor.**

### COLLIERY EXPLOSIONS.

[24491.]—COL. J. D. SHAKESPEARE, in letter 24447, has brought this subject forward with a remedy which must convince the owners of collieries that it ought to be adopted. About 12 years ago I had the twin idea: 1, to force the gas back, or, at least, to prevent it from escaping into the mines; and, 2, to suck a fire out of a room or house, or to, at least, prevent it from spreading. The first idea, which Col. Shakespeare has so ably brought forward, I did not dare to publish, because my knowledge of mines is so small that I could not see whether it were possible to carry it into practice. The second idea, to suck out a fire, was submitted by me to the Society of Arts about ten years ago, on the occasion of that society offering a prize for the best means of extinguishing fires. The idea of preventing the gas escaping into the mines was brought out in "Ours" about eight years ago, I think; but I have forgotten the name of the writer of that letter. No further correspondence ensued at the time. I hope this time, however, those of our correspondents who have sufficient knowledge of mines will come forward and give their help to try to remedy this fearful sacrifice of life. **J. H. Schucht.**

## GRINDING TOOLS FOR HAYDON'S CUTTER-BAR.

[24492.]—As I have paid some attention to this during the last few years, I shall be glad to be allowed to explain the system I have adopted. Fig. 1 is merely a sketch of a 2ft. grindstone with a hoist; Fig. 2 shows how the hoist is made. This I find much better than blocks, which have previously been recommended in the "E.M." Fig. 3 will require more explanation. It is a grinding gauge, and some care is advisable in setting it out. Get a large sheet of paper, on which make a semicircle the exact size of half your grindstone; draw a line through the centre, mark this with 0 for zero, then set out 3°, 5°, 7½°, 12°, 17°, 21° and 25½° above zero, and 9°, 10°, 10½° and 12° below it, draw in lines as dotted in Fig. 3. The parallel lines will give the height at which the tool should be ground if it is held in one of Mr. Haydon's cutter-bars properly made. A, Fig. 3, shows the gauge I use. It is made of brass. The drawing will explain itself; but when in use the end B must rest on some part of the grindstone frame so as to bring the line marked "120 steel" exactly up to the centre of the stone. Suppose an ordinary tool for wrought iron is wanted, place the gauge in position as shown in Fig. 1; put the cutter bar on the board on the top of the hoist, raise it up until the point of the tool reaches some part of X, the top of which gives 5° and the bottom 3° for relief; remove the gauge and advance the tool, but at an angle, grind one of its lower sides, bring the end of the holder round 60°, and grind another of the lower sides. You should then have a plan angle of 120°. Reverse the tool in its holder, raise the hoist until the point of the tool comes up to the gauge mark "120 iron," grind (what will be the top face of the tool) at this height; we shall then have a first-class tool for iron with cutting edges of 60—if the same tool had been ground at "120 steel" the cutting edge would have been 70, if at "120 brass," it would have been 80. This holds good with any other plan angle if ground at at its proper mark on the gauge, that is, say, plan angle of 90°, must be ground at the 90 marks.

FIG. 2

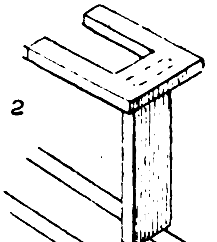


FIG. 1

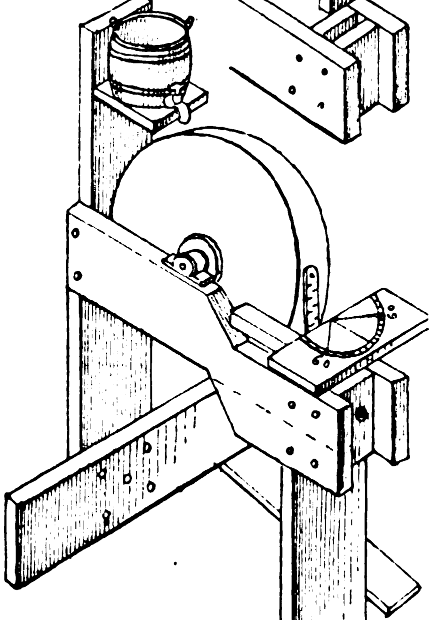
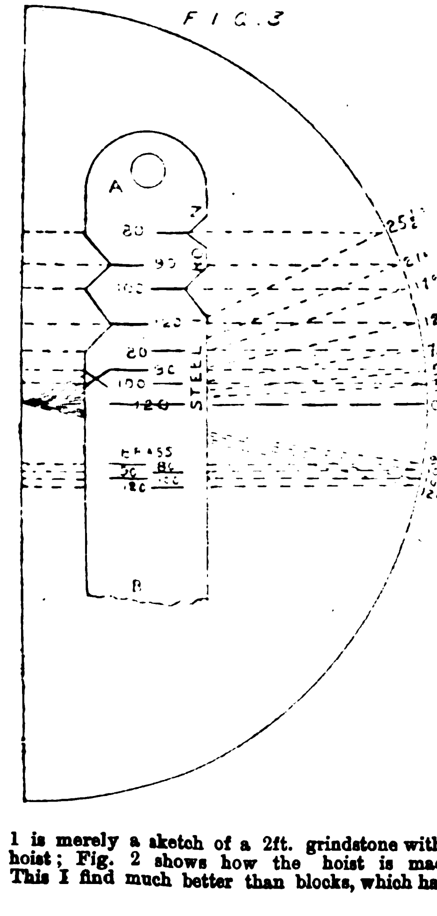
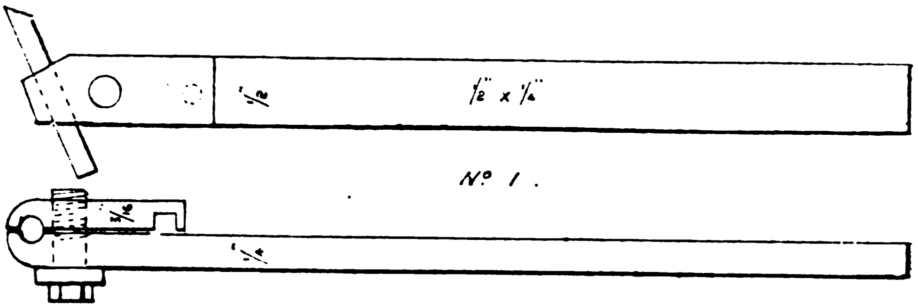


FIG. 3

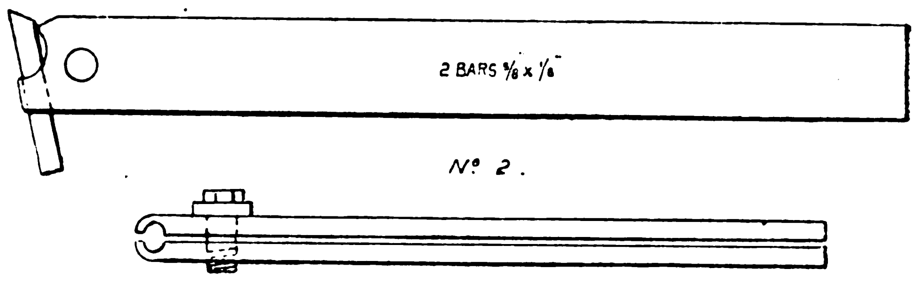


Now that "O. J. L." is giving us some articles on Mr. Haydon's double-edge system, let me advise all amateur turners in metal to closely follow his instructions, and make up their minds to thoroughly master it. For myself I can say I never go to the lathe without feeling a pleasing sensation of gratitude to Mr. Haydon, and it was with great sorrow I heard of his serious illness. For years I had been attempting slide-rest practice in metal with a small bench lathe on triangular bar. It has no back gear, and the slowest speed is two of mandrel to one of crank. My tools would grind rather than cut off a little metal. At last my attention was called to Mr. Haydon's double-edged tools and cutter-bar, and I got a set. They would not cut, and so I packed them off direct to Mr. Haydon, only asking if the fault was mine or the tools. But he went further than this, sent me several long letters, made me master of the principles of the double-edge tools, and told me how to grind. About a year after this he gave me several sheets of drawings that he had got out to illustrate the whole principle. These were intended for a book he had in hand, but unfortunately I fear unfinished. The result of his instruction is, with the same lathe I have this week removed half the metal from a ¾in. bar of iron by one trip of the tool. I never have a tool that will not cut, for they must cut. An old hand, seeing some shavings on my bench, said, "What, are you turning—lead?" This I consider the greatest compliment he could have paid to the system, except that he has since adopted it.

I wish all amateurs would give it a trial. Just a simple tool for general work at first, and it would eventually take the place of all tools for the slide-rest. **A. Atkinson.**



No. 1.



No. 2.

## SIMPLE CUTTER-BARS FOR 5in. LATHE.

[24493.]—I inclose drawings of two cutters which I have adopted after many trials. They are up to the work of a 5in. amateur's foot-lathe, and their simplicity of construction brings them within the means and tools of almost all amateurs.

No. 1 has a bar of ½in. by ¼in. steel, with a side clamp of 3/16in. by ½, gripping the cutter by a ¼in. screw.

No. 2 has a bar of two pieces, end ⅛in. by ⅝in. in size. Both held a round, square, or triangular steel Stubb's wire cutter in grooves, which are roughened or toothed by running a tap through them. The steel cutter it is well to roughen also; this may be done by indenting its sides with a cold chisel before tempering or hardening. It is not necessary to harden or temper the cutter-*bar* itself. These bars are as large as will conveniently go into the tool part of an American 5in. foot-lathe. **M.**

## DEAD-CENTRE LATHES.

[24494.]—You have, in last Friday's number, an engraving of Mr. Hampson's dead centre for lathes. Mr. Hampson's invention is 20 years old, for in 1865 my respected foreman, David Kemp, had five lathes made, four for our own use, and one for France, according to his instructions, of better construction than Mr. Hampson's, to turn two shafts in one lathe, either with dead or live centres, and the same can be seen working any day at Victoria Engineering Co., Limited, Stockport, where for this last 20 years I have worked.

**Samuel Jackson (Machine Hand).**

## AUTOMATIC MUSICAL INSTRUMENTS.

[24495.]—It is surprising that "A. S. L." (p. 412) should persist in his contradictions, when he could so easily settle the matter by examining an organette at one of the music shops, and, by referring to his back volumes, obtain other evidence. I gave chapter and verse for my statements on p. 587, Vol. XXXIX., and on p. 540, same vol., I wrote "as soon as the original inventor in America discovered that he could do better without levers, Mr. M. J. Matthews also found that his patent was worthless, and commenced the manufacture of orguinettes without levers." Orguinettes and organettes are practically identical; they are as like as two peas in their constitution. With reference to "A. S. L.'s" statement, I find on inquiry that a gentleman having those initials did receive a rough sketch of the lever action organette, but that was taken from, I believe, the only instrument of the kind that reached this country. Certainly not more than three ever came over, for the inventor soon found that levers were not only troublesome, but costly. Of course, as the orguinette was a colourable imitation of the organette, that too had levers at first, and was illustrated in No. 733. Your correspondent apparently forgets that the English Mechanic goes into all sorts of places in the habitable globe, and that it is just possible it may get into the hands of people who know more about this matter than he thinks for. At any rate, I did not write in Vol. XXXIX., nor recently, with the purpose of contradicting "A. S. L.," for I have too much to do to waste ink on that object; but I wrote because, being a humble member of the great army of English Mechanics, I wished to correct mis-statements and put the truth before my fellow-readers. The sketch, then, on which

Comparison of Tides at Liverpool and Fleetwood, for the month of June, 1885.

| Date. | Calculation. | | Observation. | | Error. | Barometer | Wind. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | ft. | in. | ft. | in. | in. | | | |
| June 1 | 25 | 4 | 25 | 1 | − 3 | 30·1 | W. | Strong; anticyclonic conditions prevail. |
| | 24 | 1 | 24 | 0 | − 1 | 30·1 | S.E. | ” ” ” |
| 2 | 24 | 7 | 24 | 4 | − 3 | 30·2 | S.S.E. | Slight. |
| | 23 | 3 | 23 | 0 | − 3 | 30·2 | S.S.E. | ” ” |
| 3 | 23 | 8 | 23 | 6 | − 2 | 30·1 | S. | Variable. |
| | 22 | 3 | 22 | 2 | − 1 | 29·9 | S. | Slight. |
| 4 | 23 | 0 | 23 | 3 | + 3 | 29·8 | S. | Slight. |
| | 21 | 6 | 21 | 7 | + 1 | 29·8 | S.S.E. | Slight. |
| 5 | 22 | 3 | 22 | 4 | + 1 | 29·7 | S.W. | Fresh to strong. |
| | 20 | 9 | 20 | 9 | 0 | 29·8 | S. | Fresh. |
| 6 | 21 | 6 | 21 | 7 | + 1 | 29·9 | Variable. | — |
| | 20 | 3 | 20 | 3 | 0 | 29·9 | Calm. | — |
| 7 | 21 | 5 | 21 | 6 | + 1 | 30·0 | S.W. | Slight. |
| | 20 | 9 | 20 | 10 | + 1 | 29·9 | S.W. | Slight. |
| 8 | 22 | 0 | 21 | 9 | − 3 | 29·8 | E.N.E. | Moderate; dominant system cyclonic. |
| | 21 | 9 | 21 | 5 | − 4 | 29·9 | E.N.E. | — — |
| 9 | 23 | 1 | 22 | 6 | − 7 | 29·9 | N.W. | Anticyclonic. |
| | 23 | 0 | 23 | 0 | 0 | 30·0 | N.N.E. | Variable. |
| 10 | 24 | 7 | 24 | 5 | − 2 | 30·1 | N.E. | Steep gradients. |
| | 24 | 8 | 25 | 1 | + 5 | 30·2 | N.W. | Wind backing. |
| 11 | 26 | 0 | 26 | 0 | 0 | 30·3 | S.W. to S. | Slight. |
| | 26 | 2 | 25 | 8 | − 6 | 30·3 | S.S.E. | Fresh. |
| 12 | 27 | 0 | 26 | 5 | − 7 | 30·3 | S.S.W. to S.E. | Variable. |
| | 27 | 5 | 26 | 10 | − 7 | 30·3 | S.S.W. to S.E. | Variable. |
| 13 | 27 | 9 | 27 | 7 | − 2 | 30·2 | S. | Light. |
| | 28 | 2 | 27 | 7 | − 7 | 30·1 | S.E. | Fresh. |
| 14 | — | | — | | — | — | — | Anticyclonic, with shallow depression. |
| | 28 | 4 | 28 | 4 | 0 | 30·1 | N.N.W. | Slight. |
| 15 | 28 | 6 | 28 | 4 | − 2 | 30·1 | N.N.W. | Strong. |
| | 28 | 1 | 28 | 0 | + 5 | 30·1 | N.W. | Fresh. |
| 16 | 27 | 10 | 27 | 6 | − 4 | 30·1 | N.E. to N.W. | Variable. |
| | 27 | 1 | 27 | 3 | + 2 | 30·0 | N.N.W. | — |
| 17 | 26 | 10 | 26 | 7 | − 1 | 29·9 | N.W. to W. | Slight. |
| | 25 | 9 | 25 | 9 | 0 | 29·9 | W. | — |
| 18 | 25 | 8 | 25 | 10 | + 2 | 29·9 | S.W. | Fresh to strong; cyclonic. |
| | 24 | 4 | 24 | 10 | + 6 | 29·8 | S.W. | Increasing. |
| 19 | 24 | 2 | 25 | 3 | +13 | 29·7 | S.W. | Fresh to strong. |
| | 23 | 1 | 23 | 7 | + 6 | 29·6 | S.W. | Strong. |
| 20 | 23 | 1 | 24 | 0 | +11 | 29·5 | S.W. to W.S.W. | Strong to gale. |
| | 22 | 0 | 23 | 0 | +12 | 29·4 | S.W. | Strong; bar. low. |
| 21 | 22 | 2 | 22 | 7 | + 5 | 29·6 | N.W. | Strong; cyclonic. |
| | 21 | 8 | 22 | 2 | + 6 | 29·8 | W.N.W. | Strong. |
| 22 | 22 | 0 | 22 | 3 | + 3 | 30·0 | S.S.W. | Fresh to strong. |
| | 22 | 0 | 22 | 10 | +10 | 29·9 | S.W. | Strong. |
| 23 | 22 | 6 | 22 | 2 | − 4 | 29·9 | S.S.W. to S.E. | Variable. |
| | 22 | 9 | 22 | 11 | + 2 | 29·9 | N.N.W. | — |
| 24 | 23 | 0 | 23 | 0 | 0 | 29·9 | N. | Slight. |
| | 23 | 8 | 23 | 8 | 0 | 29·9 | Calm. | — |
| 25 | 23 | 10 | 23 | 10 | 0 | 30·0 | N. | Slight. |
| | 24 | 5 | 24 | 2 | − 3 | 30·0 | N.E. | Slight. |
| 26 | 24 | 1 | 23 | 6 | − 7 | 30·1 | N.E. | Fresh; anticyclonic conditions supervened suddenly. |
| | 24 | 11 | 24 | 6 | − 5 | 30·2 | N.E. | |
| 27 | 24 | 6 | 24 | 0 | − 6 | 30·3 | N.N.W. | Moderate. |
| | 25 | 6 | 25 | 0 | − 6 | 30·3 | N.N.E. | — |
| 28 | 24 | 11 | 24 | 4 | − 7 | 30·2 | N.N.E. | Slight. |
| | — | | — | | — | — | — | — |
| 29 | 25 | 9 | 25 | 5 | − 4 | 30·0 | N.W. to N. | Slight. |
| | 24 | 11 | 25 | 1 | + 2 | 30·0 | — | — |
| 30 | 25 | 9 | 25 | 3 | − 6 | 30·0 | N.N.W. | Variable. |
| | 24 | 8 | 24 | 0 | − 8 | 30·0 | N.N.E. | — |

"A. S. L." has relied, referred to the original organette, as first made; but it was certainly not made on a commercial scale with levers. The discovery that perforated paper did "as well" (I am not going to argue that point again), soon settled the levers, and as the orguinette was simply a copy of the organette, of course its levers were abolished too. If "A. S. L." had access to the patent cases tried before the U. S. Commissioners (McTammany *v.* Matthews, and Others) he would have indisputable evidence of the truth of the statements made.

**Gray's Inn.**

## COMPARISONS OF TIDES AT LIVERPOOL AND FLEETWOOD.

[24496.]—The results obtained for the month of June at Fleetwood have been tested with those obtained at the self-registering tide-gauge on Helbre Island, the datum-line of which differs usually by a foot from that placed on George's Pier, the reason being that the tides usually rise a foot higher at the latter station than at the former in consequence of the situation being less exposed. The weather conditions have been very variable, and the barometer has made large oscillations. In consequence of this the surface of the ocean has been far from level, and the difference has been noticeable even at places not remote from each other. Simultaneous observations of this kind, though difficult to be made, show how susceptible the surface of the sea is to slight changes of barometric pressure, so that, unless the range of tide is considerable, it is simply impossible to eliminate the effects of it. At Liverpool and Fleetwood this is accomplished without much difficulty, as no other ports have a more advantageous range of tide, and the height of water to be expected over the dock sill can alone decide the question whether at any particular date a ship is to reach her berth.

**James Pearson, M.A., F.R.A.S.**

Fleetwood, July 8th.

## WATER ANALYSIS — MANUFACTURE OF ALUMINIUM—WILLESDEN CANVAS — PYROLOGY — MINERAL SPRINGS NEAR LONDON.

[24497.]—"Cambrian," in query 56993, headed "Water Analysis (Qualitative)," asks for "a simple process whereby a sample of water can be tested qualitatively for sewage contamination and other impurities." Unfortunately, no thorougly satisfactory test of the sort exists or is likely to be devised. Besides, it is only by a quantitative application of a number of tests and a careful interpretation of their indication that a reliable diagnosis for sewage can be effected. For instance, in pure inland waters, not in the vicinity of salt beds, only very trifling proportions of common salt (chloride of sodium) are to be found, two grains per gallon of the water being about the maximum. But if a well water be contaminated with urine or similar impurity, the proportion of salt in the water will be considerably increased, and may rise to 30 or even 50 grains per gallon. In the case of ordinary town sewage, the proportion of salt is usually about 15 to 18 grains per gallon. Now it is clear that to detect the presence of salt proves nothing, but if the proportion be sensibly in excess of two grains per gallon, the water should be looked on with suspicion. Taken alone, however, the presence of an unusual proportion of common salt is usually insufficient to prove contamination, as it may have a perfectly innocent origin. If, however, the proportion of common salt in the unpolluted wells of a district be perfectly well known, a comparatively slight increase on the normal proportion will afford strong evidence of contamination. Again, fresh sewage contains a notable proportion of ammonia, which may be readily recognised by "Nessler's test"; but filtration through a very few feet of well aërated and porous soil will suffice to destroy the whole of the ammonia and oxidise it to nitrites and nitrates, though the water is probably little less dangerous than at first. Hence to ignore the evidence afforded by the presence of abnormal proportions of nitrites and nitrates in a water is extremely shortsighted. One of the "simple tests" which is repeatedly recommended is to "add a few drops of a solution of permanganate of potassium to a glass of the water, and note whether the violet colour of the reagent is destroyed." But nothing is usually said as to the strength of the permanganate solution, the exact number of drops to be used, or the quantity of water to be employed, and unless these conditions are prescribed and adhered to, the test has no practical value. Besides, a water from a shallow well may have had its sewage matter fairly well oxidised and destroyed during dry weather, but when a spell of rain comes the pores of the soil get filled up, oxidation can no longer occur, and the character of the water is changed materially for the worse. The hardness of water can be ascertained by a fairly simple process based on the addition of a solution of soap of known strength until a permanent lather is obtained. Details of the method are given in almost all books treating of quantitative analysis. Church's "Laboratory Guide," published by Van Voost, is the one I should recommend the querist to obtain.

The method described by "P. E. W.," on p. 418, in reply to query 56949, is not a process for the "Manufacture of Aluminium," and Webster's so-called "improvements" do not appreciably affect the price of the metal. They simply refer to the preparation of alumina, and the problem of reducing this cheaply to metallic aluminum is left exactly where it was.

"Willesden Canvas" (query 56989, p. 419) is prepared by passing ordinary canvas through a solution of oxide of copper (and zinc) in ammonia. This liquid has the property of dissolving cellulose, depositing it again on exposure to the air. The exterior of each fibre becomes agglutinated and is rendered completely waterproof and incapable of rotting. Paper of all kinds can be similarly prepared. By passing several sheets together through the cupric solution, and then between rollers, they become firmly united, and sheets of any thickness and as hard as teak can be obtained in this manner. The Willesden fabric appears especially suitable for constructing light buildings, tents, canoes, &c., and is also of service for foreign letter-paper and envelopes and probably for wrapping goods. It has more or less of a greenish colour owing to the copper it contains, but, in my opinion, the tint rather adds to its appearance. A recent visit to the Willesden works impressed me very favourably with the material, which appears capable of extended and very varied application. "K." should remember that the Willesden process is patented and very jealously guarded.

I have read with interest the letter on "Pyrology" (No. 24451, p. 412), as I do all the communications of Colonel Ross. He has shown so much patience and industry in working out blowpipe methods and devising new apparatus, that anything on the subject from his pen is certain to attract attention. On the other hand, I must protest against the accusation made by Col. Ross that any *animus* on the subject prevails amongst many English chemists. Chemists are only too glad to have useful additions made to their methods and tools, and if the processes of Col. Ross have not in all cases met with general adoption, he is himself largely responsible for the result. To give one instance, he complains of the scepticism of a "well-known London chemist" as to the constancy of composition attributed by Col. Ross to his ball of calcium borate. I fully agree with the unnamed chemist, that Col. Ross has never proved his case, although a few days' work would have sufficed for the purpose. It is, I believe, a fact, and if not *still* true Col. Ross will correct me, that the alleged constant composition of the ball has only been proved by operating in the blowpipe on 20 to 30 milligrammes of material. When Col. Ross has operated on reasonably large quantities in a platinum crucible, has definitely analysed the ball and the surrounding boric acid by processes the accuracy of which is generally accepted, and has published the results in the ordinary manner in some scientific journal, or before some society *competent to* criticise them, chemists will have their *attention* seriously directed to the matter; but while Col. Ross contents himself with arguing in a circle, and using new processes of unacknowledged adequacy to prove the truth of doubtful statements, so long are chemists likely to consider his case "not proven," and it is not to be expected that they will themselves go deeply into a matter which specially concerns Col. Ross, while he himself appears to be content to scratch the surface. I think Col. Ross does his unnamed correspondent an injustice in his attempted parody of his arguments, and, as Col. Ross appears to think it improbable that the publication and criticism of his letter will come to the writer's knowledge, I may remark that if the person who first observed the precipitation of silver nitrate by hydrochloric acid had neglected to prove the absence of silver in the mother-liquor, he would have neglected a precaution which would be obvious to most people.

Of the "Mineral Springs in or near London" (query 56975, p. 397), the majority have long been closed. The site of the old wells at Epsom was still pointed out twenty-five years ago, the Beulah Spa Gardens at Upper Norwood were closed thirty years ago, and, I believe, a swimming bath is still supplied by Bagnigge wells; of the Kensington spring I know nothing. Epsom wells yielded a water containing a notable quantity of magnesium sulphate, whence the name of "Epsom salts."

Sheffield, July 11. **Alfred H. Allen.**

## RAILWAY-SIGNAL RETURNS.

[24498.]—The Board of Trade returns relating to the railway-signal arrangements and systems of working on the 31st of December, 1884, have recently been issued, the details being given under two headings—(1) The interlocking and concentration of signal and point levers; (2) the systems upon which the lines are worked relating to the block system, &c.

The details are minute and voluminous, but the facts can be gathered from the following tables: No. 1 shows that the levers require "concentration" in 5,389 cases and "interlocking" in 5,189 instances; also, that no less than 3,130 pairs of "safety points" are requisite. From table No. 2 it will be seen that the total length of line open for passenger traffic was 17,933 miles, of which 13,822 miles were worked on the absolute block system. There are 366 miles of single railway upon which only one engine at one time, or two coupled together, are allowed: thus leaving a balance of 3,735 miles which are still worked upon inefficient principles and require the introduction of the absolute block system.

Summary No. 1.

| | Number of cases in which any passenger line is connected with, or crossed on the level by | | | | Number of cases in which the usual requirements of the Inspecting Officers of the Board of Trade have, or have not, been complied with in the following respects:— | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Any other passenger line. | Any goods line. | Any siding. | Any cross-over road. | Concentration of signal and point levers | | Interlocking of signal and point levers. | | Addition of safety points in case of goods lines and sidings. | |
| | | | | | Have | Have not | Have | Have not | Have | Have not |
| England and Wales | 3,861 | 1,336 | 17,292 | 6,499 | 25,916 | 3,072 | 26,089 | 2,899 | 16,867 | 1,761 |
| Scotland | 729 | 213 | 3,102 | 991 | 3,797 | 1,238 | 3,763 | 1,272 | 2,628 | 687 |
| Ireland | 385 | 76 | 1,194 | 277 | 853 | 1,079 | 914 | 1,018 | 588 | 682 |
| Total United Kingdom | 4,975 | 1,625 | 21,588 | 7,767 | 30,566 | 5,389 | 30,766 | 5,189 | 20,083 | 3,130 |

Summary No. 2.

| | Total length of Railway opened for Passenger Traffic. | | Distance worked on the absolute Block System. | |
|---|---|---|---|---|
| | Double | Single | Double | Single |
| | Miles. | Miles. | Miles. | Miles. |
| England and Wales | 8,451½ | 4,187¾ | 8,025½ | 3,170 |
| Scotland | 1,130 | 1,647½ | 1,067¾ | 1,113 |
| Ireland | 591¼ | 1,925½ | 141 | 314¾ |
| United Kingdom | 10,172¾ | 7,760¾ | 9,234¼ | 4,597¾ |
| Total | 17,933½ | | 13,832 | |

**Clement E. Stretton,**
Leicester, July 4. Hon. Mem. A.S.R.S.

## SHORT-FOCUS REFLECTOR.—TO MR. WASSELL AND OTHERS.

[24499.]—Is there any inherent reason why a very short-focus mirror, say four or five times the aperture, if known to be truly parabolic, will not perform well as a Newtonian? May it not be that the very short focus mirrors that have not performed well were of improper figure? I have recently experimented with a 5in. mirror of only 25in. focus and with good results. Is it not, therefore, safe to attempt a 20in. mirror with a focus of 80in. or 100in.? What is the shortest focus Newtonian known of large aperture? With no chromatic error to trouble us, I do not see why a mirror of perfect figure should not give good results with very short focus. I found it easy to parabolise the short 5in.

**B. R. W.**

## THE CALORIE, OR FRENCH THERMAL UNIT.

[24500.]—Ch. Rabache, in letter 24396, page 365, has fallen into error as to the relative values of degrees Centigrade and degrees Fahrenheit. "Tubal Kain's" statement is correct: 1° C. = 1·8 F. But before converting degrees F. into degrees C., it is necessary to deduct 32 to reduce the F. scale to the same datum as the C. scale. As an example, take the common expression: "There were 8° of frost last night"—meaning the F. thermometer registered 24°; which, deducting 32, gives − 8° F. Convert these − 8° F. by "Tubal Kain's" value, and we have − 4·4° C., which is correct.

**Libra.**

## CURVES OF LARGE RADIUS.

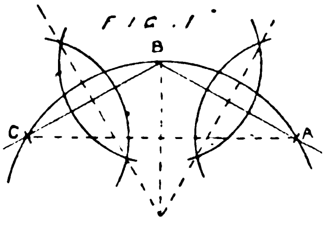
[24501.]—I have been asked by some of our friends to describe the way which I suggested to obtain "curves of large radius" sent in answer to a question which appeared some time since in "Ours." Should the Editor consider the description of sufficient general interest I am pleased to offer it.

In the geometrical problem, "three points being given, to find a circle that will pass through those points," if the given points are equidistant, and we find how much they differ from a straight line, we actually find the height of the arc of a circle required to pass through them.

I argued from this, if the angle made by the points be fixed, and this fixed angle be made to pass over the two end points A C, Fig. 1, the angular point will describe the circle; that is, it will pass over every point in the path of the curve sought.

We have thus the principle of an instrument as Fig. 2. We can fix it at any angle by the screw S working in a circular slot, and it has an adjustable pen supported by two points as a hinge to fall in the centre of the open hinge H (which is equal to the point B, Fig. 1). We are with it able to describe any curve, when we know the height of the arc required. To more accurately find this centre when adjusting the instrument, a cell was made to fit in the circle H, having a glass bottom, on which was drawn fine lines crossing at its centre. These crossed lines can therefore be made to cover any point found, which is the height of the required arc. The cell being afterwards removed, the pen can be adjusted to fall on the same point that was covered by the cross lines.

FIG. 1



To measure the height of arc correctly to the third place of decimals:—On a stretched length of paper draw a straight line, say 7ft., and on the line fix two pins 6ft. apart; on the point of bisection between the pins raise a perpendicular, and divide this perpendicular into inches and tenths of an inch, numbering them upwards. Have the two rules as in Fig. 3. On the lower one, D, a scale is graduated from its centre towards the left hand 10in. long, divided in inches and tenths. The upper one, E, has its upper edge as thin as possible, and the distance between the pointers marked on it is 10in. At one pointer this rule is $\frac{9}{10}$ of an inch wide, and at the other pointer $\frac{10}{10}$, or one-tenth wider than the other. It will be seen, therefore, that every inch the first pointer on rule E slides over rule D, the upper edge rises at the starting point $\frac{1}{100}$ of an inch, and every $\frac{1}{10}$ of an inch on rule D the pointer passes, the upper edge rises $\frac{1}{1000}$in. To measure, therefore, the height of arc on the graduated perpendicular line, the inches and tenths are first found on that line; the pointer at the upper edge of rule E is then placed on that tenth, which is the first decimal; the rule E is then slid along the rule D; the pointer at the inches marks the second decimal, and at the tenths of the next inch the third decimal. The upper edge of rule E will then show on the perpendicular the height of the arc

FIG. 2

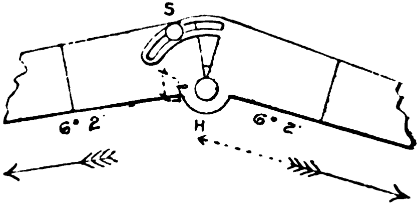


FIG. 3

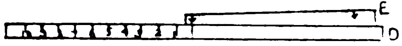
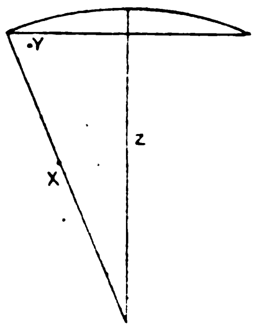


FIG. 4



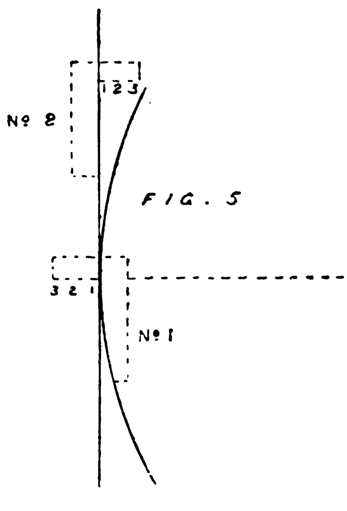


FIG. 5

required. The accuracy of the result will depend on the accuracy of manipulation.

When the height of arc is thus found, the instrument must be adjusted correctly to that point by the cross lines on the cell, and the circle described by passing the instrument from one point to the other, A to C, Fig. 1.

The table of heights of arc was calculated thus: (Euclid, Book I. Prop. 47.) The square upon the side subtending a right angle is equal to the sum of the squares of the other sides. Therefore, in Fig. 4, subtracting the square of the side Y (which is half the chord of the arc) from the square of the radius X will leave as remainder the square of the other side, Z. The root of this deducted from the radius X will leave the height of the arc for that radius. This was done for each radius to form the table.

TABLE SHOWING THE HEIGHTS OF ARCS FOR EVERY FOOT RADIUS BETWEEN 5FT. AND 100FT., THE CHORD OF ARC BEING ALWAYS 6FT.

| Radius in Feet. | Height of Arc in inches. | Radius in Feet. | Height of Arc in Inches. | Radius in Feet. | Height of Arc in Inches. | Radius in Feet. | Height of Arc in Inches. |
|---|---|---|---|---|---|---|---|
| 5 | 12 000 | 29 | 1·867 | 53 | 1·020 | 77 | ·702 |
| 6 | 9 645 | 30 | 1·804 | 54 | 1·000 | 78 | ·692 |
| 7 | 8·104 | 31 | 1·742 | 55 | ·982 | 79 | ·684 |
| 8 | 7 005 | 32 | 1·690 | 56 | ·964 | 80 | ·675 |
| 9 | 6·176 | 33 | 1·639 | 57 | ·948 | 81 | ·667 |
| 10 | 5·527 | 34 | 1·591 | 58 | ·931 | 82 | 658 |
| 11 | 5·004 | 35 | 1·545 | 59 | ·915 | 83 | ·650 |
| 12 | 4·572 | 36 | 1·502 | 60 | ·900 | 84 | ·643 |
| 13 | 4 210 | 37 | 1·463 | 61 | ·885 | 85 | ·636 |
| 14 | 3·909 | 38 | 1·423 | 62 | ·871 | 86 | ·628 |
| 15 | 3 636 | 39 | 1·387 | 63 | ·858 | 87 | ·620 |
| 16 | 3·396 | 40 | 1·352 | 64 | ·844 | 88 | ·614 |
| 17 | 3·201 | 41 | 1·318 | 65 | ·831 | 89 | ·607 |
| 18 | 3·021 | 42 | 1·287 | 66 | ·818 | 90 | ·600 |
| 19 | 2·859 | 43 | 1·257 | 67 | ·806 | 91 | ·593 |
| 20 | 2·715 | 44 | 1·228 | 68 | ·792 | 92 | ·586 |
| 21 | 2 584 | 45 | 1·201 | 69 | ·783 | 93 | ·580 |
| 22 | 2 466 | 46 | 1·174 | 70 | ·771 | 94 | ·574 |
| 23 | 2·358 | 47 | 1·149 | 71 | ·760 | 95 | ·568 |
| 24 | 2·258 | 48 | 1·122 | 72 | ·750 | 96 | ·562 |
| 25 | 2·168 | 49 | 1·102 | 73 | ·740 | 97 | ·556 |
| 26 | 2·084 | 50 | 1·081 | 74 | ·729 | 98 | ·550 |
| 27 | 2·006 | 51 | 1·059 | 75 | ·718 | 99 | ·545 |
| 28 | 1·934 | 52 | 1·039 | 76 | ·710 | 100 | ·540 |

To find the parabolic curve for a long focus:—As the parabola is "a curve whose path is equidistant from a fixed point and a fixed straight line," at the centre of the curve the two distances meet at that point. Draw, therefore, the straight line (the directrix) at that point, and, touching that point, draw with the instrument a curve with a radius equal to the distance of the focus of the desired parabola; we have then only to deal with the path of the remainders of the distances. This will be immediately appreciated by the following suggestion:—

Fig. 5. Make two thin cardboard templates, one to the curve as No. 1 in the figure, the edge graduated to the left, and another graduated to the right as No. 2. By making these overlap and pass along, the one on the directrix and the other on the curve, as they can be easily made to do guided by two small pins placed on the lines and on the curve, wherever the distances coincide on the two graduated edges will be a point in the required parabola. From these points the parabola can be drawn.

I trust this description is clear. The instrument would be useful to surveyors and civil engineers, and could of course, be made on a smaller scale, and a table calculated to a shorter chord. This one was made to fulfil the conditions required in the "E. M." J. S. B.

## AUTOMATIC MUSICAL INSTRUMENTS.

[24502.]—I HAVE read with the greatest interest the letter from Mr. F. H. Wenham, describing his appliance for playing the piano, and, being myself subject to attacks of *automatic fever*, should very much like to have a little further information.

Would it be encroaching too much on Mr. Wenham's good nature to ask for a drawing and description of the principal action? His idea seems to solve the difficulty of making at once a portable and effective substitute for a pianist, and one in which the command of piano and forte passages are well under control. The music, too, being of cartridge paper, can be made very cheaply. My arrangement for cutting cards, described in the "E. M." some time since, will cut easily six thicknesses of cartridge paper, and not being hinged, like the card music, it could be made at less than one-fourth the cost, or something like 6d. per yard.

I have heard and read vague rumours of a company called the "Miranda Pianista Company"; but can anyone tell me if there is such a company, or is it but "the hare-brained chatter of irresponsible frivolity"? Rook.

## USEFUL AND SCIENTIFIC NOTES.

**The Patent Office.**—The Comptroller-General of patents, designs, and trade marks, issued the other week in the form of a Parliamentary paper his report, the second since the passing of the Act of 1883. That the new Act has worked well in the interest of inventors may be seen from the fact that the number of applications for patents, which had risen with some variations, almost constantly in the course of 30 years, from 1,211 in the year 1852, to 6,241 in 1882, leaped with a bound to 17,110 in 1884. There was a slight depression in 1883, possibly on account of the change of the law, which makes last year's numbers the more remarkable. The increase is in fact as between the years 1883 and 1884, no less than 195 per cent. Seventy-nine per cent. of the applications were made by persons resident in the United kingdom, namely 12, 356 being residents in England and Wales, 901 in Scotland, and 254 in Ireland. Of the rest the largest numbers were from the United States, 1,181, from Germany 890, and from France 788. Residents from 27 other countries also made application to the office, 13 such countries being British possessions, from which 175 applications were made, and three, it my be added, were made from Egypt. Only three appeals were made in the course of the year against the decision of the Comptroller, so that it may be taken that his decision is almost invariably satisfactory to applicants. The greatest number of applications made in any month was in January, 2,499; the smallest in August, 992. The greatest numcer made in any single day was, as might be supposed, on January 1, 266. The total number of patents sealed upon the 17,110 applications will not be known before next year. The number of readers who frequented the Free Library of the Patent Office in 1884 was 39,508, as against 32,748 in the previous year. Sets of the publications of the office have been sent to 46 towns, to a large number of public offices, and seats of learning in the United Kingdom; to nine British colonies, and to nine foreign States. Complete series of abridged specifications have also been sent to nearly 280 mechanics, literary and scientific institutes in various parts of the United Kingdom and the United States. The number of designs registrated in 1884 was 19,515, as compared with 17,166 in 1883; and the number of trade-marks applied for was 7,104, to 4,105 in 1883. The receipts of this office amounted to £103.827, of which £88,996 was for patents' fees, £3,477 for designs' fees and stamps, £7,014 for trade-marks' fees, and more than £4,000 for the sale of publications. The chief payments made were £36,225 for salaries—all of which are set forth in detail in the report—and £17,000 to Messrs. Eyre and Spottiswoode paid for printing. There was a surplus income of nearly £40,000. Tables are added showing the different classes of designs and trade-marks, with the fees paid for each.

**Interior Temperature of the Earth.**—The German Government is having a deep shaft sunk near Schladebach, with the object of obtaining various kinds of scientific information, and especially trustworthy data concerning the rate of increase of the earth's temperature as we descend into the interior. The excavation is being carried on by a diamond-tipped borer driven by water. So far back as the beginning of this year the shaft had reached the depth of 1,392 mètres, which is believed to be the lowest depth yet reached by boring. The temperature at successive stages is ascertained by an ingenious instrument which serves as a special thermometer, the principle of construction being the fact that as the heat increases the mercury will expand so as to flow over the lip of a sufficiently short open tube in greater and greater quantities. The measurement of the differences of those overflows will give the rate of increase of the temperature. It has been ascertained that the temperature at the depth of 1,392 mètres was 49deg. centigrade, or 120deg. Fahrenheit. If the temperature increases regularly at this rate, the boiling point of water ought to be reached at a depth of 3,000 mètres, and at 75 kilomètres we should find the heat at which platinum melts. This would go to show that the earth's crust cannot be more than one-ninetieth of its radius.

**How to Become a Successful Amateur Photographer.**—Messrs. Lancaster and Son have just issued the tenth thousand of their sixpenny handbook, "How to Become a Successful Photographer." Every amateur who does not already possess it should obtain a copy. The directions are so clear and comprehensive, and the size so handy, that nothing is left to be desired.

## REPLIES TO QUERIES.

*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[56061.]—**Vapour Density.**—I hope M. Ch. Rabache will not deem me discourteous when I say that I must decline to enter into a discussion on this subject with him. He is evidently to chemistry very much what Mr. Hampden is to astronomy—a paradoxist of a very pronounced type, with whom argument is useless. I have a lively recollection of the letters, five-and-twenty pages long, with which he favoured me some years ago.—WM. JOHN GREY, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[56314.]—**Strength of Gear Wheels.**—To "GLATTON."—I do not want the weight to swing at the end of a lever, but probably I ought to have said hang, as it is to be, so as the chain or rope may nearly touch the roller it is wound upon; it is to be raised slowly.—C. B.

[56439.]—**Separating Potash and Magnesia (U.Q.)**—Potash and magnesia cannot exist together in solution. If the barrel contains only a little water, it will be better to add sufficient, and then filter. The potash will be dissolved, and will pass through the filter. Evaporate the filtrate, and the potash will be recovered. Well wash the precipitate on the filter (adding the washings to the potash solution), dry, and ignite.—ALTO PETIT.

[56440.]—**Warnerising (U.Q.)**—It consists in treating cloths with a specially-prepared oil. As well as I can now remember, this oil is a hydrocarbon oil from which the free acid has been removed by distillation. Full particulars will be found in the specification at the Patent Office, taken out, I think, in the name of Mrs. Eliza Warner. At the time I took a note of the number of the patent, but cannot at present lay my hands on it. Should "R.M." require it, and state so, I shall search further for him with pleasure.—ALTO PETIT.

[56500.]—**Gravity Leclanche Batteries.**—The querist will find a drawing of same, with remarks on its working, in Roberts's lecture on "Batteries" in Vol. VI. of the *Journal* of the Society of Telegraphic Engineers, page 257. Should he be unable to see the book, if he will advertise his address, I will send him a tracing with pleasure.—ASSOC. SOC. TEL. ENGS, Birmingham.

[56606.]—**Ink for Rubber Stamps.**—I notice one or two slight misprints in my reply last week (p. 415). "Buryed" should be "brayed" (i.e., "thoroughly incorporated"). Also water-*glue* should be water-*glass*.—PERCY W. STANLEY, 119, Manchester-road, Poplar, E.

[56620.]—**Steam-Carriages.**—I have seen the steam tramway locomotives to which Mr. E. F. Baker refers, p. 415. I even took stock of the line while it was being laid: it is, I believe, the first to be worked regularly in London; but though London is a big place, it is not the United Kingdom, and there are as good arrangements to be seen in the "provinces," as they are called. But steam tramways have nothing to do with steam carriages. "Progress No. 3" (wonder if this is the original "Progress") thinks that "other people" will dub him crazy when he says he is preparing to build a train of five vehicles to be propelled by the pistons' direct pressure on the road, such pressure being obtained from the explosion of gas to be ignited by electricity. I should imagine that "Progress No. 3" has formed a correct opinion of what "other people" will think of his scheme; but then I studied the rudiments of mechanics some years ago, and no doubt they are much improved. By the way, I am not quite sure that the notions of "Progress No. 3" are new; but I am sure that "ridicule" would be utterly wasted on them—at all events "until our ideas are better comprehended."—NUN. DOR.

.[56620.]—**Steam-Carriages.**—In connection with this subject, I would refer to "B. B." (24455, p. 412) on "Crank Axles," in which he speaks of the usual practice of each pair of wheels being fixed in rigid connection with its fellow. In my sketch of a train carriage on p. 415, I mention its capability of easy turning, which is obtained by each wheel working quite independent of others, and turning on the bearing point of the tire, the load resting on a pivot over each wheel; it will then turn in any direction with the greatest ease. This avoids the use of any axletree as at present used; but whether the wheel should revolve on the spindle, or be fixed and revolve on side bearings, is left for after determination. I should also avoid steel-plate springs, such being often a great source of noise. E. F. Baker, p. 415, in stating that tramway locomotion is done daily "on" common roads, I suppose him to mean the tramway is laid on the road, but the locomotion of the engine and cars takes place by trammelled wheels "on" grooved iron rails, and my contention is that on a hard level surface and speed under ten miles per hour, the flat-tire vehicle has 25 per cent. advantage over the flange and groove system. Much information on this subject is contained in "Tramways: their Construction and Working," by Mr. D. K. Clark, two vols., price 30s. As to horse-labour for tramways, p. 261 says, "that the life of a horse is four years on tramway service, and four and a half years on omnibus service." Page 263 reads "The proportional number of carcases and living horses sold by one company during one year was 1,208 carcases and 676 living horses, showing that two-thirds of the horses that were sold either died or were worn out in the service, and that a third were sold as only fit for agricultural work—too weak, or afflicted with bent knees." The number of horses "used up" in London (only) is supposed to range between 400 and 500 per week, or between twenty and twenty-five thousand per year; and yet we call this a Christian country—but the horses would say, Where are the Christians? On p. 351 is an account of experimental proof of the tractional resistance of a tramcar in France. The length of line traversed was a third of a mile, on a level, at 7½ miles per hour. The removal of two flanges was accompanied by a reduction of the tractive resistance by one-third. Encouraged by the results, another flange wheel was removed, running the car with only one flanged wheel and three flat-tire wheels; the result was that the resistance was reduced a half as compared with the original car with four flanged wheels. The comparative difference in cost of motive power on tramways is shown on p. 417 as 4d. per mile run for steam motive power, as against 7½d. the cost for horse power; other accounts say 5d. per mile for steam, against 9d. for horse power. In a late prospectus of the North London Tramways Company, they state they have 15 steam-engines of an approved type in course of delivery. The Croydon and Norwood Tramways Company is to be worked by a fireless locomotive, under the Dusseldorf system. It is said the engine can be driven up a gradient of one in twelve and a half with nine tons behind it with ease. Some of the advantages to be gained by using mechanical power on iron bearing can be reckoned by taking the average cost and work done by one horse during one week on macadam road, the cost of the horse being 20s. per week of six working days, or 3s. 4d per day of eight hours at three miles per hour. During the eight hours he will draw a load of one ton weight for a distance of 20 miles equal to 2d. per ton per mile, and by using mechanical power at one-half less cost, it would reduce the charge to 1d. per ton per mile; then, by use of the iron rail, the cost of the same work would be again reduced three-fourths, making a total reduction in cost of motive power for either goods or passengers of 87½ per cwt. Pedal power machines on iron bearing, where gradients are slight, would carry a load of 8 to 10 cwt, without any charge for motive power, the driver himself propelling the machine. If any reader of "E M." can detect an error in my statements, and will point it out, I shall be pleased to "sit corrected." —PROGRESS (4).

[56650.]—**Lead Burning.**—I have used Brigg's patent soldering and lead-burning machine repairing large bilge pipes of telegraph s.s. *Minia*, and may say there is no zinc or vitriol required, and cannot be damaged, as its working parts are all protected, and no gas can escape, as it only generates gas when in use, and then enough heat can be got to burn any lead or melt solder for any size of plumbers' wiped joint or braze ¼in. steel telegraph wire or expand cable links, or iron nuts for engineers, and has been strongly recommended for economy, safety, and cleanliness.—WM. MAN.

[56650.]—**Lead Burning.**—Referring to the repeated correspondence appearing in your journal for the last four years between plumbers and lead-burners, and finding that one of your correspondents in your issue of July 10th has referred to our patent machine, as shown at the International Inventions Exhibition, Stand 220, South Gallery, North Court, we would thank you for the information of the trade to take notice of a few particulars relating to the same. In the first place, under the present system spelter and acid are required to generate the gas, when an air-pump or bellows is required to force it to burn the lead, with two tubes running into one with regulating cocks; this machine is more or less dangerous, the flame being liable to run back. We have seen more than one accident happen by the machine exploding. It is more than twenty years since we commenced working one of these machines, and by repeated experiments for the last four or five years have succeeded in making a machine which requires no acids or spelter, neither does it require any attention when at work, for when it is charged the gas does not generate until the pump is set at work. The machine consists of one cylinder and only one tube and blow-pipe, with regulating cocks which may be left open without the gas escaping, and is ready to burn lead from 4lb. to ¼in. thick at any moment, or to make plumbers' wiped or other joints without the use of forge or heated irons, and may be carried anywhere, not being heavy. It is particularly noted that the flame is perfectly clean and dry, and does not discolour the work. We have many testimonials from engineers testifying as to its superiority over the old system as far as safety, cleanliness, and economy are concerned. Knowing Mr. Davies to be a thoroughly practical engineer, we should esteem it a favour if he would view our exhibit at the Inventions and give his opinion of the same through the columns of your valuable journal.—BRIGGS AND CO., 58, Rokeby-street, Stratford, London, E.

[56676.]—**Free Reeds.**—The reply furnished on p. 393 to this query might well be added to the list of instances in which "presumption" follows "ignorance." I consider it, therefore, my duty to point out the misconception of "G. L. B." on p. 393. If "G. L. B." will refer to the original query, which appears on p. 157 (query No. 56400), he will soon discover the mistake he has made with regard to the exact requirements of the querist. The querist there asks distinctly, "How can I tune reeds?" and evidently does not merely require to know how to bring or file reeds up to a standard pitch. What on earth is the use of telling a private individual how to file reeds up to pitch, when that has already been done before they (the reeds) are purchased? May I also ask "G. L. B." of what use is the employment of a flutina bellows, as suggested in query No. 56676, for the purpose of tuning reeds? In the pages of "Ours," at least in musical matters relating to keyboard instruments, we want more practical information and less theoretical humbug and misconception, both with regard to queries and replies. Some queries are so thoughtlessly worded, and carelessly arranged, that a reply, or replies, of a somewhat similar character are bound of necessity to follow as a natural consequence. "G. L. B." may now learn that the querist does not require to know how to file reeds to pitch, but how to tune reeds. This I am fully aware of, in consequence of a private letter which I have received from the querist, and to which I replied by post. The query, No. 56676, which is addressed to me, was sent to the Editor for insertion afterwards, and the querist in this instance also changed his title, a fact which may partly account for "G. L. B.'s" misconception. The foolish ideas referred to by me in my last reply is simply the querist's notions of being able to tune reeds by the aid of a flutina bellows, as expressed in the query, combined with ideas equally absurd which were expressed in his private letter, and which are at present unknown to "G. L. B." I trust this explanation will suffice.—G. FRYER.

[56679.]—**Supported Beam.**—If in a uniformly loaded beam there is a shearing action at the centre, will "Bacchus" say what this shearing force is in terms of the load? Is the "correct answer" the one which the examiner expects to receive, any other being rejected? If so, the question is simply a catch.—J. S. C.

[56703.]—**Algebraical Problem.**—The expression $\underline{|r}$ (factorial $r$) means the product of the integer numbers up to and including $r$. For instance, if $r = 6$, then—

$$\underline{|r} = 1 \times 2 \times 3 \times 4 \times 5 \times 6 = 720$$

The number of combinations of $n$ things taken $r$ at a time is (as stated on page 309)—

$$\frac{n\,(n-1)\,(n-2)\,\ldots\ldots\ldots(n-r+1)}{\underline{|r}}$$

From the conditions of the problem, the last term in the numerator of the above expression must be 10, because it is stated that the number of permutations $r$ at a time is to the number $r - 1$ at a time as 10 : 1. Thus we get—

$$\frac{10}{\underline{|r}} : \frac{1}{\underline{|r-1}} : : 5 : 3$$

multiplying out we have—

$$30\ \underline{|r-1} = 5\ \underline{|r}$$

$$\text{or } 6\ \underline{|r-1} = \underline{|r}$$

that is factorial $r - 1$ needs to be multiplied by six to make it $= r$, and $\therefore r = 6$.—WM. JOHN GREY, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[56739.]—**Books.**—"Student" should procure the syllabus, and attend one of the science classes, the teacher of which will be able to recommend books. The list he requires would be a tolerably long one, and would of necessity partake somewhat of the nature of an advertisement. The "tip" is to read up such books as are known to be used by the examiners.—S. K.

[56751.]—**Portrait Drawing in Crayons.**—This query is really a question about enlarging photographs. That has been answered many times. See, for instance, p. 302, No. 923, p. 119, No. 1019; and look through the indices of back volumes. If not available, procure one of the cheap and handy guides to photography. They mostly contain chapters on enlarging.—AN AMATEUR PHOTO.

[56754.]—**Filtering Water.**—This querist will not obtain a better filter for his purpose than that made of broken hard-burnt stock bricks. He should have two tanks—one to be at rest and dry while the other is working, and should clarify the water before passing on to the filters by taking it through screens of coarse canvas and afterwards felt. The bricks, broken up to pieces about the size of Spanish nuts, will thoroughly clean any water, if the latter is passed on to them freed from its more solid impurities.—ESSAR.

[56758.]—**Friction Clutch.**—These are well-known mechanical devices. One is illustrated on p. 28, Vol. XXXVIII.—E. G. M.

[56781.]—**Telegram Codes.**—Dr. Algar's is a good one, and is very generally used; but where it is to be obtained I do not know. Try Effingham Wilson, Royal Exchange. If you have only a few correspondents, you might easily draw up a code of your own, taking care to choose words which are not likely to be transmitted so erroneously as to lead to mistakes. That is the merit of Dr. Algar's code: he has chosen words to represent all sorts of commercial messages, which are so different that there is not much likelihood of their being mistaken for others. With a good code one can send, say, ten "messages" in the shilling telegram, for, if it is understood, the word "corn" would suffice for a broker to buy 1,000 bushels of wheat at a certain price.—S. R.

[56791.]—**Telephone Law.**—I am afraid this querist must study the decisions already given in the law courts, and make the best of them he can. The English Mechanic telephone is free, because that has been disclaimed.—NUN. DOR.

[56792.]—**Coal.**—Coal, being principally carbon, is a conductor; but it comes below the metals.—S. E.

[56793.]—**Seltzogene, Leaky.**—The top is probably cemented on with best plaster of Paris mixed with alum water.—ESSAR.

[56796.]—**Boiler.**—Has not "Invicta" made a mistake in the weight for safety-valve? Diam. valve, $1\frac{3}{16}$in.; area, ·518; length of lever, 5in.; fulcrum to centre valve, ¾in.

$$\frac{\cdot 518 \times 75 \times 24}{5} = 1 \cdot 86$$

= 30oz. nearly.—W. W.

[56813.]—**Fracture of Water-gauge Tubes.** "Bacchus" says he has never known an iron wire to scratch a glass tube and it is certainly not the means usually employed to break them. This is negative evidence one way—which is no good at all —and positive the other—which is readily contradicted by innumerable queries and replies in the forty volumes of the ENGLISH MECHANIC already issued. I have those forty volumes, and if I have, as your correspondent courteously expresses it, "floundered out of my depth," I am sure I have done so in good company. I am much afraid that "Bacchus" has no depth at all; but I congratulate him on the immunity he seems to have enjoyed from fractured gauge tubes. I thought every one knew the simple fact that glass tubes often "go" in a rather unaccountable manner.—NUN. DOR.

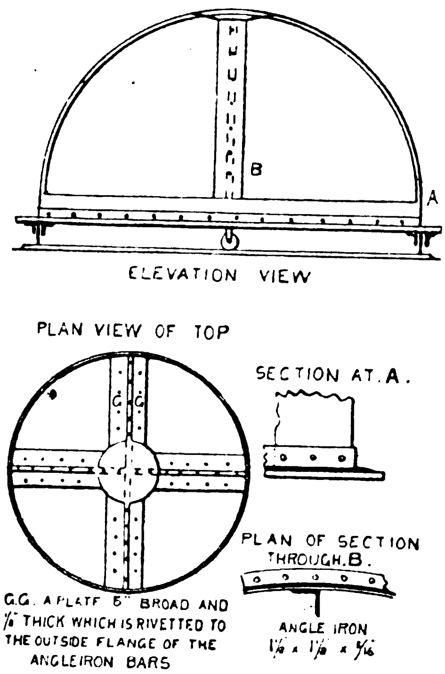
[56871.]—**Whitewashing.**—Get three or four quarts of skimmed milk and mix it up with the water and lime; I'll assure you that it won't come off for a while.—A YOUNG YOUNGSTER.

[56875.]—**Thymol.**—The two varieties of this substance are ($\alpha$) Thymol, obtained from oil of thyme by fractional distillation, which forms crystals; and ($\beta$) Thymol, prepared artificially from cymyl-sulphurous acid, which is a yellow viscid oil. "Novice" is evidently using the former variety. Both are isomeric with canacrol.—WM. JOHN GREY, F.C S., Analytical Chemist, Newcastle-on-Tyne.

[56885.]—**Potato Cleaning.**—I have been looking in back numbers for a machine, much used in Lancashire towns, which was described and illustrated some time back, but I cannot now find the number to refer you to; perhaps our kind Editor will do so. It consisted of an open cane-work basket with stout projected rim, which fitted down into a tub of water, the rim resting on top of tub; from the bottom of this basket a spike projected upwards. The other part was a circular-board brush with a hollow stem and a winch handle. The brush was stout reed, similar to an ordinary yard brush, which are set in bottom face. When in use the tub is three-parts filled with water, the basket put in, the potatoes put in the basket, the hollow stem of brush put on to the spike, and several sharp turns given to it; the basket is then lifted up, the water and skins run through into the tub, and if the potatoes are not all clean enough shake them up and repeat the operation. Perhaps an enlarged and improved make on this plan would answer your purposes.—J. I. S.

[56881.]—**Observatory Dome.**—The following sketch, I think, should make the construction of his proposed observatory dome a very simple matter to

"W. T. C." The foundation for your dome could be constructed of light planking. I would prefer teak wood, as it is the most durable, or, say, an iron plate of ¼in. thick; if you use the iron plate you would do better to have it in two plates, and strapped at its edges by a plate-strap on the inside, and by an angle-iron bar on the underside. You will find this latter method stand the weather much better, especially if it is placed in an exposed position. The size of the bottom angle-iron should be about 2in. by 1½in. by $\frac{3}{16}$in.; this bar is attached with its (2in.) flange to the bottom of the dome, and the side plate (6in. high, ⅛in. thick) is riveted to the 1½in. flange of the angle-iron bar. The size of rivets required for this will be ¼in. in diameter, and spaced 5 diameters apart. Two angle-iron bars cross each other at right angles at the top of the dome, a slot being cut out of the one that passes over the other; and on the top of the dome is placed, for strength, a plate, 2ft. in diameter and ⅛in. thick.—Dumbarton.


B
A
ELEVATION VIEW
PLAN VIEW OF TOP
G G
SECTION AT. A.
PLAN OF SECTION THROUGH. B.
G.G. A PLATE 5" BROAD AND ⅛" THICK WHICH IS RIVETTED TO THE OUTSIDE FLANGE OF THE ANGLEIRON BARS
ANGLE IRON 1½ x 1½ x 5/16

[56891.]—**Shocking Coil.**—I forgot to mention the size of secondary wire. It is No. 36, silk-covered, and the connections are from the binding-screw to the switch, and through the primary coil and out to the electro-magnet contact-breaker, and then down the platinum screw pillar and back to the other binding-screw. The secondary wire from the binding-screw through the reel and to the switch, and to the other binding-screw I have connected a piece of wire to the secondary about ¾ of the reel, and then to the other part of the switch to give a weaker power.—I. O. G. T.

[56914.]—**Socket Joint Making.**—I am extremely obliged to Mr. A. Richardson for his reply; but I have not got exactly at what I should like. I am afraid white and red lead, &c., would not make a sure cure of it, and the second recipe, no doubt, would do very well; but Mr. Richardson says, caulk with it. Now, owing to certain fixtures, which would be very expensive removing, we cannot get to caulk them, and anxiously wish for something to point up, like cement, that would make them perfectly tight, remembering that there is the weight of water from pipes two stories higher than the faulty or leaky joints. Can Mr. Richardson or anyone help me any further, as I really wish to make a good job of them.—Anxious.

[56935.]—**Choke-Damp.**—Choke-damp is the term applied to the $CO_2$, or, more correctly, to the mixture of $CO_2$ and N produced by the explosion of the marsh gas in a coal mine. The equation is—

$$\underset{\text{firedamp}}{CH_4} + 4\underset{\text{air}}{(O + 2N_2)} = CO_2 + 2H_2O + 8N_2$$

Two volumes of $CH_4$ need (about) twenty volumes of air for complete combustion.—Wm. John Grey, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[56942.]—**Electro-magnet.**—"D. W." must not expect to magnetise even a sewing needle with a magneto-electric machine, as the currents from it are alternate. I believe there is a special bell that is rung from such a machine, called the magneto-bell.—Fra. Broadbent, Hammersmith.

[56948.] — **Gas - Producing Apparatus.**—Fletcher's apparatus makes capital heating gas, but you will want the pressure of air; but having had some experience, let me warn you as to the use of this gas. Fletcher puts a good safety-chamber to his generator, and all is safe unless you leave some of the gas past the safety chamber, and then have a light back. This gas is more dangerous as compared with common gas.—Z. Y. X.

[56930.]—**Three Problems—Errata.**—In my reply to this query on p. 417, there is an obvious arithmetical blunder at line 15, where $\frac{16}{192} = \frac{1}{12}$ and not $\frac{1}{18}$ as there stated; consequently, the odds are 11 to 1 against the event, and not 17 to 1. Also at end of reply, by a printer's error, $\frac{1}{24} \times \frac{1}{64}$ stands instead of $\frac{1}{24} + \frac{1}{64}$ the correct reading.—C. Planck.

[56932.]—**Periphery of Ellipse.**—In reply to "A. S. L.," the radius of curvature can be found from the expression $\frac{(1 + p^2)^{\frac{3}{2}}}{q}$, where $p = \frac{dy}{dx}$, and $q = \frac{d^2y}{dx^2}$; in the ellipse $\frac{dy}{dx} = -\frac{b}{a} \cdot \frac{x}{\sqrt{a^2 - x^2}}$ and $\frac{dy^2}{dx^2} = -\frac{a\,b}{(a^2 - x^2)}^{\frac{3}{2}}$, the result being

$$r = -\frac{(a^4 - a^2x^2 + b^2x^2)^{\frac{3}{2}}}{a^4\,b},$$

*a* and *b* being semi-axes. Now, to find the co-ordinates of the extremity of the radius of curvature for any point *x*, *y* of the curve, call the co-ordinates of the extremity X and Y; then X will be found to be $\frac{a^2 - b^2}{a^4}x^3$, and Y will be—

$$-\frac{a^2 - b^2}{a^3\,b}(a^2 - x^2)^{\frac{3}{2}}$$

Then, if we require an equation between X and Y to represent the curve formed by the ends of all the radii, we must eliminate *x* from these two equations, and we get—

$$Y = \frac{1}{b}\left[(a^2 - b^2)^{\frac{2}{3}} - (a\,x)^{\frac{2}{3}}\right]^{\frac{3}{2}}$$

I have not given the various steps required to find these equations, as they are troublesome to print; but I can give a sketch if required. Now, about the series for calculating the periphery of the ellipse, I have used the following for the whole periphery—

$$2a\pi\left\{1 - \frac{1}{2^2}e^2 - \frac{3}{(2\,.\,4)^2}e^4 - \frac{3^2\,.\,5}{(2\,.\,4\,.\,6)^2}\,.\,e^6 - \frac{(3\,.\,5)^2\,.\,7}{(2\,.\,4\,.\,6\,.\,8)^2}e^8 - \&c.\right\}$$

where *e* is the eccentricity of the ellipse, and is equal to $\frac{\sqrt{a^2 - b^2}}{a}$. This series is not difficult to work if, instead of working out each term, we act as follows. If we call the term involving $e^2$ the first term, ignoring for the present the 1 at the commencement of the series, then suppose we have calculated any term, say the *n*th, the next term can be found by multiplying the *n*th term by

$$\frac{(2n - 1)\,(2n + 1)e^2}{(2n + 2)^2}.$$

I have calculated with this the periphery with axes 8 and 4. I have not taken more than five terms; the result is 19·4058.—M.I.C.E., Bath.

[56949.]—**Aluminium** can be obtained from cryolite. $Al_2Fl_3\,3\,NaFl + 3\,Na = 6\,NaFl + Al_2$. Al = 13·10 per cent. A short time since I obtained Al from $Al_2O_3$ in a simple and inexpensive way without the aid of sodium, and also Ca from CaO, which contains 71·42 per cent., by the same process, a beautiful white metal which it appears to me is destined to become a most useful metal some day, as it will not oxidise. It is advertised in Birmingham at 2s. per grain = £700 per lb. Can any person inform me of the present price of Al?—F. W. G., Wolverhampton.

[56949.]—**Manufacture of Aluminium.**—This metal is made at Salindres by M. Pechiney. The process consists of three stages—1st, alumina is prepared from bauxite; 2nd, the alumina is converted into double chloride of aluminium and sodium; 3rd, this salt is reduced by means of metallic sodium. The method is practically the same as that worked out by St. Claire Deville, and is necessarily very costly on account of the price of sodium, and the chief item in the cost of sodium is the small iron vessels in which the distillation is carried on. These vessels wear out with such rapidity that their cost is fully half the total cost of sodium. Some time ago a correspondent of the "E. M." spoke of having succeeded in reducing $Al_2O_3$ by sugar. I wrote stating that the reaction was impossible, a statement to which he took grave exception; but I have never heard anything of the cheap aluminium which he predicted.—Wm. John Grey, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[56951.]—**Dynamo.**—To Mr. Bottone or "W. H. E."—I should like it to be able to run 10 c.p. lamps, and, therefore, the E.M.F. not less than 20 volts. Ten lamps would be sufficient. Definite instructions would be esteemed.—Carnforth.

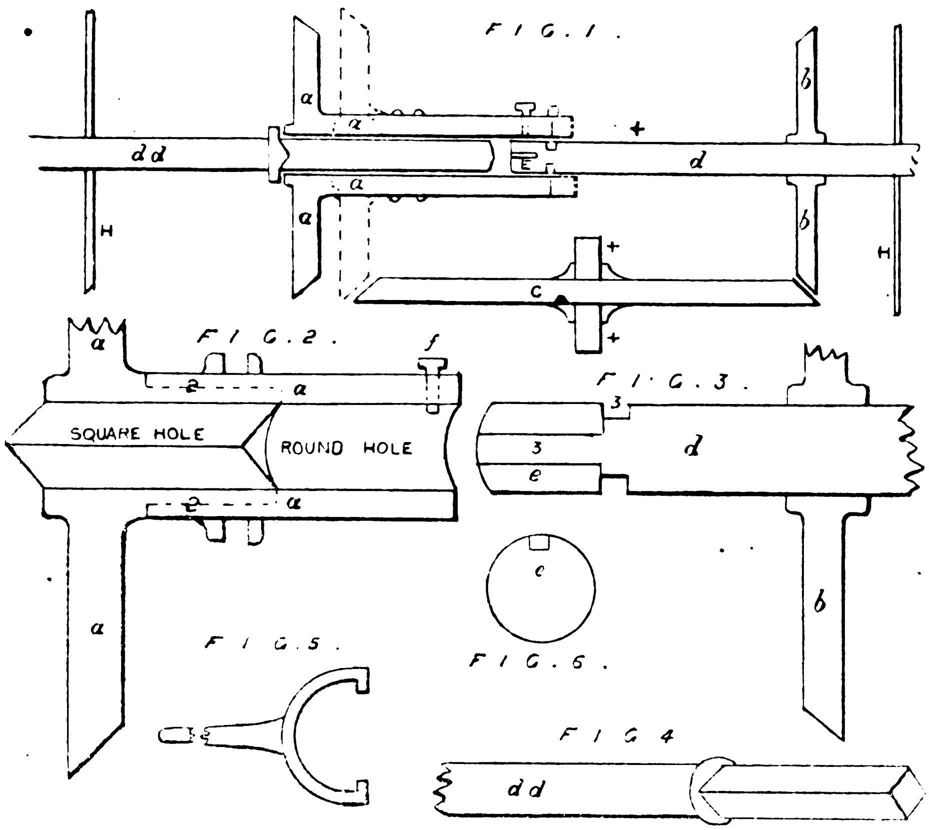
[56955.]—**Photography.**—"B. Sc." should not give such uncertain advice. A wet plate can be developed, fixed, and washed in the same time it would take to develop a dry plate only. The principle advantage of a dry plate is its quickness. Putting that on one side, there are many advantages in a wet plate for studio use. I use both in a portrait studio, and say what I know.—Gwent.

[56956.]—**Ball Bearings.**—I think Mr. Chas. Hosken is mistaken about gun-metal bearings. What he says about an engine is quite true; but does not apply to a bicycle, as he would know if he were a practical rider. The grit of an ordinary road would cut them to pieces in a week—in fact, I have known them so done; whereas, in ball bearings, the grit is allowed to collect between the steel balls, and is prevented from getting between the bearing surfaces themselves and so grinding the bearings. This is, in my opinion, the principal advantage they have, and it is a great one. I venture to refer Mr. Chas. Hosken to the last paragraph printed above the correspondence column.—F. J. Garrard.

[56956.]—**Ball Bearings.**—Thanks to "Invicta" and C. Hosken for their replies on this subject; but I think that the latter is somewhat wide of the mark in comparing the bearings of a bicycle or tricycle with those of a steam-engine. In the one case you have steam as a great force, and in the other only the slight power exerted by a man's body, therefore requiring only a very small bearing surface. Now, I am going to state facts which C. Hosken cannot controvert as to this particular case, in which he says the friction of the ball bearings is shown. The tricycle was bought about two years since, and has been in constant use ever since; between 4,000 and 5,000 miles having been run. Now, I will make it as short as I can. The last few days before the discovery of the worn out balls, I noticed that it did not run quite so lightly as before, and thought I would take out the bearings and overhaul it generally. Now, the only place where I found any stiffness was in the box filled with the remnants of one crushed ball, and eleven others mixed with the bits, and grinding each other away. In the other boxes the balls were quite good, and needed nothing at all. It is rather puzzling why the broken one, being soft, should grind the others away, or why one should give way and no other. I can assure C. Hosken that directly I put new balls in the box the machine ran a deal lighter—in fact, just as it did at first, and as the total bearing surfaces do not measure more than about a square inch, I fail to see why the ball bearings are a mistake. It is an undisputed fact that machines, not steam-engines nor looms, but bicycles and tricycles, do run lighter with ball bearings, and if further proof is wanted take the balls out, and run the machine on the collars of the axle, and it will show itself soon. I, and more besides, would like to have this matter well ventilated, and there are plenty that can do it.—Secundus haud Ulli.

[56959.]—**Castings.**—If "Foundry" will use his sand as dry as possible, and dust his moulds very lightly with Morgan's plumbago, I do not think he will have to complain again of the small holes spoiling his castings, especially if he pours his metal very hot, and allows the moulds to cool before opening them.—Metal Moulder.

[56961.]—**Boating.**—I have not seen or heard of any invention of this kind; but the drawing is a rough sketch of a plan of my own that I thought of over five years ago. I feel confident it would answer your purpose. Fig. 1 is a plan of the parts when fixed together; *a* is a bevel wheel with a square hole part way through and a round one the rest of the way with a bolt at *f*, tapped into the round end and a guide for a brake at 1 (*a* can be made into two parts, as shown by the dotted lines in Fig. 2), *a* must be made in the square hole, so as to ride easily on the shaft *d d*. *b* is a bevel wheel made to be fixed on shaft *d*, as shown in Fig. 3; *a* and *b* wheels must be made both the same size and same number of teeth; *e* is the end of the shaft *d*, fitted so as to work into the round part of *a*, a groove cut lengthways and around, as shown at 3 3—that is, for throwing the machine into different gear when you want to go ahead or astern, the bevel wheel *a* must be in the position as shown in Fig. 1, but when you want to back water with one and pull with the other, by placing the bevel wheel *a* in the position as shown by the dotted lines in Fig. 1, Fig. 4 is the shaft for Fig. 2 to work on; Fig. 5 is the brake that fits on Fig. 2 at 1, so as you can move Fig. 2 with, so as to lock the shafts together, so as to enable you to work the paddles as you want to. C in Fig. 1 is a big bevel wheel with a handle on it to drive it with, or if that is not power enough, you may add more cog-wheels on to



c. A stand could be made so as the bearings will come where it is marked with crosses, and you could put a bearing on the gunwale of the boat. Fig. 6 is the end of shaft *d* at *e*, showing the groove at 3. I trust you can make this out, or someone else may improve upon it.—T. HUNDEL, 1, Milk-street, Frome.

[56967.]—**Deafness.**—The causes of deafness are various. If the drum of the ear is perforated, there is little, if any, hope of being able to hear again. This case of deafness, like numerous others, cannot be successfully treated apart from personal inspection of the ear by a good aural surgeon. Avoid quacks, as any particular disease of the ears demands skilful treatment, and should not be tampered with by non-medical persons. I am much inclined to think that your case is not one in which the drum is perforated, as you state that you can hear sometimes. When the drum of the ear is perforated no vibration of the surface of the drum can take place, and in the absence of vibration of this particular portion of the ear total deafness must in consequence follow. I have no faith in artificial drums, and believe them to be similar to most other things that are so extensively advertised; but I am not prepared to state that artificial drums are of no use, as I have never tried them, or yet ever intend to. I know of one case of deafness in which the patient was told that the ear was perforated, and was advised to have an artificial drum fitted. Fortunately for the patient, the advice was discarded, as the real cause was an accumulation of wax in the ear, which is a common cause of deafness. My opinion with regard to the case in question is that the deafness proceeds in consequence of a small tumour existing in the external ear—that is, outside the drum; but the treatment of it should be placed in the hands of a good aural surgeon. Deafness from the result of a cold proceeds in consequence of the Eustachian tubes being partly closed, which prevents the vibrations of certain portions of the internal ear, through deficiency or total loss of the necessary amount of air required.—G. FRYER.

[56968.]—**Chlorophyll.**—According to text-books on chemistry, this substance may be obtained by digesting green leaves for several days with ether, evaporating the filtered liquid to dryness, treating the residue with boiling alcohol, and adding to the solution a small quantity of milk of lime, which throws down the colouring matter. The precipitate is treated with hydrochloric acid and ether, whereupon the latter rises to the surface, and leaves chlorophyll on evaporation. Chlorophyll thus obtained is an earthy powder insoluble in water, and very stable. Mulder assigned to it the formula $C_9H_9NO_4$, and Morat thought $C_{18}H_{20}N_2O_5$ was better. According to Hoppe-Seyler its percentage composition is—carbon 73·74, hydrogen 9 72, oxygen 9·54, nitrogen 5·68, ash 1·72; and as neither Mulder nor Morat take into account the ash, their results are erroneous. It certainly contains iron, and plants deprived of iron become chlorotic, being unable to produce chlorophyll. According to Griffiths it is a compound of iron with some sort of a glucoside, possibly analogous to amygdalin, $C_{20}H_{27}NO_{11}$. Dr. A. Yschirch argues very strongly that pure chlorophyll has not yet been obtained, and that the stuffs got from leaves by such methods as given above are merely products of decomposition, more or less remote from true chlorophyll. I am inclined to agree with this view, for when we consider the marvellous power which green plants have of decomposing $CO_2$ under the action of light, a power possessed only by plants containing chlorophyll, we must, I think, come to the conclusion that the body which confers this power has a vastly more complex formula than any of those assigned to the so-called chlorophyll. It has never been formed artificially, and there is no chance of its synthesis, so long as its formula is nearly as great a mystery as that of protoplasm itself.—WM. JOHN GREY, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[56969.]—**Hydraulic Ram.**—You are correctly informed as to this. There are two valves, one opening into the air-chamber, the other controlling the waste water. There is nothing so abstruse about the question, as you will see. By a well-known law, the normal pressure multiplied by the speed gives the maximum pressure. Hence, though the pressure of the head of water itself would not support the escape valve of the ram, yet at each stroke the velocity of the flowing water, multiplied by the permanent head, is not only much more than sufficient to raise the valve, but is also able to on its closing to open the valve in the air-vessel. The hydraulic ram acts by momentum, and not by constant pressure. In your case, no doubt, the valve is made in itself heavy enough to more than balance the permanent head of water. No sooner is the force due to the momentum expended first in closing the waste-water valve, and forcing also into the air-vessel, than a recoil or rebound takes place also, so that the escape valve must fall owing to want of pressure behind it. The recoil is utilised and proven by the action of the snifting valve, allowing air to pass into the ram, as if a momentary entire absence of pressure did not take place, the valve could not open at all.—INVICTA.

[56969.]—**Hydraulic Ram.**—"Melting Mechanic" asks a very natural and intelligent question; but he would search in vain for a satisfactory reply to it in any English work which I have seen touching on this subject. It is, indeed, marvellous that so admirable a machine should have been so much neglected by our writers on hydraulics. Now, as to the cause of the fall of the outer valve, which puzzles "M. M.," as it has puzzled most people who have thought about it: clearly it is not the weight of the valve alone which brings it down—there must first be a removal of pressure from below it, and this is effected thus: At the moment when the outer valve closes there results an immense increase of pressure on the whole inner surface of the ram. This lifts the inner valve, and drives a quantity of water through it. When the force of the impact is spent, the inner valve descends again with a force due to the pressure of water in the delivery pipe above it. The inner valve thus becomes itself a kind of ram butting against the water in the motive column and giving it a backward motion, which it retains by reason of its inertia even after the inner valve has closed. At this critical period, which lasts only for a small fraction of a second, there is a removal of pressure from below the outer valve, enabling it to fall by its own weight; it not only falls by gravity, but is "sucked" down by means of the more or less, perfect vacuum beneath. The valve should have no more weight than is required for strength; of course, more water is sent up through the inner valve than returns. There can be little doubt that there is also an alternate expansion and contraction of the metal of the ram causing a recoil of the motive column, similar to that resulting from the descent of the inner valve. If a horizontal piece of brass tube be connected with an ordinary tap, and the open end of the tube be bent upwards and furnished with a little valve like the outer valve of a ram, the valve will begin to rise and fall alternately as soon as the tap is turned on, and will continue to pulsate as long as there is a flow; indeed, even without this contrivance, the recoil of the water may be both felt and heard at the tap itself if the pressure is sufficient and the tap admits of being closed smartly. The outer valve of a working ram will continue to rise and fall with the inner valve plugged and with no air-chamber. I must forbear to speak of the inner air-chamber, important as it is, further than to remark that its office is to supply air to the air ball, and to moderate the violence of the ram's action. It does not, on the whole, assist the fall of the outer valve, as one is sometimes told in books, and as I long supposed it did. On the contrary, the outer valve falls with more force and promptitude without it.—W. A. S.

[56972.]—**Watchwork.**—There is nothing which exemplifies the old adage "Practice makes perfect" better than polishing; indeed, it is only by constant practice that anyone can become a good polisher; but when once you get into it, it is quite simple. The steel must first be filed or turned quite square, and then hardened and tempered. It can now be polished with red stuff, either by rubbing on a bell-metal block (which has been filed and stoned quite true) with a circular motion by means of a pointer. I generally use a drill stock, or place the work on a piece of soft wood in the vice, and use a long bell-metal polisher. By far the best medium for giving the work a finish is diamantine, which must be used with a white metal polisher; but great care must be taken, as it polishes very quickly, and if used too quickly is apt to make the work look foxy. In all polishing it is very important to keep the work and polishers quite square and true. Great care must also be taken to keep the work, polishers, &c., quite clean; this is especially important in regard to diamantine, as the least atom of grit or dirt will quite spoil the finish. In the above I have supposed that "Escapement," as he is in the trade, is acquainted with the different tools, and the way to mix the polishing mediums, &c. The best way to clean the work is with soft bread.—C. A. W.

[56974.]—**Boiler.**—To "INVICTA."—Your boiler has, supposing the firebox to be from 12in. to 13in. diam., ample heating surface for driving an engine 2in. bore and 3½in. stroke, as long as the speed is moderate. The firebox is too low; with a 3ft. shell, it should have been not less than 18in. in height with a baffle plate; for the low-pressure steam it will generate it will steam fast enough. As to the working pressure, some careful experiments with copper generators recently have made me very careful; and in view that copper rapidly decreases in strength as the temperature rises, I should want a good factor of safety, and would, therefore, say 10lb. as the safe working pressure. I have perused the pages of this week's issue, but cannot find the description of dynamo you mention, so that I cannot give you an opinion; but it must be a very small dynamo that something less than the one-eighth of a horse-power would drive with much effect; therefore, unless the dynamo be a mere model, your engine will not drive it. I am assuming that with full steam you get 200 revolutions a minute from the engine, which I doubt, with a load. When the description in question appears, if it escapes my notice, remind me, and I will tell you what is then my opinion.—INVICTA.

[56977.]—**Load on Short Span.**—For the sake of the querist, will "Dubliniensis" show how the result 18·29 is arrived at? The moment of inertia of a square section being $\frac{1}{12} A d^2$, and of a circular section $\frac{1}{16} A d^2$ (A being sectional area, and $d$ the depth in each case), give a ratio of about 10 to 6 in the strength of the two sections of the same depth; then the strength of a square beam on its side and on its edge being in the ratio of 2 to $\sqrt{2}$, how is the result 20·21 arrived at?—J. S. C.

[56979.]—**Model Locomotive.**—(1) No; your boiler will not drive even one such cylinder properly. All the parts are too small; such a boiler would not supply even a single cylinder ½in. by 1in. properly. And one point is, that with a single 1in. flue you cannot deal with the heat necessary to make the firebox do its share. The boiler must be both larger and also designed in a technical way to work satisfactorily. I will help you in this, if you desire, with plans, but the present boiler will not do. Size of ports for cylinder ¾in. by 1¼in., stroke should be ⅜in. long by ⅛in. wide for steam, and ⅜in. by ¼in. exhaust. Bars $\frac{3}{16}$in. wide.—Invicta.

[56980.]—**Electrical.**—If the coil were fixed and the core free to move, on passing a current through the former the latter would be drawn into the coil, tending to embrace as many lines of force as possible; conversely, if the core is fixed and the coil movable, the latter will be drawn on to the core.—Fra. Broadbent, Hammersmith.

[56983.]—**Window Glass.**—A piece of ordinary looking-glass is fitted into a frame of angle zinc or copper, with a back of the same metal, a brass socket made of a piece of tube and provided with a set screw being soldered to the centre of the back in a horizontal position. Another socket, also having a set screw, is fixed on the frame or wall outside the window in a vertical position. A piece of brass rod about 12in. long is bent at a right angle 2in. from one end; the short arm of this is fitted into the wall socket, and the end of the long arm is passed through the socket on the back of the frame. The glass can thus be freely swung both horizontally and vertically, and can be clamped in any required position by means of the set screws.—R. T. Lewis.

[56984.]—**Legal.**—You run a very great risk, and would have some trouble to convince a magistrate that you gave the ale away. He would, in all probability, say you were evading the law.—C. D. R.

[56987.]—**Volvox Globator.**—May be kept alive if placed in any fresh-water aquarium and supplied with pond or rain water. Of course, fission takes place. To mount whole ring a cell with an ebonite ring fastened down to the glass slip with Canada balsam. When dry, fill the cell with a mixture of equal bulks of methylated spirits, water, and glycerine. Take up a little of the fluid containing the volvoci, drop it into the mixed solution, which at once kills and preserves them, slide over a thin cover glass, wipe the edge with blotting paper, run a circle of good gold size round the edge of the cover glass, which circle repeat every three days for a fortnight.—S. Bottone.

[56987.]—**Volvox Globator.**—(1) I know of no good means of keeping them long alive. They are usually accompanied by small crustaceans—Cyclops especially—which feed on them. (2) They may, I am told, be dried on a slide, heated, stained by gently pouring stain on them, so as not to displace them, and mounted in balsam. (3) A volvox is a green globe, freely swimming and rolling in the water, and of about the size of the dot of an i, or rather larger. When fully grown it is hollow inside. On examination with a power of 25 or so, a volvox is seen to be generally of a light green, studded with dots of an intenser green, and these dots are nucleated cells lying beneath a transparent layer which is visible round the edge, and is thicker in the younger and smaller specimens. In the younger specimens the cells are massed together; they recede from each other with growth, leaving, however, lines of connection between them, which may be seen by a somewhat higher power, aided by a condenser or the use of oblique light. Most of these cells remain single cells, and from the nucleus of each, or of very many, proceeds a split flagellum, and the sphere is rolled through the water by the united action of these. At the edge the nuclei may be seen to be pear-shaped, the stalk of the pear being the flagellum or undulating thread; in the middle or in front view they look circular, or almost so. In other cells, however, the nucleus divides and subdivides, and round each subdivision of it a cell-wall is formed, so that instead of a single cell we have several closely aggregated together. The aggregation contracts at the edge, and becomes saucer-shaped instead of plate like; the rim of the saucer clinging to the inner side of the hollow sphere, which the original volvox is. By a continuation of the same process, the saucer becomes a cup, and the cup a sphere, and this new sphere is a young volvox, which presently becomes detached, swims about in the central cavity of its parent, and may there attain a considerable size. About fifteen months ago I mounted about a dozen slides of volvoxes, which now seem to me to be as good as when they were first put up, though I suppose they must have deteriorated somewhat. First, I took them up from the water in which they were swimming, and put them into cells made on slides with gold size some time previously. This I did with a glass tube drawn to a point, taking off the superfluous water till I had enough volvoxes. Cells made with rings of metallic zinc would have been better. Then I drained off as much of the water as possible with a tube, and by the same means introduced a 1 per cent. solution of osmic acid, which I allowed to remain for a few minutes, till they just began to change colour, when the osmic acid was in turn drained off, and they were treated to several changes of distilled water, to the last of which some drops of an alcoholic solution of iodine aniline green were added. This was then washed out with Haentsche's fluid, coloured red with magenta, and, the red fluid being removed, they were mounted in plain, uncoloured Haentsche's fluid. The result is a double stain, which is distinctive, but not very effective; but the flagella, the nuclei, and the lines between the cells are as visible as I remember them ever to have been. The Haentsche's fluid, as directed by Haentsche, is three parts alcohol, two water, and one glycerine; but these proportions are not intended to be superstitiously adhered to. I was sparing with the alcohol, and finally used perhaps 50 per cent. or more of glycerine, gradually increasing it in the various washings. My mistake was to use two shallow cells, in consequence of which many of the larger volvoxes have burst, or ruptured from the pressure of the covers; but, except for the tear at one side, they are perfect volvoxes. I am not sure that these torn volvoxes are an unmitigated evil, for they have discharged the young ones in their interior, which can be seen more clearly.—Francis Grant.

[56988.]—**Siphon.**—When the siphon is simply put with the shortest of its legs in the liquid, the atmospheric pressure is exerted equally inside it, the siphon being now filled with air. When it is filled with water and replaced, the column in the longest leg runs out; this causes a vacuum which draws up some more liquid through the shorter leg, and this process is continued till the whole of the liquid has run through the siphon. If you don't fill it with water, but suck the air through the longest leg, a vacuum is produced, and, once started, the process goes on as before. The longer the long end of the siphon is, the faster the water goes through, for the simple reason that the long end being lower, the difference between the height of the surface of water and the bottom of the longest leg is increased, and therefore the pressure is greater.—R. A. R. Bennett.

[56988.]—**Siphon.**—To "Invicta" and others.—When you place the short leg of the empty siphon in the tank, did you give the following question a thought—viz., why should the water rise in the empty siphon tube, and then run down the longer leg? Is there any natural or other law, except that of capillary attraction, that would cause water to spontaneously rise above its own level? If our friend will consider a moment, the action of a siphon is exceedingly simple, as is caused thus: The column of water or fluid in the long leg, obedient to the laws of gravity, would, on the exit being opened, at once descend. In thus descending, a partial vacuum would result in the bend of the siphon; but the atmosphere, pressing on the surface of the liquid, instantly forces fluid into what otherwise would be a partial vacuum, and thus a constant descending flow of water is produced until the fluid sinks below the end of the short leg of the siphon. Air then passes in to fill the space left void by the water, and the action of the instrument naturally ceases, because an equilibrium is set up. Therefore, unless you fill the siphon first, where is the column of fluid to fall by gravity, and thus set up a siphon action? By the same train of reasoning, the longer the length of the long leg of the siphon, the greater the speed of the flow would be, because the length of the descending column is longer. In practice, there are many other considerations, such as pipe friction, for instance; but, in theory, the longer the pipe in vertical height, the greater should be the speed of flow, and, therefore, the volume delivered in a given space of time.—Invicta.

[56988 (**Siphon**) and 56892 (**Hydraulic Ram**).]—The information asked for can be found in any elementary book on hydraulics.—J. S. C.

[56990.]—**Bell Telephone Circuit.**—I do not understand your question. Express yourself more precisely, and I will assist if I can.—S. Bottone.

[56991.]—**Blowhole.**—It must depend on the locality of the hole. But, in any case, my advice would be, if it be at all possible, to drill out the speck, and screw in a small pin of either iron or brass as tightly as possible, and file off to the surrounding surface.—Invicta.

[56992.]—**Hydraulic Ram.**—I do not know in what direction you want the information, or I would with pleasure give it. Something is stated on the subject on page 418 even. A ram with a fall of 9ft. should be able to deliver water into a tank 80ft. above it readily enough.—Invicta.

[56995.]—**Fixing Boiler.**—There are two plans almost equally good. If room is not an object I should fix it in brickwork similar to the regular egg-ended boilers, the furnace being underneath the front end; but the minimum space I could advise would be 4ft. 6in. in length × 3ft. 6in., that being the floor area. If that be too much room then you may put the boiler on end, in which case it would stand in a total space of 3ft. 6in. each way; but that system would render it almost imperative to have a mud catcher fitted inside. In view of this I should myself prefer the fixing horizontally. Let the flue be then a simple flash flue from the bridge to the end of boiler, and thence by a square section flue to chimney. Carry water level at the 15th inch from the bottom, and bring flue up to the 12th inch only on each side. I should myself run with, say, 30lb., not more, unless I saw or knew the boiler to be safe for more. It should be safe at 60lb., at least, supposing all was right; but as it is best to err on the side of safety, and not having seen the boiler, I would say 30lb., and be safe; but an hydraulic test to, say, 75lb. would be better—Invicta.

[56997.]—**Hydropathy.**—I have derived great benefit from the "tub and sponge," but with the addition of Tidman's sea salt; and I knew of a very severe case of nervous depression cured by means of the "pack" used twice a week. To learn how to do the pack properly, "Quixote" should visit a hydropathic establishment for a few days—not one of the flirting and match-making description, but one like Smedley's at Malvern, where hydropathy is really practised.—B.Sc., Plymouth.

[56997.] — **Hydropathy.** — I am afraid "Quixote" will not receive much benefit from above practised at home. The great point is change of air, scenery, society, and a carefully regulated diet. There are numerous hydropathic establishments in all parts of England and Scotland. "Quixote" should enter one of them, if possible, for as long a term as he can spare; even a short stay will do him more good than he will ever receive from medicine: at least such is my experience. I took gallons of medicine prescribed by eminent doctors (I am not exaggerating in the least) without benefit; in fact I got steadily worse, until I got into a very weak, nervous state; life was a burden. This was about forty years ago. I then went to a hydropathic establishment, learned to live properly, went through the regular treatment, which at that time was strict, both diet and treatment, and have lived comfortably till well turned the allotted span of life. I may add that it can scarcely be called a "cold water cure" now, as hot water, Turkish baths, &c., are much used in the present treatment. I would strongly urge "Quixote," or anyone labouring under nervous disease, indigestion, &c., to go and do likewise.—W. Grimshaw.

[56999.]—**Question in Algebra.**—The twelve soldiers can be arranged in line in $\underline{|12}$ different ways, and so can the twelve sailors. We have, therefore $(\underline{|12})^2$, different ways of arranging the men in two lines, one containing all the sailors, and the other all the soldiers. We can now break up our line of soldiers into three sections of four men each, and we have 13 different positions among the sailors (namely, between any two or at either end), from which we must choose three in which to place our three sections of soldiers. This can be done in $\frac{13 \times 12 \times 11}{\underline{|3}}$ ways, and remembering that the sections must not change their positions with regard to one another, we see that there are

$$\frac{(\underline{|12})^2 \times \underline{|13}}{\underline{|3} \times \underline{|10}}$$

different arrangements satisfying the conditions

$$\text{or} \quad \frac{13 \times (\underline{|12})^3}{\underline{|10} \times \underline{|3}}$$

—C. Planck.

[57000.]—**Spark Coil.**—Fasten a piece of stout copper wire into a wooden handle and cross it in the flame of a gas or spirit lamp. The projecting end will serve as an excellent soldering tool for all kinds of small work. You must tin the wire first, of course, and use resin as a flux.—C. D. R.

[57000.]—**Spark Coil.**—The tinfoil of condensers is usually placed between boards, which are a size smaller than the foil-plates. One inch or so of each alternate plate consequently projects over the sides of the board. Press the edges together and bend them over on the board, fastening them down to it by small binding-screws. Connect the condenser by short lengths of wire from the screws, soldering the connection of the lengths to the wires which come from the pillar and the spring. If the point of contact is thoroughly clean, the touch of a bolt should do no harm.—Bobadil.

[57000.]—**Spark Coil.**—If you trace the connections underneath you will find that one main wire goes to the spring of the contact breaker and another main wire to the contact breaker pillar or that part which carries the adjustable screw. The condenser, you will find, is made of tinfoil insulated. All the plates of foil coming out on the one side must be connected together, and by the aid of a piece of insulated wire with the spring of the contact breaker, whilst the other series of foils must be similarly connected to the contact breaker pillar. The main wires I refer to will also not be fine silk-covered wires such as you describe, but should be wires, say, at least No. 18 wire gauge.—Invicta.

[57001.]—**Carbon.**—A battery cell made as described would answer your purpose for a bell, if sufficiently large; but you would obtain better results by using two plates of carbon with one of zinc between them, and sal-ammoniac instead of common salt. If charged with a solution of bichromate of potash in sulphuric acid and water, it would work a coil.—R. T. Lewis.

[57001.]—**Carbon.**—If sufficiently large enough it will give a current sufficient to ring a bell, but only for a short space of time, as polarisation almost immediately would ensue. You can obtain a better result by increasing the carbon surface six or eight times that of the zinc, but even then the cell is of no practical use, as the Leclanché is far superior in every way. For coils and motors the cell is of no use however.—C. D. R.

[57005.]—**New Steam Motor.**—To "Invicta."—The motor in question being a patented machine, I am sorry that I cannot myself assist Mr. Miles. But, as in the case of another querist, I have written the manufacturers, asking them to communicate with you. In another case they have granted him a free special license to make one engine only, and I understand it is in hand already. I have no doubt that my request to them in like manner would procure you satisfactory terms to make one engine for own use only. I cannot say how far such special license will be granted, but so far they have been issued as a personal favour to me and to readers of the "E. M." only, so that any one else interested may most likely be dealt with in the same way if they express their desires through the medium of this journal. My own personal influence would certainly be employed in their favour in that case.—Invicta.

[57008.]—**Granule Battery.**—I should not recommend "W. Y. K." to use a granule battery, as I tried one myself made up of six quart cells, and could not light one 5-c.p. lamp properly. Also there is a very unpleasant smell with it, and it is very troublesome to recharge.—W.

[57008.]—**Granule Battery.**—It is quite possible to make a 6-cell granule battery in the way you propose, but it is not advisable; they always leak, and are very awkward to recharge. Marine glue can be purchased at most shops; it is made by dissolving one part of indiarubber in 12 of benzine, to which is added 20 parts of lac; it should be applied hot with a brush. The E.M.F. of an ordinary granule is about 1·60. You can use outer cells made of any waterproof substance; large jam jars or glasses will do equally well. It is impossible to say whether the size you mention will give the current required without measuring; you must find this out for yourself. If you do not pack the granules tightly round the electrode the resistance will be very large. The granule cell has been very much overrated. You must, therefore, be prepared to be disappointed if you expect too much from it.—C. D. R.

[57010.]—**Swan's Studio Plates.**—Mr. Chapman's assistant was quite right; these plates, if properly treated and duly exposed, will yield good pictures with any known developer. "N." must be wrong in his work.—S. Bottone.

[57010.]—**Swan's Studio Plates.**—"N." had better write to Messrs. Mawson and Swan for a small book entitled "Photography," price 3d., which gives directions for working their plates. I may say that they recommend Edwards's developer as well as their own.—A. R. F.

[57010.]—**Swan's Studio Plates.**—Chapman's assistant was quite right in saying that any developer will do; and if "N." has tried four, the difficulty lies in a wrong exposure or access of light to the plate. Swan's developer is: No. 1 Solution, 30 grains pyro, 10oz. water; No. 2 Solution, 1 drachm liquor ammoniæ, 1 drachm bromide of ammonium, 10oz. water. Use these solutions in equal proportions. For an amateur, the standard developer of the New York Photographic Society is better, although it is very slow, and the developing dish should be kept covered as much as possible. It is as follows:—For a ¼-plate, water 2oz., dry pyro 4 grains, carb. soda 11 grains, sulphite soda 22 grains, carb. potash 11 grains, yellow prussiate potash 11 grains.—B.Sc., Plymouth.

[57013.]—**Boiler.**—To "Invicta."—In comparing the two boilers, one 32in. long by 13in. diam., and with dished or egg ends, and the multitubular boiler, 20in. long by 11in. diam., and with five 1in. tubes from end to end, I may tell you that the available heating surface is practically the same in both; but looking at the matter all round, I should prefer the 32in. boiler to the tubular one, as a large portion of the latter would not be as effective as that of the former; whilst the tube ends would be likely to give trouble some day, besides acting on the speed of the draught. The externally-fired boiler also would hold steam better from the larger bulk of water, and the water level would not be subject to the same rapid variations; therefore, stick to your first boiler.—Invicta.

[57014.]—**Watch Jobbing.**—I am puzzled to know what "Lever" really does want. The most generally useful tool for watch jobbing and making is a good Swiss mandrel; cost about £7. But for turning in balance staffs, pinions, cylinders, &c., he must use the ordinary turns, cost about 10s., and require a lot of practice.—Escapement.

[57015.]—**Steam Canoe.**—This is decidedly a case where the paddle engine could better be utilised than the screw, as the narrowness of beam needs all the additional stability that can be imparted. The boiler should certainly be horizontal, to keep the centre of gravity low; whilst a small paddle-engine would take the minimum volume of steam. Had our friend given me the depth of his canoe, I could have better dealt with the question for him. Neither has he told us the length of stroke of his 2in. cylinder. I am also writing him direct to oblige me with sketch of his canoe—firstly, because I want to see the general design, and also that I might better advise him as to the engine and boiler. If the opinions I form would interest the readers of the "E. M.," I shall be happy to express them.—Invicta.

# UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

Since our last, "Alto Petit" has replied to 56439, 56440.

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56525. Cyclist Tour in Scotland, 222.
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56554. Ordnance Factory, Enfield, 223.
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56748. Barbadoes, 311.
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56752. Raising Water by Ejector, 311.
66760. Accumulators, 311.
56761. Three-cylinder Engines, 311.
56762. Safety Bicycle, 311.
56766. Building, 311.
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56768. Ancient Lights, 311.
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56771. Calico Dyeing, 311.
56773. Glucose in Leather, 311.
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56785. Kites and Kite Carriages, 311.
56790. Limited Liability Company, 3 2.

**Transmission of Power.**—The following particulars of the cost of transmitting power by the Daft system are given in a pamphlet issued by the Safety Electric Power Company of New York, which possesses territorial rights acquired from the Daft Company. The nominal radius covered is 2¼ miles. Engines, boilers, foundations, &c.; eight dynamos, aggregating 500 horse-power; line receivers, switches, &c., total £17,100. Running expenses per diem: Rent, coal, engineers, linemen, two firemen, station dynamo men, outside receiver men, 10 per cent. depreciation, oil, waste &c., total per diem, £19. It is assumed that 350 horse-power will be ready for delivery at any moment, and following the ordinary practice of power producers, at least 600 horse-power can be rented therefrom to small consumers, limiting the delivery to, say, 10 horse-power for any one consumer; in this way an average of £30 per horse-power per annum may be realised in New York City, which would therefore return after deducting running expenses, a net income of £11,000, or 65 per cent. per annum on prime cost. The estimate of running expenses is probably excessive, since 365 days of working expenses have been provided for, whereas this would in practice probably be reduced to 313 days, thus reducing the expenses and increasing the earnings. The plant for a ten-mile section of street-car lines, on the assumption that fifty cars are to be run and that 150 horse-power is ready for delivery on the track at all times is 62,000 dollars. Fifty loaded cars may be moving at the same time. Assuming a run of sixteen hours per day per car, the expenses are put at 49 dollars, or less than a dollar per car, whereas the care and maintenance of 400 horses cost 286·687 dollars per day, or more than 5 dollars per car.

# QUERIES.

[57022.]—**Galvanic Batteries.**—To "Sigma."—I have just purchased a copy of your work on "Electricity," and am reading it with the greatest interest and pleasure. Would you kindly give me some information on the following point? I understand that the current in a galvanic battery is due to the difference between the energy, which is generated (by chemical action) at one plate, and that which is expended (by producing chemical decomposition) at the other plate. Thus, in the Daniell battery, sulphate of zinc is formed in one cell, and sulphate of copper is decomposed in the other; but the energy of the combination of the acid with the zinc is greater than that of the acid with the copper; the force generated in one cell is greater than the force expended in the other cell, and hence there is a current, equal to the difference (minus resistances) of the energies, flowing from the zinc to the copper. But there is a battery of German origin, lately invented, in which the fluid is chloride of iron solution, and the elements iron and carbon. The chloride is decomposed, its chlorine forming fresh chloride with the iron plate, and its iron being reduced at the carbon plate. Now I want to know what is the source of the current in this battery; where does the energy come from which is transmuted by the battery into electricity?—for the force expended in pulling asunder the chlorine and the iron must be exactly equal to the force generated by their union; the energy developed at one plate is absorbed at the other, and the result ought to be nothing. The forces being equal and opposite, the equation might be thus put: $x - x = 0$, but there is a current. I understand that the reduced iron is oxidised by the action of the air, and falls to the bottom as oxide. Can it be that it is this oxidation which is the source of the current? If so, then it seems to me that the current ought to flow the wrong way, that is, from the carbon to the iron. Would you kindly explain the action of this battery, especially with reference to the principle of the conservation of energy?—Ex-Garrison Gunner.

[57023.]—**Second and Fourth West India Regiments. Colonial Police Forces, &c.**—Will any of your numerous readers inform me as to the qualifications necessary for entry into the Second and Fourth West India regiments, more especially the last named? I find no mention of the Fourth in an old Army List in my possession, but a gentleman lately returned from South America, assures me that there is such a regiment, and that he has heard that entry is not difficult, but is unable to give particulars. I should also much like to know something of the police forces in our newly formed colonies—Guiana for instance—and whether it is possible to get an appointment in one of them, and the *modus operandi*. I have served for six years in South Africa, throughout the Galeka, Gaika, Basuto, and Zulu Campaigns, and am anxious to get military or colonial police work again, if possible. The fullest information will oblige.—Morosi.

[57024.]—**Dead Centre.**—Could any correspondent inform me of the cause of the difficulty I experience in my launch engine to get over the dead centre? The slide valve, in the opinion of two engineers, is set right.—Amateur.

[57025.]—**Midland Scotch Express.**—Can any of your readers inform me what was the number of the engine which took this train, on Thursday, July 9, between London and Leicester, when the driver was killed by coming in contact with a bridge whilst mounted on the tender?—Bogie.

[57026.]—**Problem.**—Can any kind reader work the following, algebraically?—I cannot get an elimination between the three unknown quantities. A man has whisky worth 16s. a gallon, and another lot worth 19s. a gallon. How must he mix these with water to make a mixture of 51 gallons worth 12s. a gallon?—Bogie.

[57027.]—**Pure Phosphorus.**—Will Mr. Alfred H. Allen kindly give me a simple method of preparing absolutely pure unoxidised phosphorus? I am informed that when taken internally in this form it has proved very beneficial in nervous exhaustion, and being a sufferer, I am anxious to prove the truth of the statement.—Phos.

[57028.]—**Stamping in Relief.**—Can you kindly give me the process of above suitable for thin brass patent tickets, and the probable cost of the needed appliances? I am having a good deal of annoyance and delay getting my tickets, and think I could turn them out to better advantage myself.—Stamper.

[57029.]—**Turbine.**—What power can I get out of a 2in jet of water under a pressure of 15ft. by means of a turbine? Also oblige by giving directions how to make a turbine? What number of revolutions per minute would it run at?—Highlander.

[57030.]—**Galvanising Clout Nails.**—Could any one inform me how to galvanise ordinary clout nails? Also the pickle required for cleaning them, previous to dipping in the bath of melted zinc?—Nails.

[57031.]—**Soap Analysis.**—Will any of your readers kindly inform me how to estimate the percentage of alkali (soda) in soaps, also fat and water?—Y. C.

[57032.]—**Clock Making.**—I intend making clock from instructions given in "E.M.," Vol. XXXI., and wish to know the most suitable lathe to get for the job; perhaps someone will advise—Nomen.

[57033.]—**Refining Gold.**—Would any fellow reader who is up in chemistry kindly inform me how I may separate the copper and silver from nine carat gold, so as to form chloride of gold? Also how to recover the silver as well? Any information will be thankfully received.—Alloy.

[57034.]—**Painting Iron Bath.**—I shall feel obliged for instructions how to prepare paint and apply it to a cast-iron bath, so that it will stand hot water?—D. B. and S.

[57035.]—**Bicycle Spring.**—I wish to make a spring somewhat after the Arab style. Will "Invicta," or others tell me the sort of steel rod to use—will Bessemer do? Ought it to be bent cold, or at a dull red heat

Does it require hardening and tempering to a blue? The rod will be about ¼in. diameter.—E. O. B.

[57036.]—**Bicycle Painting.**—Which is best to clean grease off from spokes, &c., preparatory to painting, benzoline or solution of caustic potash in water?—E. O. B.

[57037.]—**Sewing-Machine Work.**—I shall be glad to be informed if and how the stitching is marked out in ladies' garments—corsets for instance? I want a quantity of sewing done very evenly.—J. W.

[57038.]—**Wimshurst Influence Machine.**—Will Mr. Wimshurst kindly inform me whether it is possible to construct a multiplate machine on his principle, and if so, would he give me, through the medium of your Reply Column, full details relating to the construction of such a machine with twelve pairs of plates?—Aurora.

[57039.]—**Firing Mines.**—Wanted to know simplest plan of firing charges of gunpowder, 100yds distance, by electricity; have a ½in. coil, and what form of battery to use for constancy? To be fired about three times daily.—Mikado.

[57040.]—**Voltaic.**—I want to make some simple electric motor which, actuated by a small galvanic battery, would show a school boy the effect of motion produced by a voltaic cell. How can I manage this?—Pith Ball.

[57041.]—**Battery.**—What is the reason opticians sell us those small cells for bell and coil work? Those cell require acids powerful in proportion to their smallness to work them. Will it not answer to use much larger cells, requiring for the development of electricity diluted acid, thus reducing the working cost. Where the size of the battery is no objection, is not there a decided gain in large carbons, and zinc actuated with weak acid? Is there not a mania amongst our opticians and electrical engineers, for making those small batteries?—E. B. Fennessy.

[57042.]—**Spark Coil.**—Would some good friend favour me with a list of experiments, which I may perform with a coil—something else than showing the spark through vacuum tubes, and giving shocks?—E. B. F.

[57043.]—**Spectroscope.**—My spectroscope shows the D line as a thick line, having two conspicuous but much thinner lines close to it on the red side of the spectrum; the instrument has five prisms. Should it show the thickest of those three lines double, or does the sodium line, the D line, actually consist of two fine lines, and one coarse line?—Jolly Miller on the D.

[57044.]—**Silver-Plating.**—I have just commenced silver-plating, and like other amateurs, have met with a difficulty. I have been successful with brass and copper, but I cannot succeed with German silver. I get a good coating of silver on the metal, but as soon as I put on the scratch brush, it peels off. I have made a solution of cyanide of mercury, but I don't know the correct way to use it, and should it be used for all articles? I have used a battery of carbon and zinc, placed in a large glass for holding 1qt., and I have also tried the same with copper and zinc, using in both cases, oil of vitriol and water as chemicals: they both act very well, but which is really best for the purpose? I shall be thankful for a little information respecting the above, or any hints on the subject.—A Beginner.

[57045.]—**L. and N.W. Compounds.**—Will "Meteor" or any other reader, kindly give a full list of numbers and names of above locos.—Cotswold.

[57046.]—**L. and N.W. Manchester Express.**—What class of engine is new working the 12 noon from Euston to Rugby?—Cotswold.

[57047.]—**G.W.R. Goods Engines.**—Can any correspondent give principal dimensions and weight of 2321 class?—Cotswold.

[57048.]—**Hardening Dividers.**—Would any kind reader inform me how to harden a pair of dividers? I have tried several times, but cannot harden them properly. I have hardened them in oil, but they either snap or bend, and will not go back.—E. B. W.

[57049.]—**Dynamo.**—I beg to thank Mr. Bottone for suggesting cog armature 4in. long, in reply to my query 56909. Before proceeding, however, I desire to state that the malleable field magnets are arranged on a frame, so that they will all bolt to one side of the pole-pieces; therefore I would further ask if the embracing pole-pieces being consequently 4in. wide, would be magnetised throughout their widths, considering the F.M.'s are only about 4½in. long on the space for winding between their faces, and being arranged in circular form, the pole-pieces will, I anticipate, be evenly magnetised in their radii; but perhaps you will consider a narrower ring of greater diameter will suit better now that I explain the F.M.'s will only operate on one side of the pole-pieces only, being arranged on a circular frame like the Siemens alternate machine. What should be the neutral space between these poles?—Subscriber from No. 1.

[57050.]—**Dynamo Construction.**—To W. H. Graves.—Will you kindly give dimension of armature for dynamo, to give about 15 amperes at 50 volts., together with a description of field magets and winding? I require it to be shunt wound. Also give description of field magnets for the armature you described lately in "E.M.," which I have nearly completed.—Electra.

[57051.]—**Legal.**—I am married, but no family; I have made a will, and bequeath all and every my real and personal estate and effects, unto my wife, absolutely. After this will is made, I buy a freehold land and house, and in the deed I find this clause:—"And the said E. Pelham doth hereby declare that he was married since the first day of January, 1834, and that no woman who shall become his widow shall be entitled to dower out of, or in the said land, messuage, and hereditaments." Will this clause prevent my wife having this freehold at my death?—E. Pelham.

[57052.]—**Weight and Stress of Beam.**—Would any reader work out the following for me?—A beam of any material, say (fir, Riga) supported at both ends, 10ft. long, 7in. deep, 2in. thick. Find the weight, and prove that stress is proportional to strain.—R. B.

[57053.]—**Coil Connections.**—Will any of our electrical correspondents assist one of their struggling friends in the following?—1. How must I connect the wires from a medical coil, with only one kind of wire used? 2. How must I connect the wires from a medical coil, with primary and secondary wires used? 3. How must I connect the wires from a 1in. spark induction coil, with condenser, dischargers, and commutator of the cylindrical shape? A sketch would greatly assist.—Weekly Subscriber.

[57054.]—**Cleaning Stationary Engine.**—To "Invicta."—A friend of mine who is in charge of a stationary or land boiler of the Robey principle, is much perplexed about the cleaning of it, as the only water obtainable contains a great quantity of lime, and the tubes being placed zigzag, it is almost impossible to dislodge the deposit. Perhaps your extensive experience would enable you to suggest something which would soften the deposit, and render its removal possible without drawing the tubes. I may mention that a great force of water cannot be obtained to wash out with.—Apprentice.

[57055.]—**Electric Bells in Series.**—There always has been a difficulty in working three or four bells in series, from one battery; this appears at last to be overcome, judging from the following:—"The short-circuiting device was in use for series working the bells some years; but it is now abandoned for the far more satisfactory double-wound electro-magnet. By the new arrangement the resistance of a bell is greatly reduced when striking the gong, and as all the bells are independent of one another, they offer less resistance, and take less cells." A description of the double-wound electro-magnet used in the above, will much oblige.—M. S. E.

[57056.]—**Problem.**—Will one of our readers kindly inform me how to ascertain which is the greater number, those that have died since the time of Adam, or those that are alive at the present time, as we all know that the population of the earth is always on the increase, and that more are born than what dies? Some persons contend that the number of living exceed the number of the dead, but as more are born than what dies, in a stated time, the greater number seems in favour of those living. If any of "ours" will kindly state how to solve this problem, I shall be exceedingly obliged, as others contend that the number of the dead exceed that of the living by 50 per cent., but no proof of this statement seems to be possible to obtain. Will any reader throw some light on the subject?—G. Fryer.

[57057.]—**Transmission of Power by Belts.**—Would some of your numerous readers kindly give some easy method, or formula, of measuring the above, in the case of belts transmitting small powers? I have tried several formulæ, but without success.—H. L. C.

[57058.]—**Science Examination, May '85. Mathematics, Stage II.**—Would any of your numerous correspondents kindly give a solution of the following? "Two circles touch each other externally at C; show how to draw a straight line through C to meet the circumferences at A and B respectively, so that AB may equal a given straight line, less the sum of the diameters of the circles?"—A Student.

[57059.]—**Power.**—Kindly tell me what power, in foot-pounds, would it take to carry a weight up stairs at an angle of 60deg., 110lb. 22ft., and what it would take to lift same by chain pulleys, which are as 1 to 24?—Hydrathana.

[57060.]—**Theoretical Mechanics.**—Will some reader kindly inform me whether a knowledge of the Calculus is absolutely necessary in order to enable one to acquire sufficient knowledge to pass in Honours in theoretical mechanics at the May exams.? If so, what work would be suitable for the purpose?—G. H.

[57061.]—**Platinotype Process.**—Will any reader of "Ours," who has tried the above process, give me his opinion as to whether it is easier or cheaper than the ordinary toning process for prints? It looks very simple and easy when one sees it done at the Inventories; but I should like to know if it answers well in the hands of an amateur, before I get a license from the company, which I am very much inclined to do.—R. A. R. Bennett.

[57062.]—**Automatic Musical Instruments.**—Will someone kindly tell me whether the aurephone is made on the lever principle like the organina, or simply suction through valves of paper like the orguinette? If one makes a continuous band of music, is it possible to repeat one tune any number of times, as the separate verses of a hymn?—R. A. R. Bennett.

[57063.]—**Specific Heat.**—If 5grm. of snow at 0deg. Cent. be mixed with 25grm. of water at 30deg. Cent., I want to find the temperature of the mixture?—Edmond Murray.

[57064.]—**Bisulphide of Silver.**—Will Percy W. Stanley (reply 56584) kindly give more particulars about Roseleur's bisulphate of silver method of silvering? I should much like to try it. Also, if it will require varnishing over on a barometer dial?—Argent.

[57065.]—**Cork-cutting Machine.**—Will some of our kind friends give me a sketch of a cork-cutting machine, to cut a cork from ⅝in. to 1½in. in one cut, and the largest size to be cut with the same machine is 2¼in. and the smallest size is ¾in.?—X. Y. Z.

[57066.]—**Reducing the Amount of Lime in Chalk Water.**—There is a process, I am told, for doing this. Clarke's patent is being used in some places, and I wish to know where I can learn what the Clarke's patent process is? I have been told it is mixing a certain small weighed portion of quicklime with so many gallons of the water; the hydrate of lime enters into chemical combination with the lime already in the water, forming an insoluble salt of lime; the result being that when the sediment has deposited, the clear water is left with a much less percentage of lime in solution than before. It will be a great boon if any of your readers can inform an old subscriber to Mechanic of this process.—C. H. D.

[57067.]—**Mineralogy.**—As I am spending three months in the heart of the mining districts of the Oural, am anxious to make a collection of stones. Unfortunately, my knowledge of mineralogy is very limited indeed. Will some of your readers, who understand this subject, have the kindness to inform me what stones it is best to collect, how to judge good specimens, and if a good collection has any value in England? As specimens are easy to be obtained, I wish to take this opportunity of making a collection, which, if I do not keep myself, can give to my friends who care to have them.—Oural.

[57068.]—**Dynamo.**—To W. H. Eaves, Coventry.—Having nearly completed an armature (exactly two-thirds less in all its details, with the exception of thickness of the sheet-iron discs) from the admirable description and sketch given by you in letter No. 24267, May 22, will you kindly inform me in regard to the following points? 1st, What size wire (and approximate quantity) will be best to wind the said armature with, which I intend for lighting purposes? 2nd, What number of 20-c.p. lamps may I reasonably expect from such a machine, granting the machine to be fairly well made from an electrical point of view? 3rd, If not too impertinent for me to inquire, when may we expect your promised letter, giving particulars in regard to winding field magnets, &c., and supposing when it appears (as I hope it will soon), in order to save further troubling you, if I make everything exactly two-thirds less in all its dimensions, what size and quantity of wire I will require for field magnets, &c.?—Cymro Gwledig.

[57069.]—**Hot Water.**—I have a hot-water arrangement that does not answer unless the fire is constantly attended to. The boiler, a copper one, is 9in. by 9in. by 4½in., is set up in a 16in. sham register grate, and is 17in. below the hot-water cylinder, which is 21in. by 11in., total length of flow and return pipe 82ft., which is ½in. lead, 7lb. to yard, it supplies five toilet cocks, the first one being 21ft. and the last one 41ft. from the cylinder. It supplies also, when necessary, about 50ft. of 1in. wrought-iron piping for heating purposes. My requirements are from one gill to a pint of very hot water about every three minutes from any of the cocks. Would a larger cylinder make the difference, or would the addition of another boiler, heated by gas and placed 3ft. from the first cock, and so arranged as to work jointly or separately? If so, a sketch would oblige.—Les Doents.

[57070.]—**Telephone.**—Having completed a pair of telephone (bells) I find that they will not speak at all. The magnets are 4in. by ⅜in., and each has a ½in. bobbin, wound with ten layers of No. 40 covered wire, the diaphragms, 2¼in. diameter, I adjusted to about a 1-30th of an inch from the magnets in each case, and can get no result at all. I sent a current from a small bichromate cell through about 1,000ft. of covered wire, and inserted the telephones in the circuit, one at each end of the wire, and when the circuit was completed, I could distinctly hear a click in both, at a distance of about 5in. from the phones. Are my magnets strong enough?—they each can lift about ⅞oz. If not, could I make them stronger by sending a current from a battery round the bars? Also have I got too much wire on the bobbins?—if so, how many feet ought I put on each bobbin of No. 40 wire, as it is difficult to tell by ounces how much of each wire to wind on, each number being thicker or thinner than the other, as I suppose would make a great deal of difference in strengthening or weakening the induced current, the same as it does with the inductoin coil, according to the wire used. Would Mr. Bottone or Mr. Lancaster, kindly put me to rights in this matter, as I should to have a pair of these instruments to talk with, merely for an experiment than anything else.—Telephonic.

[57071.]—**Beat Valves in Hydraulic Rams.**—I should like to supplement the inquiry of "A Melting Mechanic," and ask what rules govern the weight of the beat valves in hydraulic rams, and how the best weight is calculated when the height of fall and diameter of inlet pipe are known. What would be the weight for inlet pipes 1in., 1½in., and 2in. diameter? Also, how is the size of the inlet pipe calculated? What system do the makers go upon, and what proportion should the delivery pipe bear to the inlet pipe? What are the reasons why hydraulic rams are not in favour among engineers, and what are the chief sources of failure? What governs the length of inlet pipe—*i.e.*, what proportion should the length of the inlet pipe bear to the fall? Any further information on the subject will be very acceptable.—R.

**Cement for Marble, &c.**—Stir to a thick batter with silicate of soda, twelve parts Portland cement, six parts slaked lime, six parts fine lead, one part infusorial earth. Very excellent for marble and alabaster. The cemented object need not be heated. After twenty-four hours the fracture is firm, and the place can with difficulty be found.

**Every Workman** connected with the Building Trades requiring a Situation should advertise in "THE BUILDING NEWS," published every FRIDAY, price Fourpence, at 332, Strand, London, W.C.

"THE BUILDING NEWS" is the Principal Journal representing Architects and Builders, and has the largest circulation of any Professional Journal in the kingdom.

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The charge for Advertisements for Situations is One Shilling for Twenty-four Words, and Sixpence for every Eight Words after.

**Holloway's Pills.**—Indigestion, flatulence, and cramps.—These stomachic Pills are invaluable for all complaints of this character. They also correct the liver, and give tone to the whole alimentary canal. They purify the blood, correct all vitiated secretions, and elevate the tone of the nervous system when it is depressed.

## ANSWERS TO CORRESPONDENTS.

⁂ *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

### HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

⁂ Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

**The following are the initials, &c., of letters to hand up to Wednesday evening, July 15th, and unacknowledged elsewhere :—**

Rev. A. Willan.—C. P. Krauth, jr.—Chas. J. Simmons.—F. Hotham.—J. Epps and Co.—T. Fletcher.—Vacuum Brake Co.—G. Pardoe.—John Browning.—S. Beeching.—Lancaster and Son.—Gaseous.—Geo. Cordon.—An Anxious One.—A Working Man.—Mine Agent.—Wheels.—Brother Pivot.—Cambrian.—Accumulator.—Eyepiece.—C. A. W.—W. B.—Glatton.—F. H. Wenham.—J. C. L.—J. H.—Bobadil.

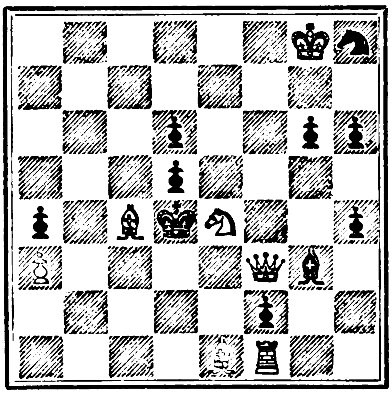
J. O. Evans. (We do not know that anyone is prepared to fit up the apparatus necessary; but there is much about the system in recent numbers.)—W. Ouin. (Receipt implied by the statement that it would be noticed. See p. 420.)—Robt. H. Hibbert. (We really do not know. Look in the files of the engineering papers. 2. No doubt there are both photographs and engravings of Hawarden Castle and Hughenden Manor, and an advertisement in the Wanted Column would probably bring you several offers. 3. If you mean directions for making a camera, they have been given several times—see, for instance, pp. 212, 380, 474, Vol. XXXVII.) — Architectus. (The question was answered, as well, perhaps, as it can be, in No. 1,009, p. 472, under the heading of Flies or Midges. It is stated that the Japanese lily (L. auratum), when it is in flower, will keep flies out of a room.)—Arnold T. Reed. (See answer to "Watchmaker" last week. If you want more mathematics than Guthrie uses, you should try Clerk-Maxwell's and Sir W. Thomson's works. In preparing for South Kensington examinations it is always advisable to join a class, as teachers know, as a rule, the most suitable books.)—Electron. (They nearly all depend upon making a bit of platinum wire red hot by its resistance to the passage of the current. Consequently, any cell which has a high electro-motive force, if only for a minute or so, is better suited to the purpose than a constant battery. 2. See recent back numbers and the indices generally.)—A. B. C. (See p. 61, No. 1,017, p. 592, No. 1,014, and the indices.)—R. S. Trews. (We do not think it is fully explained in any one number, though there is much about it in many.)—A Constant Reader. (Your six questions have nearly all been explained in recent numbers. The second is not explicit. Do you want to turn the rods hollow?)—H. W. B. (Most likely chloride of zinc; but see indices.)—J. Cox. (Apparently only a case of long sight complicated in some way that an oculist could not determine without personally examining the eyes.)—Highlander. (It depends on what you mean by practical. You should read up the numerous articles which have appeared in this paper. Dickson's "Practical Organ Building," Crosby Lockwood and Co., will perhaps suit you.)—Walter Griffiths. (The diving bell used at the late Polytechnic was, of course, supplied with a set of air-pumps, and air was pumped into the bell as soon as its mouth was sealed by the water.) — Ninnim. (Sperm thinned with a little paraffin oil is as good as anything in the shape of oil; but for some purposes plumbago mixed with purified fat or glycerine gives excellent results.)—Skinner. (Why not examine a specimen? If we recollect, it twines with the sun—that is in the direction of the hands of a watch.)—A Young Youngster. (Phosphorus is usually sold in the form of sticks kept in water or naphtha. What you appear to want is luminous paint. 2. We suppose you mean a picture of a colt foal; but whatever you mean the question is of no interest, and is on a par with the "dead donkey.")—J. Trutman. (The pamphlet is published by the U. S. Department of Agriculture, Washington, D.C. We do not know how it is to be obtained except on application to the department.)—A. B. C. (We cannot undertake the responsibility of defining what is and what is not an infringement of a patent; nor can we supply numbers and prices of specifications unless we happen to know them. Patent agents will supply the desired information for a small fee, and the specifications can be readily obtained from the Sale Office, Cursitor-street, Chancery-lane, W.C., by means of post-office orders, &c., addressed to H. Reader Lack.)—Patent Office. (The Patent Office is situate in Southampton-buildings, Chancery-lane, at No. 25, we believe; but if you address your communications to the Comptroller, Patent Office, London, they will be delivered as certainly as if you put the full address.)—Roland Oldham. (B. is right. So long as there is sufficient depth to kick out in, mere bulk of water under the swimmer makes no difference. The denser the water the easier the swimmer supports himself in it.)—Velocity Ratio. (We think you can obtain the examination papers from Chapman and Hall, 11, Henrietta-street, Covent-garden, W.C.)—J. Wilson. (A mixture of finely-powdered plumbago and washed fat, such as hog's lard, will, if wiped on in the thinnest possible film, preserve the iron for a long time if not handled.)—A. R. F. (Water gas is usually understood to mean the gas obtained by passing steam over or through incandescent coke. See recent numbers and the indices.)—Celt. (We do not see how anyone can give a satisfactory answer to such a question without knowing more about your method; but if you are quite sure that you have discovered a means of using packing for engines which makes it last five times as long as by the ordinary methods, it would certainly be worth while to take out letters patent.)—W. D. H. (Answered many times. Rub the article over with soap or wax, scratch through with a needle, and apply nitric acid in the lines. The rules are engraved by proper dividing tools.)—Engineer. (Why not join the classes in your city? A resident of Glasgow should have no difficulty in obtaining education, and you have at least one or two libraries. Read Rankine's and Fairbairn's works, and enter yourself at Anderson's College.)—New Subscriber. (The father is powerless, and must, moreover, support his daughter. His only remedy is by an action against her seducer for damages for the loss of her services. This is the present disgraceful state of the law which has been so severely commented on lately by the Archbishop of Canterbury and others.)—Dubliniensis. (Reply by all means, and demonstrate the error in Molesworth.)—Bernard O'Reilly. (Why should they not emigrate? With their united capital and disposition to work hard, they should do well either in Canada, New Zealand, or the United States.)—Turner and Fitter. (The best month to arrive there is October. If Scotch, go to Dunedin; if English, to Lyttelton or Auckland. Go by sailing vessel. Clothes required much the same as at home, and tools the same. A little stock of preserved meats, jams, cocoa, &c., to supplement the rations aboard ship, is advisable.)—W. C. (Yes.)—R. S. Nolan. (You are too good for this world, that is all! A six-foot graduate of a University "philosophical, mathematical, determined, stern," with a father with large influence with M.P.'s and others, who condescends to inform an editor that he desires employment of a gentlemanly nature where no "cringing" or "asking favour" is expected, must surely be joking.)

## CHESS.

All Communications for this department must be addressed to J. Pierce, Langley House, Dorking.

### PROBLEM DCCCCXLVIII.—"Tessie."

*Black.*



*White.* [7+10

**White to play and mate in three moves.**

### Solution to 946.

| *White.* | *Black.* |
|---|---|
| 1. Kt-Q Kt 6 | 1. Kt-K 6, or K-K B 5 (*a*) |
| 2. B-Q 2 | 2. Anything |
| 3. Mates | |
| | (*a*) 1. Kt takes Kt (*b*) |
| 2. B-Q B 3 (ch) &c. | |
| | (*b*) 1. Kt-Q Kt 5 |
| 2. Kt-Q 7 (ch) &c. | |

### NOTICES TO CORRESPONDENTS.

Correct solutions to 945 by A. A: E. Lecluse, (a most visible key move, otherwise meritorious), and T. L. Robins.

To 946 by R. A. Bennett (difficult; variation of B-Q 2 very good) F. A. Vincent, E. Stanley Follwell (but main play not given!) V. S. Pochin, B. Fison (a very fine and difficult problem), G. T. Stringfellow, A. S. Olver, and H. Culmer.

To 947 by E. S., H. Culmer, A. S. Olver, Streetgate, J. A. Miles (an excellent problem).

N. and F.—Your solution of 946 breaks down if

1 ———
P moves

L. S. Chivers.—If your solution is intended for that of 945, you had better look at it again.

A. S. Olver.—Thanks for the problem, which is interesting. You are right as to the number of solutions in 945. The solution to which you refer was incomplete.

## NOTICE TO SUBSCRIBERS.

Subscribers receiving their copies direct from the office are requested to observe that the last number of the term for which their subscription is paid will be forwarded to them in a PINK Wrapper, as an intimation that a fresh remittance is necessary, if it is desired to continue the Subscription.

## USEFUL AND SCIENTIFIC NOTES.

**Alkali, &c., Works Regulation Act.**—The Chief Inspector, Mr. A. E. Fletcher, has issued by the Local Government Board his report of the proceedings under the Act during the year 1884. The growth of the department may be judged by the fact that 20 years ago the report then issued dealt with the inspection of 85 alkali works. The number of works now registered under the Act of 1881 is 1,041, and the number of manufacturing operations is 1,420, two or more being in some cases under one certificate of registration. This great increase is due partly to the development of the chemical trades, but mainly to the taking in of several branches of chemical manufactures by the Act of 1881. When Mr. A. E. Fletcher took up, in 1884, the work of his predecessor, Dr. Angus Smith, he carried out the latter's intentions by rearranging the districts, so that there are now seven districts where there were five. These districts are more compact than before, and thus much time is saved that was spent in travelling under the old arrangement. These districts are (1) Scotland and Ireland with 144 and 50 works respectively; (2) Newcastle or the Northern district with 86 works; (3) St. Helen's, consisting of Cheshire, North Wales, and part of Lancashire, 161 works; (4) Manchester, consisting of East Lancashire and Yorkshire, 158 works; (5) Birmingham or South Midland, 112; (6) Bristol or South-West, 125; and (7) London or South-East with 205 registered works under inspection. There are in all nine inspectors. Scotland and Ireland have each an inspector, and each of the other districts one. There is besides an additional inspector appointed for Widnes. The 1,041 registered works—this number is an advance of 51 on that of 1883—are classified as follows:—Alkali, 127; sulphuric acid, 153; chemical manure, 222; gas liquor, 16; nitric acid, 69; sulphate and muriate of ammonia, 247; chlorine, 3; salt, 111; and cement, 93. Only one prosecution took place under the Act during the year. To the general report are appended elaborate local reports from each inspector, containing tables dealing with the statistics of every single work in the several districts.

Of the forty-six students from the City of London College, prepared by Mr. Henry Adams, M.I.C.E., F.S.I., examined in Building Construction by the Science and Art Department last May, only one failed. Over ninety-four per cent. of the students from this college during the last twelve years have been successful.

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⁂ It must be borne in mind that no Displayed advertisements can appear in the "Sixpenny Sale Column." All advertisements must be prepaid; no reduction is made on repeated insertions; and in cases where the amount sent exceeds One Shilling, the publisher would be grateful if a P.O.O. could be sent, and not stamps. Stamps, however (preferably halfpenny stamps), may be sent where it is inconvenient to obtain P.O.O's.

The address is included as part of the advertisement, and charged for.

Advertisements *must* reach the office by 1 p.m. on Wednesday, to insure insertion in the following Friday's number.

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5s. 6d. for Six Months and 11s. for Twelve months, Post Free to any part of the United Kingdom. For the United States, 13s., or 3 dols. 25c. gold; to France or Belgium, 13s., or 16f. 50c.; to India (via Brindisi), 15s. 2d.; to New Zealand, the Cape, the West Indies, Canada, Nova Scotia, Natal, or any of the Australian Colonies, 13s.

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Messrs. JAMES W. QUEEN and Co., of 924, Chestnut-street, Philadelphia, are authorised to receive subscriptions for the United States for the ENGLISH MECHANIC, at the rate of 3 dols. 25c. gold, or Thirteen Shillings per annum, post free. The copies will be forwarded direct by mail from the publishing office in London. All subscriptions will commence with the number first issued after the receipt of the subscription. If back numbers are required to complete volumes, they must be paid for at the rate of 4d. each copy, to cover extra postage.

Vols. IV., VII., XXVI., XXVIII., XXX., XXXII., XXXIII., XXXIV., XXXV., XXXVI., XXXVII., XXXVIII., XXXIX., and XL., bound in cloth, 7s. each. Post free, 7s. 9d.

All the other bound volumes are out of print. Subscribers would do well to order volumes as soon as possible after the conclusion of each half-yearly volume in February and August, as only a limited number are bound up, and these soon run out of print. Most of our back numbers can be had singly, price 2d. each, through any bookseller or newsagent, or 2½d. each, post free from the office (except index numbers, which are 3d. each, or post free, 3½d.)

Indexes for Vols. I., VI., VII., VIII., and IX., 2d. each. Post free 2½d. each. Indexes to Vol. XI. and to subsequent vols., 3d. each, or post free, 3½d. Cases for binding, 1s. 6d. each.

## OUR EXCHANGE COLUMN.

*The charge for Exchange Notices is 3d. for the first 24 words, and 3d. for every succeeding 8 words.*

**Good Value Offered** (cash or instruments) for all kinds of sound or repairable Scientific Appliances.—Caplatzi Science Depot, Chenies-street, near British Museum. Established 1862.

New £18 **Operatic Musical Box**, 6 airs, select, richly inlaid Zither, patent winder, inlaid glass lid, all improvements. What exchange?—Seel, George's-road, Bolton.

Iron Grand £60 new **Piano**, by Grunow, all improvements, including voix celeste, treble; bronze medallion front, walnut, £25. What offers?—Seel, George's-road, Bolton.

American walnut 280 dollar new **Organ**, two new swells, 12 stops, &c., all improvements, five years' warranty. £20, part exchange.—Seel, George's-road, Bolton.

Eight Original **Oil Paintings**, signed Slater, artist; grapes, &c. Approval with pleasure. New frames, English gold; choice. What exchange in clothes?—Address above.

What offers for small **Lathe**, cash or otherwise? Bicycle preferred; value £4; wood or iron. Willdeliver.—Particulars, P. Hurst, 15, Radnor-street, Plymouth.

What offers for "**English Mechanics**," from Nov. 18th, 1881, to Dec. 26th, 1884, unbound, 6 numbers missing.—J. Ellison, 33, Stanope-street, Newcastle-on-Tyne.

Exchange **Bench Lathe**, 4½ centres, removed for larger; iron bed, tap for chuck fitting; with or without faceplate, or Foot Motor.—Linscott, Ramsgate.

Gregorian **Telescope**, 4in. mirror, two small ones, two eyepieces, brass table stand, all perfect. What offers?—Linscott, Ramsgate.

Patent **Ice Cream Freezer**, 3-quart, with valuable Recipes and instructions; worth 18s. 6d. Exchange.—Printer, 12, Mersey-street, Higher Openshaw, Manchester.

Every description of **Printing or Picture** Framing neatly executed; in exchange for anything useful.—Address, stating particulars, Printer, 12, Mersey street, Higher Openshaw, Manchester.

**Printing Materials** wanted, in exchange for a splendid Silver Lever Watch, value £3; or will give cash.—Printer, 12, Mersey-street, Higher Openshaw.

Two-lens **Victoria Camera**, nearly new; 750 clean C.-de V. Mounts; 150 sheets Albd. Paper; for Lathe, Microscope, or anything useful.—W. Sharpe, Madeley, Salop.

"**The Carpenter and Joiner's Assistant**," nearly new, good condition, by Newlands; wanted, "Saunier's Treatise on Modern Horology."—J. H. Andrew, 3, Market-place, Penzance.

**Lathe**, 3½-centre, for American Chuck, cutter bar and cutters, slide-rest, or tools to value 30s.—A. W. Marshall, 184, Loughborough-road, Brixton.

Wanted, **Lists**, Engineering, Architectural, and Scientific Books; Civil Engineers' "Proceedings," early vols., "Engineering," any vols. Exchange Instruments, or cash.—Z. C., 62, Loddiges-road, Hackney.

Model **Horizontal Engine**, 1in. bore, 1¾in. stroke, and Vertical Copper Boiler, with fittings complete. Also small Fan. Offers.—G. Lund, Brereton-road, Bedford.

**Lathe**, 3in. centre, three speeds, all iron, and complete set of wood and iron turning tools, &c.—G. Lund, Brereton-road, Bedford.

**Lathe**, very powerful, 3in., back-geared, head and poppet, heavy 2ft. 6in. planed bed, made to order, never been used. Exchange to 5 guineas.—C. Blanchard, 29, Earl-street, Lisson-grove, London.

Complete **Jobbing Printer's Outfit**.—Press, Type, Ink, Roller, &c., 50s. Bench Lathe, 25s. Particulars given. Offers wanted.—Blakeley, Ainleys, Lindley, Huddersfield.

5 Octaves of **Pianoforte Keys**, suit amateur harmonium makers; accept anything useful to value of 5s.—J. Yeomans, Provident Cottages, Waterloo-road, Uxbridge.

**Musical Box**, 6 tunes, 40s. Electric Bell Set, worth 14s. Pocket Coil, 10s. Large Bottle Bichromate, worth 8s. Offers.—Below.

**Induction Coil**, worth 15s. Large Vacuum Tube, worth 15s. Wanted Model Slide-Valve Engine, 48in. Bicycle, or offers to W. Williams, 4, Ashton-road, Oldham.

**Electro Magnet**, weighs 8lb., 4-cell Leclanche Battery, sealed in mahogany case. Particulars sent. Wanted, good screw plate and taps.—Address above.

"**Dr. Fleetwood's Life of Christ**," unbound, complete, with presentation plate, cost 30s. 6d. Exchange for fan (for blowing fire), or anything useful to value of 10s.—S. Mitchell, 29, St. John's-place, Halifax.

**Ash-Pan**, steel, brass-mounted, double sliding action, with under pan. What offers? Lancaster's Merveilleux wanted.—Braun, 1, Kilburn-square, N.W.

5in. **Treadle Lathe**, dogs, carriers, rests and tools, surface plate, leg vice, files, &c. Must be cleared out. Exchange anything electrical or offers.—Apply, Jas. Hudson, 18, Westmorland-lane, Newcastle-on-Tyne.

Glass Engraver's **Lathe Head**, gun-metal, mandrel fitted and perfectly true. Make good polishing head. Cash or exchange.—As above.

Wanted, short 18-carat **Gold Chain**, curb pattern preferred. Exchange small rifle (Tranter's patent), value £3.—Particulars, T. A. C., Fairfield House, Warrington.

Series **Dynamo**, Paccinotti armature, 5½ by 3½, lights six 10 c.p. lamps; exchange £4. Electrical or Mechanical offers preferred.—J. Fulwell, 52, Craven-street, Coventry.

4½in. centre back-geared **Lathe**, treadle motion, double throw crank driving wheel, iron bed, standards, chucks, &c., in exchange for 2 h.-p. Vertical Boiler, good condition.—12, Union-street, Wells, Somerset.

**Electric Motor**, by Cuttriss, equal to new, recently cost £1 10s. Will exchange for Horizontal Engine, or anything useful.—W. Goodyear, New-road, Spalding.

**Bichromate Battery** of eight cells, 2 quart size, worth 5s. 6d. per cell. What offers for whole or part?—W. Goodyear, New road, Spalding.

Wanted, four five candle-power **Lamps**, in exchange for first-class Silver and Coraline Brooch and Earrings, in case, quite new, cost twenty-five shillings.—Lowe, 11, Wills-street, Lozells, Birmingham.

To Engineers and Others.—15in. **Ratchet Brace** and Adjustable Bracket, six drills; cost £5; is very strong.—Offers to W. G. S., 59, Percy-road, Kilburn.

I have two **Banjos**, mechanically made, with German silver band, one with 20 brackets and 30 handles, inlaid with pearl, with all the latest improvements: cost £3 10s to make; will exchange either for small Lathe or Bicycle.—Apply, 103 South Lambeth-road, Clapham-road.

Muzzle-loading **Revolver**, in handsome case, cost £10. Musical Cabinetto, cost £6, new condition; for Photographic, Magic Lantern, or useful exchange.—Beds, Belbroughton, Stourbridge.

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The English Mechanic
AND WORLD OF SCIENCE AND ART.
*FRIDAY, JULY* 24, 1885.

## GAS ENGINES.*

THE author thinks it strange that an industrial machine having so widespread an application as the gas-engine should have "no literature," by which phrase he means that hitherto no work has been issued in this country devoted solely to the consideration of gas-engines, for there is much literature on the subject to be found in various periodicals, in Transactions of societies, and even in books. The gas-engine has, however, taken so prominent a place in the industrial world, especially amongst small power-users, that there are many who will gladly welcome Mr. Macgregor's work, although it does not profess to be exhaustive, and will not convey much information to those who are acquainted with the German treatises on the subject, and familar with the theories of thermo-dynamics. Mr. Macgregor avoids all references to the cycles of Carnot, for he considers that in practice the gas-engine has no affinity with them, and is not at present worth studying as a theoretical heat-engine. In the chapters devoted to the theory of the gas-engine he has consequently confined himself to deductions made from the experiments of the best authorities. Starting with the definition of a gas-engine, which will be objected to by hypercritics—for the author speaks of heat generated by the "combustion" of illuminating or similar gas, whereas it is really that rapid kind of combustion which is termed explosion—Mr. Macgregor points out that the first cannon might have been called the first gas-engine. The Abbé Hautefeuille, in 1678, invented a powder machine for raising water, and Huyghens, seven years later, improved on that, for he employed a cylinder and piston; but John Barber, in 1791, was really the first to take out a patent for the production of force by the combustion of hydrocarbons in air. F. Lebon, in 1801, constructed a furnace for making gas, which gas, mixed with air, he compressed into a recipient and presumably exploded the mixture with an electric spark, as he recommends an electric machine; but in those days new inventions were not taken up by syndicates, and there were few papers in which descriptions of new inventions were given, so that the records in the Patent Office are the only evidence available, and they are not always trustworthy, for a specification was often drawn so as to conceal the real method adopted by the patentee. It may, however, be accepted as true that the gas-engine on paper is at least as old as the century, and certainly Cheverton, who wrote in 1826, had the gift of foresight, for he pointed out that the practical mechanic wanted a dynamic engine, which is always ready for work without costing too much to drive, and causing no loss of time in preparation; and he went so far as to say that the advantages which society would derive from such a machine would be incalculable, even if the cost should be greater than that of steam. To the Frenchman, Lenoir, is due the honour of starting the gas-engine on its road to success, for he did produce a practical motor, which subsequently fell into disrepute because it was unable to substantiate the claims made for it. Hugon and Reithmann claimed the invention, but although the dates are only a quarter of a century old, there is much uncertainty about the matter. Like all new inventions, many of the experiments were carried out in secret, and it is most likely that several inventors had been endeavouring to carry out the same principle in a different manner. However, Lenoir made a gas-engine that would work, albeit rather expensively, and in 1867 Otto and Langen exhibited their engine, which is practically the forerunner of all successful applications of gas as a motive power, for it combined a knowledge of the theoretical requirements with considerable mechanical skill, and in a very few years a large number of their engines were sold. The start thus gained has never been lost, and the success which attended the earlier efforts of the firm established at Deutz enabled them to proceed with the development of the gas-engine, and the result is well known so far. Of late years, many improvements have been introduced, and the Inventions Exhibition shows, if any evidence is needed, that the gas-engine is the motor of the future, at all events where small power is required—say up to forty horses. The Otto and Langen engine of 1867 was, however, anything but satisfactory, for it made a fearful noise, and, like the earlier steam-engines, obtained its power from the atmospheric pressure on the piston—that is, the piston had a rod with a rack, which, when the explosion took place, was jerked upwards, and a partial vacuum being created in the cylinder, the piston was forced downwards, the rack, by means of ingenious clutch gear, imparting motion to the shaft. The Italians, Barsanti and Matteucci, seem to have been earlier by ten years than Otto and Langen in devising a practical gas-motor; but for some reason they did not persevere, and Gilles, of Cologne, having succeeded in making a comparatively noiseless engine, Otto was put on his mettle, and produced his well-known "silent" motor. An historical résumé of the invention of the gas-engine appeared in Vols. XXVI. and XXVII., based on the records of the Patent Office, and although Mr. Macgregor seems to have omitted a reference to the gas-engine invented by Mr. F. H. Wenham in 1864, it is on record in Vol. XXVII., p. 63, that Wenham "brought out in an almost perfect form the double-piston atmospheric gas-engine"—in fact, he has the honour of being the first to bring out an economically-working gas motor. Others may have introduced practical gas-engines, but Wenham's was an economical as well as practical success. Of late years the gas-engine has made great strides towards perfection, and except that in a work dealing with the gas-engine it is necessary to trace its historical development, the detailed descriptions of the earlier models are of little interest. Otto's engine is the typical gas motor, and is that one which has been the subject of the greater number of experiments. Mr. Macgregor gives a number of these in detail, including those of Messrs. Brooks and Steward, which we described in Vol. XXXVIII. p. 527. These gave the indicated work as 18 per cent. of the total heat of combustion of the gas, and the useful work as 14½ per cent. The experiments of Brooks and Steward were carried out under the direction of Prof. Thurston, with the view of checking his own results obtained from engines of various size and different design. Prof. Thurston found that a horse-power was obtained from 21 to 23 cubic feet per hour of water gas, the quantity used increasing slightly in the smaller engines. Messrs. Brooks and Steward found that 21 cubic feet of average good quality coal-gas might be accepted as the datum for calculations; but it is obvious that the quantity of air will depend on the quality of the gas, and to obtain the best results it is always advisable to ascertain the average composition of the gas used. Brooks and Steward found the ratio of air to gas to be about 7 to 1 when the Otto with which they experimented was running most economically; but they used a poor quality (Hoboken) gas, and probably a safe datum is from 7 to 10 volumes of air to one of gas, according to the quality of the latter. Crossley's improvements in the Otto are not changes in principle; but they have had the effect of increasing the efficiency and steadiness of the motor, and of remedying some mechanical defects. Mr. Macgregor mentions the various patents which have been taken out from time to time; but devotes more space to such designs as the Lenoir, Bischopp, Wittig and Hee, Körting-Lieckfield, Simon, Maxim, Siemens, Clerk, and Otto. Of Atkinson's designs he says, all present "novelties of ignition, regulation, and distribution, that we regret it is beyond the scope of this work to consider." Other well-known designs seem to have been dismissed in as few words, and of Siemens' latest we are told that "it is more notable for its theoretically perfect plan than for any practical results that have as yet been attained by it. It is very simple, and should be productive of highly efficient results; but it is observable that the highest results have not always followed the best theoretical design, particularly in gas-engines." Dugald Clerk's engine is described at some length, and a chapter is devoted to Clerk's theory, as set forth by that inventor in his well-known paper. Mr. Macgregor also devotes a chapter to the views of M. Witz, and another to the researches of Berthelot and Vielle, as given in the *Comptes Rendus*, on the relative speed of combustion in gaseous explosive mixtures. The chapter on the theory of the gas-engine, in which the method of calculating the heat evolved by the combination of the hydrogen and carbon of the gas with the oxygen of the air is set out, will be useful to many. The calculations, according to Mr. Macgregor, are more readily effected in the decimal system; but he afterwards gives reduction factors, where necessary, to "convert the results into the irrational system still in use by English engineers." The next sentence reads, "Taking 100 litres as the volume of gas employed, we find the weights in grains," which we take to be a typographical error, as the heading in the tables reads "Grms. per 100 Litres." As the work is, we presume, intended for English engineers, it would perhaps have been better if the author had adopted their "irrational system" throughout, for it is, to say the least, rather confusing to have litres and "heat in water-gramme degrees" in one chapter, and "cubic feet," "foot-pounds," and "heat-units per cent." in another. The chapter on the indicator diagram of the gas-engine will be useful to a good many who are studying these motors, provided they understand the formulæ, which are those of Profs. Ayrton and Perry. The work is illustrated by seven plates, containing altogether seventy-five figures, the engines selected being shown mostly in sectional drawings, with detailed sketches of parts, and as the text is divided into chapters on (1) direct-working engines without compression, (2) engines working with compression, and (3) compression engines with compression pump, the practical man will be able to readily obtain a good idea of the different types of gas-engines, and of the principles on which they are constructed.

## BELTS v. ROPES.

THE contradictory statements made in reference to the relative advantages of belts and ropes might with advantage form the subject of an inquiry by the Institution of Mechanical Engineers. A series of properly conducted experiments carried out by experts ought to be, and would be, of great interest to engineers and to power users, for as matters stand opinions are, to say the least, divided, though possibly the majority favour the belting. Even in connection with belting there is considerable difference of opinion as to the truth of the saying "nothing like leather," for while some declare for the comparatively new link belting as the greatest improvement in modern times, others will have nothing but cotton belting, or the patent beltings made up of plies of different materials. Those interested in the matter have a good opportunity of seeing the various kinds applied to all sorts of machines at the Inventions, and in spite of what has been said about ropes, two of the large engines have them, while in some cases they are employed in driving dynamos. There are certain conditions in which ropes are specially indicated, as, for instance, in driving from one pulley to several floors; but where the ropes all drive on to the same shaft, that is on one pair of pulleys, it is contended that they never pull all together as one: each rope has its own travelling speed, and consequently there must be a loss of power as compared with abelt. Ropes are, however, less costly than main belts—whether they are really cheaper is the point to be decided, and that can be satisfactorily done only by first determining the actual work of which ropes are capable as compared with belts; and then ascertaining their average life under different conditions, and the cost of replacing, in the shape of time required, when worn out, and also time occupied in tightening up, &c. These latter items could be easily found by users amongst themselves in the course of a few years; but we want first some authoritative figures made with the aid of the dynamometer in a series of experiments. Makers of leather belts are, as a matter of course, advocates of their own goods, but they not unfrequently state their case with fairness when reading a paper before a society. At the convention of the National Association of Millers, held a short time ago in Glasgow, Mr. John Tullis, of that city, read a paper on "Belts v. Ropes," in which he endeavoured to settle the question by reviewing the relative advantages and disadvantages of the two systems. Both have their admirers and advocates, and both, in Mr. Tullis's opinion, have proved worthy of much patronage. First cost is not everything, and though there is no doubt that main belts are more expensive than ropes, it is necessary, also, to take into account the extra cost of the grooved as compared with plain belt pulleys. Well-made, properly-stretched leather belts will run for 30 years, says Mr. Tullis, and will be good then for cutting up into smaller sizes. Belts and ropes both drive well, when the distances between the centres of the pulleys are great, and the pulleys themselves of large diameter, but ropes are beaten, Mr. Tullis thinks, when the shafts are near each other and the pulleys are less than 54in. in diameter. There are one or two exhibits at the Inventions which might cause him to modify that opinion, though, in the cases meant, it is true that the ropes are not employed for transmitting much power. Mr. Tullis's remarks on the treatment of belts are so good that we quote them almost *in extenso*, with the remark that many power users prefer to employ castor oil in preference to dubbin and boiled linseed oil. Mr. Tullis says:—After having been taken up once or twice during the first year, good belts require very little attention during subsequent years. If the belt is driving in a warm engine room it ought to get a coating of curriers' dubbin three times a year. All belts having much work to do ought to present a clammy face to the pulley, and this condition can be best maintained by applying one coating of dubbin and three coatings of boiled linseed oil during a year. This oil oxidises, and the gummy surface formed gives the belt a smooth, elastic driving face. A belt looked after in this way will always run slack, and the tear and wear will be inconsiderable. On the other hand, dry belts have to be kept tighter, because they slip and refuse to lift the work. The friction of the running pulley "burns the life" out of the belt while this slipping is going on. The driving face is made as hard as millboard, and as well polished as a millstone. Bushes are ground down, shafting worn, oil consumed, the belts killed and condemned, because the disease has been misunderstood. If a belt is wanted to do more work than was originally intended, by, say, an addition to the machinery of the mill, a very good plan of getting power is to run a second belt upon the top of the one in use. Do not connect them in any way, and the outside belt will work for itself, and do a large proportion of the driving. By way of experiment, I have made four 6-in. single belts, running independently on the top of one another over 4-ft. driver and driven pulleys, transmit over 80-horse power, the belts travelling at a speed of 1,800ft. per minute. Each of these belts did its own share of the work, and while running over its own circumference each gained a little over 30ft. per minute upon the one below; so that the outside belt travelled over 90ft. per minute more than the inside belt. The best leather for making belting is that known as "Orange Tan." This leather is made from the heaviest and best-grown Highland ox hides. During the process of tanning, instead of swelling, as is the case with all bark tannages, this leather becomes thinner in substance, and weighs 45 per cent. less than if tanned with oak bark. The breaking strain, according to Lloyd's Proving House test, is 45 per cent. greater than oak bark tanned leather. There are life and spring in it not found in any other leather. For driving machinery this leather stands first. Long belts should never be made heavy, because the weight makes them swing to a certain extent. The heavier the belt the greater the oscillation. Double-orange tan belts will work as steady as ribbons up to 350ft. long.

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* Gas Engines. By William Macgregor. London: Symons and Co.

As to which side of a leather belt ought to run next the pulley, Mr. Tullis points out that although it is well known the "grain" side gives the best results at first, it is better to put the belt on in the natural position, for it will have a longer life. If the boiled linseed oil is applied as he recommends, the flesh side will become as smooth as the "grain," and quite as much driving power will be obtained. Mr. Tullis states further that with the flesh side to the pulley the belt is more pliable, and a strip of leather well pulled will curve naturally with the flesh side inwards, thus teaching what practice proves to be correct. A properly-made joint is, however, of the first importance, and, according to Mr. Tullis, a good butt joint with the holes punched to the diamond pattern, and well laced, is as good as any.

Referring to the patent leather chain-belting, or link belting, which is "arched" to suit the curve of the pulley face, Mr. Tullis says that no unequal strain comes upon the rivets, as the belt is made thicker at the edges than in the centre, to suit the curve of the pulley—all that is needed for guide being a template of the pulley. This kind of belt, it is asserted, will transmit 25 per cent. more power than a flat solid leather belt of the same width; because, in Mr. Tullis's opinion, a flat belt always retains a cushion of air between itself and the pulley, which air escapes between the links of the chain belt. A simpler method would be to perforate the periphery of the pulley; but the fact is the link belt has other advantages than spaces for the escape of air. The joint is made by riveting the links, which leaves a belt without a visible joint, and perfectly endless, running straight and steady at any speed. Mr. Tullis has a good word for cotton belts, for they are used in the works with which he is connected, and are exposed to the weather, the only protection being a coat of boiled linseed oil applied every two months; but they are protected from fraying at the edges by Tullis's patent projecting leather edge, which is riveted on with copper wire, and takes the thrust of the shifting fork. With regard to leather ropes, which have been introduced in various forms, Mr. Tullis makes the following remarks, but confesses that none of the devices have been able to compete successfully with cotton or hemp ropes:—There is the ordinary cable-laid hide rope, the strands of which soon cut themselves into pieces by pressure and internal friction. There is also the "Combe" rope, which is made of a multitudinous body of long leather strands twisted together; the friction and pressure also soon cut them up. Then there is the V-shaped solid leather rope, which is much too stiff and hard. The bottom plies get all cut and broken by the outside strain. There is the V-shaped rope with two or more plies of solid leather, with friction sections riveted on these plies. The openings left between these sections are meant to make this rope more pliable, and less liable to cut. It has done good work, but is not a success. There is the square solid leather rope that is now being made, the faults of which are the same as those of the solid leather V-rope. However, there is nothing like perseverance. The outcome of this desire to improve is the patent V-shaped chain rope. This rope seems to possess all the qualities required to enable it to become the driving rope of the future, for it can be put on or shortened in a few minutes, it works well over pulleys of any diameter, can be made to fit any shape of groove, and gives four times the working contact of a round rope. The fact that great differences of opinion prevail shows conclusively that belting, after all that has been said and written about it, is not thoroughly understood, and it would be to the advantage of power users if a series of exhaustive experiments were made in order to obtain some thoroughly trustworthy data.

## THE INTERNATIONAL INVENTIONS EXHIBITION.—XII.

### Philosophical Instruments and Apparatus.

THE student of science who expects to find all the more modern philosophical instruments and apparatus gathered together in this group will be disappointed; but by turning to the preface in the catalogue, which is from the pen of Prof. G. Carey Foster, M.A., F.R.S., he will obtain a brief résumé of the progress that has been made in the last thirty years or so. Scientific instruments may be divided roughly into two great classes—those for producing special physical conditions or particular phenomena, and those for defining the conditions or phenomena or for the observation of the resulting effects. It is in the latter class that by far the larger number of improvements have been introduced, and in every branch of science the fullest prominence is now given to numerical measurements. Walking through the group the visitor will almost of necessity be attracted by the gigantic influence machine which Mr. Jas. Wimshurst, one of the consulting engineers to the Board of Trade, made for the physical laboratory at South Kensington. We described this machine in No. 1035; but it will be worth while to repeat that it is the largest and most powerful in the world, the two discs being of plate-glass $\frac{3}{8}$in. thick and 84in. in diameter, each weighing 280lb. These discs have 16 radial sectors of tinfoil 19in. long, presenting a total metallic surface of more than 500 square inches on each plate. The machine represents the latest improvements of Mr. Wimshurst, and belongs to what is now the leading type. The discs are rotated in opposite directions, and the foil sectors are swept by little brass brushes carried by neutralising rods placed at an angle of 45° diametrically across the discs. The electricity is collected by four combs, two to each disc; but these do not aid in the induction, for if they are removed and the sectors are comparatively close together the sparks will leap from one to another. A 12in. "compound continuous electrophorus," specially designed to exhibit this phenomenon, is placed on the stand, in company with an 18in. laboratory machine, and the separate parts for making the latter, so that all who desire to make a machine of the kind may have an opportunity of thoroughly comprehending its construction. For several years Mr. Wimshurst has devoted a considerable portion of his spare time to the practical study of electricity, and the machine which bears his name has in its latest forms attained to a wonderful degree of perfection. Mr. Wimshurst includes in his exhibit a Nicholson's revolving doubler of 1780, the parent of all influence machines. Prof. Carey Foster, however, says that the earliest application of induction on the "compound-interest principle" appears to have been Bennet's Doubler, 1787, an application revived by Varley in 1860, and since made familiar in the machines of Töpler, Holtz, Voss, and Wimshurst. Specimens of the Voss machine are shown by Becker and Co., of Maiden-lane, Covent-garden, at a stand in a corner of the Swiss Court, or the east-central gallery, so that students will have an opportunity of comparing the two machines. Some members of the Physical Society of London exhibit apparatus which are of necessity in a glass case, and as there is no attendant the visitors will not learn much unless they already know something about the instruments. A similar remark applies to opticians, philosophical instrument makers, and others, who have crowded apparatus into a case and left them without labels or a word of explanation. Two instruments or machines which attract much attention are Edmondson's Circular Calculating Machine for working the four fundamental rules of arithmetic, and Tate's Improved Arithmometer. The former is exhibited by J. Edmondson, of Heath-avenue, Halifax, and is an adaptation of the circular principle, which admits of any product disc being brought opposite any digit on the face-plate while the figures appearing in shallow apertures are easily read. Click springs are dispensed with, and the "eraser" brings to zero any part or the whole of the figures on the circle. The driving handle is conveniently placed, and must be turned in one direction always. The machine deserves the attention of those who have long sums to work in the first four rules of arithmetic. The arithmometer exhibited by Mr. Tate, of Gloucester-street, Clerkenwell, resembles the calculating machine of Thomas de Colmar, which was illustrated in Vol. XXII., p. 642, but materially improved and simplified, while it is a strong and trustworthy apparatus. It is in use in many offices, and at the Exhibition an attendant is ready to show off its capabilities. M. Hedicke and Co., of Adelaide-place, London Bridge, exhibit the interest-calculating machine of Herr Hartmann, which is said to be the first of its kind ever produced. It calculates the rates of percentage from ½ to 5, divided in sixteenths, and from 5 to 10 in eighths, the working being simple, while the results are rapidly obtained. It consists of a scale having on its right a roller containing the numerical table, and on the left a cylinder with a graphical table and two sliding indicators. The cylinder is a supplement to the roller. Mr. T. Dixon, of Buttershaw, exhibits his combined circular, multi-circular slide-rule, which is equivalent to a straight rule 50ft. long, and also the machine for setting out and dividing spiral and circular slide rules. Aston and Mander, of Old Compton-street, Soho, exhibit the slide-rule of the late General Hannyngton (see Vol. XXXVII. for a discussion on slide-rules), and a collection of their own well-known productions. Not many of the opticians show telescopes, but Ross and Co., of New Bond-street, have one or two, and several microscopes, including both monocular and binocular with the Zentmayer swinging tailpiece. Wenham's paraboloid, diffusion condenser, and reflex illuminator are also exhibited. R. and J. Beck, Cornhill, exhibit the "star" microscope (illustrated on p. 406), and, amongst a notable collection, the ribbon-cutting microtome, which is really an attachment for taking away the slices as they are cut, and can be added to most microtomes. This simple addition is a very useful one, as it preserves the slices intact. C. Baker, of Holborn, amongst his exhibits has an ether freezing, Haile's universal, and Rutherford's freezing microtomes. He shows also Stephenson's erecting binocular, and the colorimeter used by Drs. Tidy, Odling, and Crookes in determining the purity of water, or rather its degree of freedom from cloudiness. Newton and Co., of Fleet-street, amongst other exhibits, show Wright and Newton's patent lantern microscope, and the micro-polariscope—the former being the apparatus which was highly commended at the meeting of the R.M.S. on Nov. 12 last, as reported p. 259, Vol. XL., and some details of which were supplied by Mr. Lewis Wright on p. 299, same volume. J. H. Steward, of the Strand and Cornhill, amongst a rather large collection, shows Bridgman's triple lantern, with three and four way plug dissolvers and connections for facilitating the work of the operator; slide carriers of different patterns, range finders in some variety, and a speciality in Kapteyn's chronograph for railway timing, with the scale marked in kilomètres and miles to facilitate the ascertaining of the speed of trains. Belle's registering fluid measure and indicator is also a useful piece of apparatus, as it cannot register until the fluid is actually measured. How and Co., of Farringdon-street, exhibit Dr. Dupré's improved apparatus for applying the heat test to dynamite, gun-cotton, and similar explosives, and also his apparatus for the estimation of urea by means of the hypobromite of sodium. Biological apparatus for the examination of micro-organisms, including incubators, steaming appliances, hot-air chambers, sterilising and cultivating vessels, &c., are exhibited by Griffin and Sons, of Garrick-street, while Deane and Co., King William-street, E.C., show a collection of Fletcher's patent furnaces, forges, and blowpipes. Horne, Thornthwaite, and Wood, of the Strand, show a variety of articles connected with photography and optics, including Ackland's astigmatic disc, Lennox Browne's throat illuminator, and Wood's lime-light microscope. They also exhibit a 6½in. reflector on equatoreal stand, with tangent screw adjustment. Mr. W. F. Stanley, of Great Turnstile, exhibits a number of inventions in mathematical and scientific instruments, and altogether the student has an opportunity of seeing, as it were, at one view a collection of apparatus which it would take days to find by hunting through the shops of the dealers. Amongst the exhibits of special interest may be noticed the stand of Col. Ross, which contains about thirty sublimates on aluminium plates, and a number of other specimens, which will not fail to interest the worker with the blowpipe and the student of pyrology. The gallant colonel also shows his improved patent condensing smoke-filter tobacco-pipes. As everything is clearly labelled at Col. Ross's stand, the visitor can spend half an hour there with pleasure and profit, especially if he understands anything of blowpipe analysis. Professor H. S. Hele-Shaw, of Bristol, but soon to be of University College, Liverpool, exhibits various applications of the sphere and roller integrator, which is to be seen employed for transmitting power in the group devoted to manufacture of textile fabrics. Mr. H. Cunynghame, of Fulham, has a variety of exhibits which will interest the mathematician —for instance, a machine for describing rectangular hyperbolas for use in determining questions of maximum and minimum values in political economy and other sciences, a machine for solving by mechanical means the real and impossible roots of quadratic and cubic equations, and sundry other appliances which would occupy much space to describe. In fact, there are in this group so many pieces of apparatus which it is impossible properly to describe without diagrams, that we must pass over them with the intimation that they are nearly all worth the attention of those interested in the progress of philosophical apparatus. Townson and Mercer, of Bishopsgate-street, have a good collection of chemical and philosophical apparatus; and the Cambridge Scientific Instrument Co. also exhibit some of their productions. Mr. P. Ward, of Fulham, shows a collection of apparatus for illuminating internal parts of the body, for surgeon's use, but some of these can be seen at work, as we stated on p. 378, at the stand of Mr. Swan in the Electric Group. J. J. Hicks, of Hatton-garden, E.C., exhibits a collection of thermometers, hydrometers, &c., McLeod's sunshine recorder, Beckley's self-recording rain-gauge, and a great variety of apparatus, but the principal novelty is the opaque stem chemical thermometer, which facilitates the reading of the temperature. The principle of this arrangement is applied to several instruments, a channel of plain glass being left on each side, so that the position of the contents can be easily seen. The principle is applied to water gauges for steam boilers on the patent of Crossley, Hanson, and Hicks. The tube having opaque enamel at the back, with a line of plain glass, indicates the position of the water very clearly, because the water itself magnifies the dark column, which is the boiler front seen through the plain glass. The line of demarcation is very clear, and can be distinguished without any liability to error. Mr. Hicks also exhibits a lamp for medical men, in which a platinum gauze cap is made incandescent by forcing a blast of air through benzoline contained in a sponge reservoir. Adjoining Mr. Wimshurst's great influence machine, the operation of polishing cylindrical lenses for remedying astigmatism can be witnessed at the stand of Messrs. Pickard and Curry, of Great Portland-street, W., who exhibit the magazine ophthalmoscope of Mr. John Couper, F.R.C.S., and his optometer, with index at back. Both instruments are on the same principle, and the ophthalmoscope contains 72 lenses, divided equally between minus and plus, which are passed in rotation by a simple mechanical arrangement up to the viewing hole, each lens being centred as it arrives at the point of sight. The apparatus is so arranged that it can be placed in any desired position, and from its construction the eye of the ophthalmoscopist is brought nearer to the eye of the patient than the far-point of the latter. Prof. McHardy also exhibits his self-registering perimeter with charts, which registers on either of two scales, and is adopted for ascertaining and recording the fields of direct vision and of indirect vision, and also for determining the angle of squint. Mr. W. H. Harling, of Hatton-garden, E.C., has a notable collection of mathematical, drawing, and surveying instruments, but his principal novelties are bow pens and pencils with spring needle-points, which facilitate the drawing of very small circles, and Grace's patent epicyclic elliptograph and geometrical pen, which will describe mathematical ellipses of various sizes and proportions, from 1¼in. by ¾in. up to 20in. by 10in. and more. The instrument is rather complicated in gearing, but the toothed wheels do not interfere with the operator, and by a combination of change wheels he is enabled to draw an almost unlimited number of symmetrical curves. This instrument is at present practically unknown, but there will be a considerable demand for it when its capabilities are recognised. Mr. Harling also exhibits his "Engineer's Own Level," which is provided with his patent exterior sights for reading "near sights" with accuracy and despatch.

Mr. A. J. Frost, 6, Westminster-chambers, S.W., exhibits Mr. Latimer Clark's transit instrument for obtaining time from sun or stars, which is much cheaper than the old form, and the method of using which is described in Mr. Clark's book which we reviewed on p. 488, Vol. XXXV. A very interesting collection will be found at the stand of Mr. W. Groves, of Bolsover-street, W., where Stroh's curve writer and his sonorous vibration apparatus can be seen; also Prof. Hughes's induction balance and its accessories, his magnetic balance, and a number of test pieces of steel, with sundry other apparatus of more or less interest. Adjoining, Sir David Salomons, Bart., exhibits a case containing models, &c., illustrating his numerous inventions, including a locomotive showing his method of electric signalling to the driver through a centre insulated line, a system which we described some years ago, and which automatically stops a following train, when it enters a section already occupied, by an electro-magnetic arrangement for shutting the regulator.

Messrs. A. Légé and Co., of Turnmill-street, E.C., exhibit Sir W. Thomson's improved tide indicating machine, in which the barometer, thermometer, wind-gauge, &c., are combined, and also Roberts's tide-predicting machine. In these machines the paper is not ruled, but the time is indicated by perforations in the margin, an arrangement which is said to avoid mistakes. Mr. Baldwin Latham exhibits his portable tide-recording gauge, in which the paper is either ruled or perforated by a special striker every hour, the drum being driven round once in twenty-four hours. Dr. Dudgeon shows his diving spectacles fitted with air and glass lenses; an air lens in glycerine to exhibit the refractive power, and his well-known pocket sphygmograph, which we illustrated on p. 104, Vol. XXXIV. We have already in a previous article (p. 337) mentioned Mr. J. Rigg's educational models, which properly should have been grouped in the "elements of machines," and have little space to notice other exhibits, except to point out that there is a notable improvement in mariners' compasses by Mr. F. M. Moore, of Belfast, in which semicircular correctors act on a lowered system of needles, while quadrantal correctors, in the shape of moving iron balls, assist in preventing "heeling errors," and render the adjustment of the compass easy and rapid. Dr. Richardson exhibits models of the apparatus for the painless extinction of life in animals, which we described on p. 378, last volume. W. J. Wilson, F.C.S., of Ealing Dean, exhibits a harmonograph, with specimens of the curves produced by it, and there are in the group a variety of instruments of more or less interest merely to catalogue which would exhaust our space. The student of science, even if he does not find apparatus he particularly wishes to see, will find much that will attract his attention, and many exhibits that deserve careful notice.

## ENGINE-MAKING AT HOME.—VIII.

### The Piston and Cross-Head.

HAVING the cylinder both bored and faced, chest and covers and glands fitted and holes drilled, perhaps it would be well, before preparing any more attachments, to bolt these parts together. This reminds us that we require a number of bolts of various sizes, and as such repetition work is rather tedious, we will consider the best way to get through it.

One circumstance is favourable: none of our screws are very small, and therefore not so trying

FIG. 101.

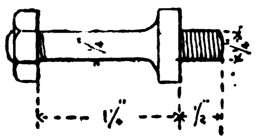


FIG. 98.

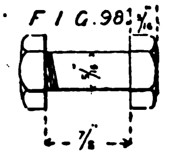


FIG. 100.

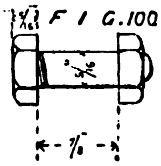


FIG. 107.

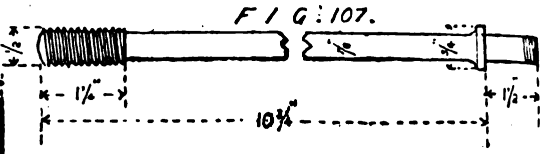


FIG. 97.

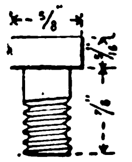


FIG. 102.

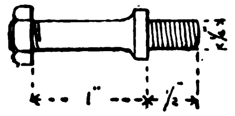


FIG. 99.

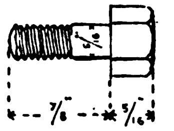


FIG. 104.

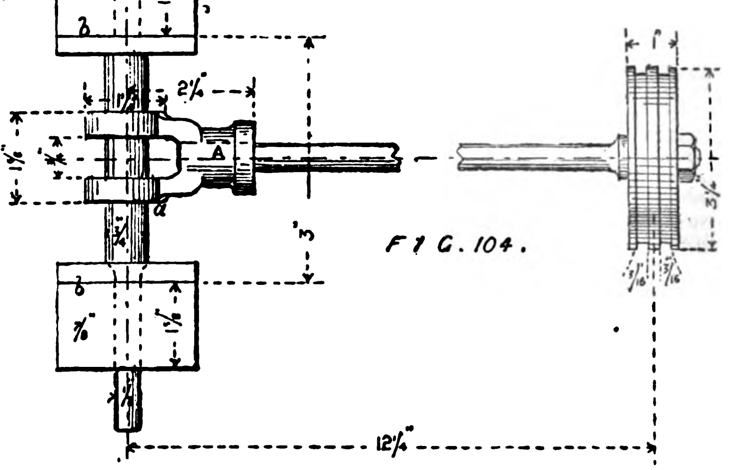


FIG. 105.

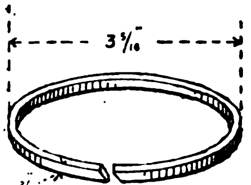


FIG. 106.

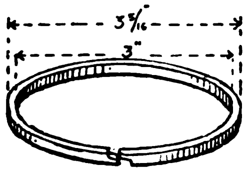


FIG. 103.

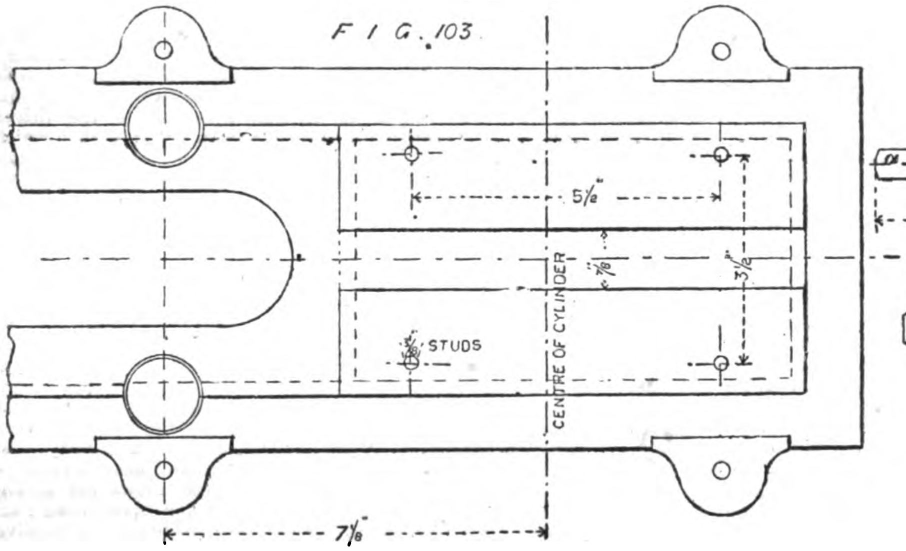
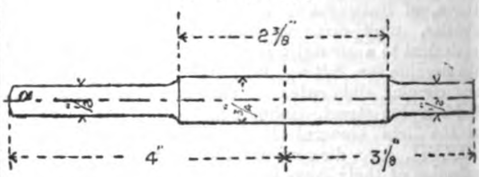


FIG. 108



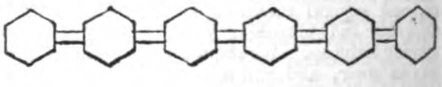


FIG. 96.

to one's patience as the toy screws of the model maker's. I should prefer, also, to make all screws of steel wire, in preference to iron or brass. Small screws when made of wrought iron are apt to bend, and brass, though easy to work, looks common in engine work; while steel takes a clean, keen thread, resists liability to twist off, or strip, and keeps a high polish.. The labour of screw-making consists chiefly in turning down from the diameter of the head to that of the screw. Each screw is better turned separately, to avoid the spring inseparable from turning a long strip of slight metal, and the best way to chuck is either between centres using a specially small driver for the purpose, or holding the head in some type of bell or self-centring chuck, and allowing the opposite end to run on the dead centre.

The best way, I think, to cut the nuts is to get a strip of metal of a thickness and width suitable for a single nut, but long enough to embrace a dozen or more, and to mark them out in line, leaving a space between each sufficient to get a hack saw in—to punch the centre of each for drilling, to drill and tap them all while in the plate, and then to saw them out afterwards; finally to thread them in batches on a screw, and file the hexagon flats off altogether, using the file length ways. The chamfer on each nut must be added afterwards, singly in the lathe. If brass nuts were used, they would be cast in a string, Fig. 96.

The screws required for present use are shown in the figures. Of Fig. 97 we require four for bolting down the cylinder; of Fig. 98, six for the *bolt*-holes in the cylinder flanges and covers; of Fig. 99, six for the *stud*-holes in the same; of Fig. 100, five for the steam-chest flange; of Fig. 101, three for the cylinder gland; and of Fig. 102, two for the gland of the steam-chest.

It will be as well to bolt these parts together at once, and afterwards temporarily remove any one section as required. If the instructions given in the last have been followed, there will be no material inaccuracy in the parallellism of the cylinder foot, so we shall bolt that down to its place on the bed, taking, however, the precaution to try a straight-edge through the bore, to see if it is lineally true, both with the face and the edges of the bed, before drilling the holes in the latter.

Fig. 103 shows the position of the holes in the bed for the cylinder studs, those in the cylinder foot being placed equi-distantly from its transverse centre, or so that the cylinder centre shall measure 7⅛in. from the centre of the first pair of guide-bar bosses. In the other direction, the position is fixed by the recess A, and the corresponding strip upon the cylinder foot. It would be more convenient, in one respect, to use bolts in this instance, and to lift the bed up, and bolt from underneath, for the steam-chest flange comes down in the way, and prevents our using a straight spanner on that one side. Still, it is better not to move the bed from its permanent fixing, but to make a bent spanner out of a bit of wrought iron for temporary use only to clear the flange, and put in studs through the cylinder-foot into the bed.

The piston, piston-rod, crosshead, slippers, and slipper-pin (Fig. 104) may now be taken together and fitted up. The piston in so small an engine is best made solid, with Ramsbottom rings. It will be turned to 3¼in. diameter, and bored to receive the screwed end of the piston-rod. Two grooves will be turned out to take the spring rings, which rings may be made by turning a short cylinder of cast iron, steel, or brass to 3$\frac{5}{16}$in. outside diameter, 3in. inside diameter, —cutting off two rings $\frac{3}{16}$in. in thickness, and sawing them either on the slope simply (Fig 105), or with a shoulder (Fig. 106).

Turn the piston-rod of steel accurately to $\frac{7}{16}$in. diameter (Fig. 107). If Whitworth gauges can be borrowed, it is better to turn all rods and bore their bearings to gauge rather than with calipers simply. The piston-rod is one of the parts which should fit well; hence it becomes necessary to take light cuts with sharp tools to avoid the risk of spring in the rod, which would be as great an evil as a slack fit; and to finish with a fine file, sliding the gauge along to get equal diameters in every section. When the piston is brought up against its shoulder, and the nut screwed up, a hole (Fig. 104) is drilled through nut and screw, and a pin driven through to prevent the nut from working back and becoming loose.

The cross-head (Fig. 104 A), made in brass, or, if preferred, from a piece of wrought iron, will be fitted up after this fashion:—Run a line with a scribe down the centre of the face, *a*, of the forging or casting. Bolt the opposite side on the slotted face-plate, or grip it with the dogs of the jaw-chuck, packing at the back until the axial centre-line is parallel with the chuck-face; then turn the outer face, bore the holes to ¾in., and with a small bent tool passed through the outermost hole turn one of the inner faces—the one which shows outwards. Also skim the bossed edge of the facing to 1¼in. diameter. Re-chuck on the plate by this turned boss, and repeat the operation of facing and turning upon the sides opposite to these just done. Then screw one boss face against an angle-plate, and adjust the latter until the longitudinal centre line coincides with the lathe centre, the circular portion standing outwards. Fix a drill in the slide-rest, and drill up the hole for the piston rod. Skim over and polish the outside, and the non-bearing parts of the cross head, and proceed to attach it to the rod.

The rod may be secured in one of two ways: either by means of a screwed, or a cottared end. If the former, the screw will be equal in diameter to the rod at the bottom of its threads—that is, a ½in. screw (Fig. 107) would be required. If cottared, that end should be enlarged to $\frac{9}{16}$in. diameter, to compensate for the weakening effect of the cottar way. This would be cut by drilling holes in line, and opening out the slot by means of a small chisel and file. The cottar should measure ½in. by ⅛in., and be made in steel.

The cross-head pin, or "gudgeon" (Fig. 108) should be turned of steel to the dimensions, and should be a tight fit in the holes in the cross-head. The prolongation at *a* is to take the eye of the pump plunger.

The two slippers will be filed parallel to ⅞in., and tried well with calipers, the accuracy of the shoulders *b*, *b* being tried with small metal winding strips. When these bearing surfaces are true, we shall employ them for the accurate production of the other working portions. The block will be screwed with its back side to the face-plate, being clipped by the flanges or shoulders,—the parallelism of the shoulders with the plate checked with internal calipers, and the parallelism of the bearing faces with the axis of the lathe being checked either by set square from the plate, or by the use of an angle plate for chucking. The centre of the block measured from the filed bearing faces and from the ends is indicated by a centre punch mark, and this also is adjusted until it corresponds with the centre of the lathe. Then the face is skimmed over, and the hole bored with a ½in. drill. By means of this face and hole, the block is rechucked, and the opposite or inner side faced, not forgetting to round the inner edge of the hole. If these successive operations are carefully performed, all the faces will be parallel, and at right angles with each other. We might, of course, have reversed the mode of operations, boring the hole first of all, and driving the block on a mandrel, have turned the faces thus, filing the bearing parts afterwards; but I think the first plan the better of the two.

## THE MECHANICAL TELEPHONE.

ON Saturday last a new mechanical telephone, on the old principle of the chip boxes and string, but with several important improvements, was exhibited to members of the Press at 4, Ludgate-circus, E.C., where it can be seen and tested by anyone interested. The new telephone is the invention of Messrs. Knudson and Ellsworth, two American gentlemen who have succeeded in converting Hooke's wire telephone into a practically useful means of transmitting and receiving messages over distances of about two miles. As our readers know, there is not much difficulty in working the simple telephones when the wire or string can be kept straight as well as taut; but Messrs. Knudson and Ellsworth have not only succeeded in overcoming the difficulty of taking wires round angles, but have also discovered a material for making the vibrating diaphragm which answers admirably. In a simple wooden box they secure firmly a disc about 6in. in diameter, made up of thin strips of willow, interlaced in the fashion of wicker-work, and varnished to preserve it from the effects of atmospheric and other moisture. In the centre of this disc is a metal plate about 2in. in diameter, with a small washer supporting a cross pin, to which the wire is attached, and by means of which it can be tightened. With such an instrument as that, nearly the whole area of the diaphragm being exposed through the perforated cover, words are heard with distinctness and precision even at a distance of several feet from the instrument, which is of course both receiver and transmitter. The greatest improvement, however, is the method adopted for taking the connecting wire round angles, for the wire must be perfectly free to transmit the vibrations. The patentees accomplish that in an ingenious manner by supporting indiarubber corks on the wall brackets, and passing through them wire loops, which hold the line wire at the requisite tension, and with two bends instead of one. At first sight it might be thought that two bends would deaden the vibrations more than one, but as a matter of fact, what with the rubber cushion and the carefully adjusted angle of bend, there is little loss of vibration, and speech can be heard distinctly between Ludgate-circus and Chancery-lane, a distance of about 500 yards, with, as we need scarcely say, a large number of unavoidable angles. In order to show how easily the wire can be led in all directions without interfering with the transmission of sound, a line has been erected at 4, Ludgate-circus, between two rooms, and altogether there are nine bends; but, notwithstanding, speech can be heard with practically perfect distinctness. Telephones of this kind should be found very useful in large works, in railway stations, in hotels, and on board ship, for the signals are clear and distinct; there is practically no buzzing, and once properly fixed, there is nothing to get out of order.

## ON THE WARPING AND CRACKING OF CASTINGS.*

WHEN a casting comes out of the sand in a different shape from what the pattern was in in the mould, it is caused by unequal contraction, some parts of it having cooled faster than others. This is usually caused by some portions of it being heavier than the rest. After the light parts are cold and done shrinking, the heavy parts are still hot, having yet to shrink, and in doing so draw the light parts with them. When the casting is of such design that it cannot bend, then it breaks, or cracks. In Figs. 1 and 2 are shown a section and top view of a truck wheel—what is known as a soft wheel. In trying to chill the rim it was found that the arms would crack every time. This was caused by the rim cooling first and the hub last, leaving a strain upon the arm. Digging out the core and cooling the hub with water did not change the result, so the following plan was tried with success:—A chill was made to suit each end of the hub, and the wheel cast with them on, as shown in Fig. 1. This had the desired effect, for none of them have cracked that were cast in this way. It is a case where the same amount of iron was in the hub each time, and shows the good effects of cooling. The chills do not come over the ends of the hubs, so it does not interfere with their being faced off. Here there is no chance for the arm to bend, so it cracks, and is a small illustration of the great strain castings are sometimes subjected to. For, calling the sectional area of the arm 2in., and the breaking strain of cast iron 31,829lb. per square inch, we have 63,658lb. exerted in pulling the arms apart. What applies to the above wheel applies also to pulleys. If the arms of a pulley crack, the rim has cooled first and the hub last, leaving the arms in tension or the rim in compression. The old style of curved arm was intended to remedy this, but it only partially did so. If the rim cracks, which is not so often the case, the hub has cooled first and the rim last, which leaves the arms in compression and the rim in tension. This is shown to be the case in the flywheel, where, if the rim is not cooled the arms have a tendency to buckle or get dishing. In pulleys that are of such a design that the arms have a tendency to crack, they may be benefitted by chambering out the hub; that is, making the core larger in diameter for a short distance in the centre, which makes the hub lighter, digging out the core as soon as cast, and also gating in two opposite places on the rim, which keeps the hot iron in the rim and allows the cooling iron to run to the hub.

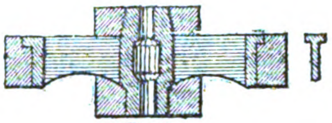


Fig.1

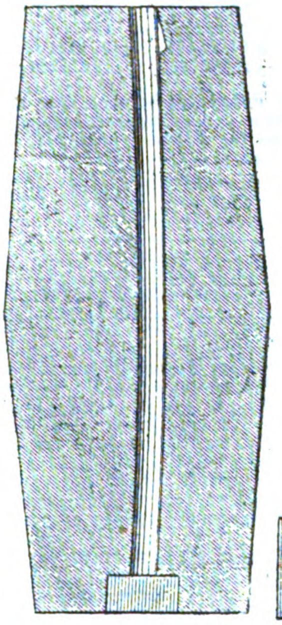


Fig.3

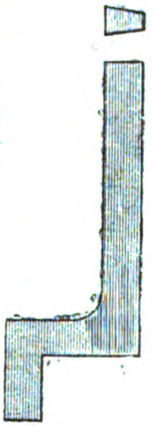


Fig.4

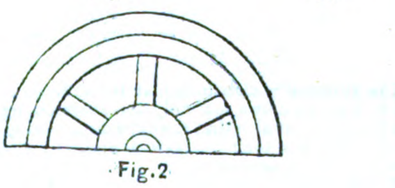


Fig.2

In casting the counter weight with a 2½in. hole through it, as shown in Fig. 3, there is often trouble in keeping the core straight, so much so that in the first two that were cast the sustaining bolt, 2in. in diam., had to be heated red hot and driven in to accommodate itself to the curved hole, this was caused by the core prints on the top and bottom holding the core and ⅝in. core rods firmly, so that it could not expand up or down, and it therefore bent sideways, to make up for its increased length. To remedy this the core print was continued through the cope, and made large enough to be a loose fit. Some pieces of cloth 8in. wide were given a coat of paste and wrapped around the top end of the core, making ⅛in. thickness on each side, when it was blacked over and dried. This projected into the casting 4in. where the iron is liquid for some time and up into the core print 4in. where the iron sets almost as soon as the mould is full; the pasted cloth burns away and leaves a space of ⅛in. on each side, which acts as a stuffing box, and allows the core to expand upwards freely.

In an air-chamber, kettle, or any brick core that acts as a rounding or spherical top where the iron runs over it, there is often trouble caused by the loam expanding, the part that is hot expanding or buckling over the parts that are cold. This, though it may not condemn, yet hurts the appearance of what might otherwise have been a nice-looking casting. A good plan for this is to saw a groove over the top of the core $\frac{3}{16}$in. wide down to the brick so as to divide in quarters. Also another groove around the core to meet them the length of the radius down, measuring from the centre on top. This leaves a space for the expanding loam to fill, and if not quite filled up it is easily chipped off. The loam for a core of this kind should be mixed as open and porous as possible, just so that the iron will not cut it when pouring.

A tedious operation about a brick core is to cut out a row of bricks after the casting is poured, to allow it to contract. This trouble may be avoided by building in a shrinkage piece, as shown in Fig. 4. A chain is attached to it at the lower end by a clevis and bolt, the chain running under the opposite side of the bottom plate through an elbow to the top of the pit. Soon after the casting is poured, hook on to the chain with the crane and pull out the shrinkage piece, which leaves a space of 2in. wide for the casting to shrink on.

The most important item connected with this subject is the iron, what is known as the regular mix in a foundry. If this is not right, nothing will be right. Whole heats of pulleys have been spoiled by a slight change in the mixture. The regular mix should have, besides the other properties required, that of a minimum of shrinkage. This is best accomplished by using three or four brands of iron. When a new lot comes in, use, say, one-sixth of it for one heat, cast some test bars 4ft. long by 1in. square; compare these with a known good quality as to shrinkage, when more or less of it can be used accordingly.

## ON TRIPLE OBJECTIVES WITH COMPLETE COLOUR CORRECTION.*

By Charles S. Hastings.

THE prime defect in the large refractors of the present day is the secondary spectrum. This, arising from the irrationality in the spectra produced by the crown and flint glass, hardly noticeable in small apertures, detrimental in telescopes of medium power, is positively obnoxious in the large instruments, and will speedily put an end to further increase in dimensions. On this account there have been many efforts to produce two kinds of glass differing sufficiently in dispersive power which would still yield mutually rational spectra. As far as I know, we are now no nearer success in this direction than when Brewster investigated the subject 50 years ago. Can we secure the same end by increasing the number of glasses in the objective? Theoretically, since a new disposable constant for colour change is introduced with each lens in the system, the answer is evidently affirmative; but if we limit ourselves by the condition that the construction shall be practicable—*i.e.*, that there shall not be too many lenses, and the curvatures shall be moderate, the conclusion is not so ready. On entering the discussion we will assume three as the limiting number of lenses, and $\frac{1}{10}$in. the focal length as the minimum radius of curvature.

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* By T. H. Radcliff, in the *American Machinist*.

* From the *American Journal of Science*, Art. LIV. No. 108, December, 1879.

The formula for the focal length F of three thin lenses in contact is, if we set $\phi = \frac{1}{F}$:—

$$\phi = (n' - 1)\left(\frac{1}{r} + \frac{1}{r_2}\right) + (n'' - 1)\left(\frac{1}{r_3} + \frac{1}{r_4}\right) + (n''' - 1)\left(\frac{1}{r_5} + \frac{1}{r_6}\right)$$

Where $n'$, $n''$, $n'''$ are the indices of refraction for the three materials used, and $r_1, r_2 \ldots\ldots r_6$ are the radii of curvature for the six surfaces successively. We may write this more concisely for our end, as follows—

$$\phi = (n' - 1)\,A + (n'' - 1)\,B + (n''' - 1)\,C,$$

calling A, B, and C the *curvature sums* of the first, second, and third lenses respectively.

The problem then, succinctly stated, is to find values of A, B, and C; no one of which shall be more than thirty when $\phi = 1$, and which shall make $\phi$ independent of the wave-length of light transmitted.

If $n$ can be expressed as a function of any variable $x$ of the form—

$$n = A + B f_0(x) + \Gamma f_1(x).$$

The problem has its mathematical expression in the equations—

$$\phi_\lambda = (n'_\lambda - 1)\,A + (n''_\lambda - 1)\,B + (n'''_\lambda - 1)\,C = 1.$$

$$\frac{d\phi}{dx} = [B' f_0'(x) + \Gamma' f_1'(x)]\,A + [B'' f_0'(x) + \Gamma'' f_1'(x)]\,B + [B''' f_0'(x)] + \Gamma''' f_1'(x)]\,C = 0.$$

But since the latter must hold true for all values of the variable $x$, the final conditions for perfect colour correction are—

$$\left.\begin{array}{r} (n'_\lambda - 1)\,A + (n''_\lambda - 1)\,B + (n'''_\lambda - 1)\,C = 1. \\ B'A + B''B + B'''C = 0. \\ \Gamma'A + \Gamma''B + \Gamma'''C = 0. \end{array}\right\}$$

the only practical limitation being that neither A, B nor C surpasses thirty as a maximum.

As to the choice of the variable $x$, the most natural suggestion is the wave-length of light, using the first three terms of Cauchy's well-known formula as an expression for $n$; but there are two objections to such a course, the first and most important being that three terms of this series will not express the values within the necessary limits of accuracy, and the other lies in the great labour requisite to compute the constants. I have, therefore, chosen to take the value of $n$ for some one material as a standard, and compute by the method of least squares the values for other materials as functions of this. The standard selected is Feil's Crown glass, No. 1219, which I have studied and described, with four other kinds, on page 273, Vol. XV. of this Journal.* The reason determining the choice is the greater accuracy of our knowledge of its constants over that of any other light glass. The form of the function is a trinomial of the second degree, thus:—

$$N = A + Bn + \Gamma n^2 \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Doubtless, by not restricting it to the first and second powers of $n$, a formula might be shaped which would make the differences between the observed and calculated values less; but as that could be attained only at the expense of much greater labour in determining the various values of the constants, and, moreover, as the errors of observation are generally greater than those of the formula, it seems unadvisable to modify it.

In this discussion I have included all the different varieties of glass the optical constants of which I have been able to find given with the requisite accuracy. Unfortunately, there are but few. Besides the five which I have determined, and are cited above, viz.:—

| | | |
|---|---|---|
| Feil's Crown, | 1,219 | α |
| " Flint, | 1,237 | β |
| " Flint, | 1,241 | γ |
| Crown, | A. | δ |
| Flint, | B. | ε |

are included the seven of Fraunhofer†, viz.:—

| | | |
|---|---|---|
| Crown | 13 | ζ |
| Crown | 9 | η |
| Crown | M | θ |
| Flint | 13 | ι |
| Flint | 3 | κ |
| Flint | 30 | λ |
| Flint | 23 | μ |

Six of Van der Willigen* (one closely resembles my A above, while two others are almost exactly alike), viz:—

| | |
|---|---|
| Crown, Merz, No. III. | ν |
| Crown, Merz, No. IV. | ξ |
| Flint, Steinheil, No. II. | ο |
| Flint, Merz, No. V. | π |
| Flint, Hoffmann, No. I. | ρ |
| Flint, Merz, No. II. | σ |

And finally one of Ditscheiner†—

| | |
|---|---|
| Flint | τ |

These are further measurements of 18 different prisms by Dutiron,‡ but so inaccurate as to be worthless for our purpose.

In the order in which the glasses are named are entered in Table I. the values of the constants for (3).

TABLE I.

| | A. | B. | T. |
|---|---|---|---|
| α | + 0· | + 1· | + 0· |
| β | 22·3186075 | − 29·1759937 | 10·2399102 |
| γ | 14·0097123 | − 17·9513549 | 6·4320057 |
| δ | ·5679958 | + ·2172063 | ·2681091 |
| ε | 21·026827 | − 27·430617 | 9·645678 |
| ζ | ·5749543 | + ·2333290 | ·259890 |
| η | ·9025943 | − ·2110704 | ·411148 |
| θ | 5·2924649 | − 6·1318968 | 2·4193199 |
| ι | 19·6074744 | − 25·7440377 | 9·1597811 |
| κ | 20·7768050 | − 27·0625275 | 9·5093547 |
| λ | 24·6152640 | − 32·2820439 | 11·2916241 |
| μ | + 25·4950932 | − 33·4611946 | 11·688423 |
| ν | 2·250818 | − 1·973145 | 0·983738 |
| ξ | 2·737385 | − 2·679993 | 1·241673 |
| ο | 19·541685 | − 25·438209 | 8·976709 |
| π | 27·444400 | − 36·035067 | 12·537277 |
| ρ | 43·623628 | − 57·822556 | 19·899438 |
| σ | 69·141334 | − 91·827575 | 31·313410 |
| τ | 19·960275 | − 26·041640 | 9·196286 |

If we tabulate the differences between the observed values and those derived by substitution in the formula, we have the following expressed in units of the sixth place:

The indices of the following groups are only given to five places of decimals, and are evidently made with much less care than the others.

By taking from Table I. the constants for any three glasses, and substituting them in formulas (2), we obtain values of A, B, and C, which would give complete colour correction; but in general the values would not all be below thirty—the limiting maximum. Of those, however, which satisfy this condition, I select four cases, confining myself to these four, not because it exhausts all the serviceable combinations, or even gives the smallest values for the curvature sums, but because it introduces eight out of the nineteen glasses which are most useful. They are—

| | | | |
|---|---|---|---|
| Case I. | α | β | ι |
| " II. | ν | π | ο |
| " III. | ν | π | τ |
| " IV. | ξ | π | ο |

giving values for the curvature sums:—

| | A | B | C |
|---|---|---|---|
| I. | 3·47026 | 7·20807 | − 8·35472 |
| II. | 9·47513 | 14·28004 | − 21·23665 |
| III. | 7·58585 | 11·57425 | − 16·59076 |
| IV. | 11·67459 | 18·10299 | − 27·22301 |

Substituting these values in the general formula (1), we derive for F the following, the first column giving the Fraunhofer ray for which the focal length is computed:—

TABLE III.

| | I. | II. | III. | IV. |
|---|---|---|---|---|
| A | — | 1·00002 | — | 1·00000 |
| B | 1·00000 | ·99949 | ·99989 | ·99968 |
| C | ·99999 | 1·00043 | 1·00102 | 1·00053 |
| D | ·99999 | 1·00026 | 1·00052 | 1·00005 |
| E | 1·00024 | ·99992 | ·99942 | ·99993 |
| F | ·99999 | ·99988 | ·99951 | ·99999 |
| G | ·99999 | 1·00002 | 1·00030 | 1·00000 |

To exhibit more distinctly the improvement in this form over the double objective, I arrange the differences in the above values between each, and the true focal length of that system in a table, supplementing it with a sixth column in which are entered the corresponding differences for a double objective of glasses *a* and β with its best colour correction, and having a focal length of unity.

TABLE II.

$n - N$

| | A | B | C | D | λ 5614 | E | F | λ 4548 | G | *h* | H |
|---|---|---|---|---|---|---|---|---|---|---|---|
| α | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| β | + 26 | − 4 | − 12 | − 31 | − 6 | + 3 | + 23 | + 4 | + 12 | − 4 | − 10 |
| γ | + 24 | − 10 | − 10 | − 21 | − 4 | + 6 | + 19 | + 4 | + 4 | − 1 | − 7 |
| δ | − 9 | − 0 | + 2 | − 1 | + 15 | + 15 | − 14 | — | − 20 | 0 | + 12 |
| ε | + 8 | − 8 | − 3 | − 10 | + 4 | + 13 | + 5 | — | − 10 | − 9 | + 12 |
| ζ | — | + 2 | + 4 | − 1 | — | + 4 | − 11 | — | − 4 | — | + 3 |
| η | — | − 15 | + 4 | + 16 | — | − 3 | + 17 | — | − 34 | — | + 16 |
| θ | — | + 4 | + 8 | − 25 | — | + 10 | + 6 | — | − 2 | — | − 1 |
| ι | — | − 2 | − 7 | − 21 | — | + 36 | + 15 | — | − 24 | — | + 2 |
| κ | — | − 42 | + 29 | + 35 | — | − 11 | − 20 | — | + 5 | — | + 2 |
| λ | — | − 1 | + 45 | − 27 | — | + 7 | − 7 | — | + 19 | — | − 36 |
| μ | — | + 19 | + 10 | − 34 | — | − 30 | + 24 | — | + 30 | — | − 19 |
| ν | + 23 | + 19 | − 22 | − 42 | — | + 14 | + 20 | — | + 13 | + 19 | |
| ξ | + 21 | − 3 | − 16 | − 15 | — | + 15 | + 11 | — | − 10 | + 22 | |
| ο | + 38 | − 27 | − 13 | − 25 | — | + 2 | + 28 | — | + 15 | − 19 | |
| π | + 54 | − 16 | − 37 | − 34 | — | − 9 | + 28 | — | + 29 | + 17 | |
| ρ | + 40 | − 19 | − 30 | − 19 | — | + 11 | + 25 | — | + 4 | − 11 | |
| σ | − 60 | − 47 | − 26 | + 25 | — | +119 | +116 | — | + 32 | − 92 | |
| | | − 8 | + 26 | − 10 | − 34 | − 0 | + 43 | — | + 8 | − 26 | |

The systematic distribution of the differences in the first group shows not only the shortcoming of the formula, but also that the extreme accuracy indicated by the probable errors attached to the indices is not imaginary.

The accuracy of the second group is also great, but much inferior to the first. Occasional abrupt changes, as in that of ι D to ι E in Table II., can only arise from erroneous values in the indices. Here we recognise at once that $n_E$ must be about thirty too great.

TABLE IV.

| | I. | II. | III. | IV. | V. |
|---|---|---|---|---|---|
| A | — | + 2 | — | − 3 | + 135 |
| B | + 1 | − 53 | − 22 | − 35 | + 66 |
| C | 0 | + 41 | + 91 | + 50 | + 41 |
| D | 0 | + 28 | + 41 | + 2 | + 0 |
| E | + 25 | − 10 | − 67 | − 10 | + 13 |
| F | 0 | − 14 | − 60 | − 4 | + 73 |
| G | 0 | + 2 | + 21 | − 3 | + 287 |

The large differences in F E is owing to an erroneous value of $n_E$ in Fraunhofer's Flint 13.

The greater differences in other cases are to be attributed to inaccurate measurements of the optical constants, inaccuracies which are most marked in Ditscheiner's determinations. It may be noted that only in the first two groups are the indices given to six places of decimals, and whatever the errors may be, they are multiplied by large factors in all but the first case. That these differences do not represent any outstanding colours we may be sure from their non-systematic character.

The problem is then solved generally, and shown to be quite practicable in the case of a number of known varieties of glass. Of course, in its practical application, this process should be used to yield a first approximation only, since the thicknesses and distances of the lenses are neglected; but having this, there is no difficulty, other than the laborious character of the computations involved, in determining by successive approximations the values of all the radii requisite to secure complete colour correction and at the same time eliminate spherical aberration. As in the case of the double objective, after satisfying the conditions of given focal length of colour correction and elimination of spherical aberration, we have one arbitrary condition to impose, so in a triple objective we have two arbitrary conditions to impose. In my opinion, were we using materials that required large curvature sums, it would be advantageous to utilise these conditions in making two of the lenses bi-convex and bi-concave, thus rendering the necessary thickness of the materials a minimum.

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* The *American Journal of Science*. See also p. 420, Vol. XXXIX., ENGLISH MECHANIC.

† Schumacher's "Astronomische Abhandlung für 1823."

* Archives du Musée Teyler.

† Sitzungsberichte der K. K. Akad. d. Wissenchaften in Wien. October, 1864.

‡ Comptes Rendus, XXIX. pp. 632–636. Poggend. Annal. LXXIX. pp. 335—336. Annales de Chimie, XXVIII. pp. 176—210. These incredible values, which are extensively quoted in prominent textbooks on optics, have given me a deal of trouble, used as they are in several places to discuss the defects and possible improvement of the double objective. Only by the merest chance I found on the last leaf of the Annales de Chimie, XXVIII. pp. 201, 502, a set of corrections to *all* the values. These new values are less fantastic, but still the errors are large, and even indicated anomalous dispersion is not wanting.

These results are directly opposed to those of a recent writer in this journal.* But his conclusions arise from erroneous calculation. Not only does his interpretation of his equation (12) imply the manifest absurdity that in a system of infinitely thin lenses in contact its properties are determined by the order of the lenses, but the interpretation is impossible. True $A_2$ should have an opposite sign to $A_1 + A_3$, but that asserts nothing as to likeness of the latter symbols in sign. Thus $n$ in eqn. (16) may be negative, and consequently his subsequent reasoning is fallacious, for in that case $n$ does not have to be infinite to cause equation (27) to vanish. I may add that the origin of the confusion is in making the ratio $\frac{D}{E}$ in equation (9) constant; it may be, and, of course, should be, indeterminate.

Professor Harkness has made another mistake, founded upon inadequate experiment, which has so important a bearing on the theory of the double objective that it should not be allowed to pass uncorrected. His statement concerning the condition for colour correction is substantially correct, though, in my opinion, it is not self-evident, but requires proof. This proof I shall supply in a forthcoming number of the *American Journal of Mathematics*. His experiment, however, directly contravenes this principle, for he finds that the focal plane does not correspond to the minimum focal distance, but to something greater. The source of error is the introduction of a variable element in the system—namely, the eye, which would adjust itself differently in observing the star and its spectrum. Had the writer used eye-pieces of successively higher power, thus lessening progressively the power of accommodation of the system with his prism, he would have seen his points $\gamma_m$ and $\gamma_n$ approach until they sensibly coincided; or, better still, had he formed his spectrum by a grating (such as a perforated cardboard) before the objective, instead of by a prism between the ocular and the eye, he could not have been misled, since the uncoloured image would serve to control the eye.

Finally, the fourth conclusion is strictly true, though we are not to conclude, as would seem from the text, that the detriment due to the secondary spectrum depends either solely upon the aperture, or varies inversely as the focal length; for though the secondary spectrum remains constant in dimension with a given aperture, and consequently its angular value decreases inversely as the focus, a stellar image (diffraction disc) increases directly as the focal length. Hence, by increasing this element, more of the central portion of the secondary spectrum—i.e., the brighter portion, would be absorbed into the stellar disc. In other words, by doubling the length of the telescope, the secondary spectrum becomes much less than half as offensive.

Johns Hopkins University, Sept. 20th, 1879.

## THE POINTS OF A GOOD LATHE.

LET us consider the common screw-cutting engine lathe, that most widely known and indispensable adjunct of the machine-shop. We say indispensable, because of all the tools in the best equipped machine-shop the lathe is the only tool that could not be dispensed with. Looking through dealers' stocks we find almost as many designs of this tool as there are builders. Some of these designs are very good, some mediocre, others faulty, but none are perfect. It may be considered a bold assertion to make, but we do not hesitate to say that the model engine lathe of to-day—with the exception of a few minor details—is not one whit in advance of its prototype of thirty years ago. The crowning fault with the majority of lathes now on the market lies in the fact that there is not metal enough in the bed itself. This is a serious fault, and has prevented the sale of many an otherwise fairly good lathe. There would seem to be no excuse for this penuriousness on the part of builders when the very low price of pig-iron is taken into account. It is safe to assert that the average engine lathe should have one-third more metal in its bed. And not only this, but the metal should be so distributed as to bring the centre of gravity of the entire tool much lower than it is usually found. Of all the nuisances to be met with in a machine-shop a top-heavy lathe is the greatest.

Another fault with modern tool builders consists in making the top part of the bed too narrow. The bottom part of the bed should be made considerably wider, also, and more spread given the legs. A lathe, as much as any tool, should be built upon the anvil principle, and top-heavy lathes are sure to tremble and weave under high speeds or heavy cuts. A lathe should be a solid, compact tool, and set upon a foundation in keeping with its weight and capacity. The bed should be wider and deeper; the legs should be shorter, and have considerable more spread, and the entire tool made to assume a more squatty appearance. Placing the lead screw on the back side of bed has its advantages as well as disadvantages. It is undoubtedly an advantage to have the lead screw tucked away under the overhang on back side of lathe, out of the way of grease, dirt, and chips, but it is equally a disadvantage to the workman when cutting such pitches as allow of running the carriage back by hand—particularly in short screws—as he is compelled to assume an awkward and uncomfortable position while handling the lock-nut lever. The splined lead screw has its admirers, and some buyers will have no other. It is always placed in front of lathe bed, and this much is in its favour. Still, we are inclined to think it is better to use the lead screw for thread cutting only, and that it should not be used for any other purpose.

The slow process of running the carriage back by belt, when cutting odd pitches, obtains to-day as well as it did thirty years ago. With the exception of a few feeble attempts, builders have done nothing to overcome this waste of time. All screw-cutting lathes should have the lead screw placed in front of bed, and there should be some device attached, which would admit of running the carriage back by hand for any pitch. This, with a properly-constructed and positive rod feed, would bring the entire mechanism by carriage movement and cross-feed immediately under the hands of the workman. Tail stocks are frequently made too short, and we have seen those that were much too light, notwithstanding the very low price of pig-iron. There are some builders who aim to get a regular gradation of speeds, from the slowest out of gear to the slowest in gear. This, of course, can be done, but it can only be attained at an expense of power, and buyers would do well to note that any lathe so constructed has not the same amount of power at which it should be rated. The master wheels should have more breadth of face, and the front journal of live spindle made longer in diameter and somewhat shorter. Builders seem to vie with each other in making long spindle bearings, although at the same time they know that there is no advantage in it, but simply because the market demands that they should be made so. The idea that spindle bearings should be made very long is an exploded fallacy, and it behoves buyers to eschew this notion, and devote their attention to points of greater importance when inspecting a lathe.

In buying a lathe lost motion should be sought for in the cross screws, and the perfect alignment of the lead screw with the half nut is a matter of the utmost importance. If one eighth of a turn lost motion be found in any cross screw, it is safe to presume that the rest of the fitting is of like character. Lathe aprons conceal much rough work and imperfect fitting, and as the buyer has no opportunity of examining this hidden arrangement of wheels, pinions, sleeves, and levers, he should exact a guarantee from the dealer that the quality of this work is in keeping with that which is exposed to view. Tail-stock arbors should have right-hand screws, as it is much easier for the workman to pull on the hand wheel than to push it. Besides, all lathes were formerly made with right-hand arbor screws, and modern left-hand screws for this purpose are a senseless innovation, for the reason that they bother and confuse veteran lathesmen, who have been always accustomed to right-hand screws. Arbor screws should have hand wheels—not cranks. This is obvious to the workman, although it may not be to the designer in pursuit of novelties. If the live spindle centre runs true when thrown in at random, it is a pretty sure indication that all other alignments and fittings are true, and good close work can be expected from such a lathe. Still, we have seen very good lathes that required the live centre always set to a mark. The fact that the lead screw is made of steel amounts to nothing. Steel being free from seams and grit, and being homogeneous throughout, is a cheaper metal for this purpose than iron. Builders also dwell particularly on the fact that all their gears are cut from the solid. Their is no necessity for this enlargement at all. For it is a well-known fact that cast gears are more durable than cut gears, but as the teeth of cast gears cannot be got mathematically correct, cut gears are used instead, because they are cheaper.

Some builders still keep up the fancy scraping craze; in fact, they overdo it. While this sort of ornamentation adds nothing to the working value of a lathe, it certainly costs something, and somebody must pay for it. Fancy scraping and oil stoning, while pleasing to the eye, and apt to catch the unwary buyer, is a positive detriment to keeping the lathe clean. We would rather not have any in ours. To sum up: a lathe should be made of perfectly sound castings. The bed should be heavy and well braced, and quite deep; the legs short and have considerable spread. The cone and back gears should be designed for power instead of regular gradation in speed. The wheels have broad faces and accurately cut epicycloidal teeth, to prevent rattling and backlash. The cone should take a wider belt than is common. The tail stock should have a long bearing on its V's, and a receptacle on back end for tools, chalk, &c. The studs should be so made that change wheels could be slipped off and on without taking off the nuts. The alignment of live and dead centres should be as near perfection as human ingenuity and improved machinery can get. The live centre should not run out of truth more than $\frac{1}{16}$ of an inch, 6in. from the face plate. There should be no lost motion in cross screws. The lathe should have a compound rest if the swing will admit of it, and, where admissible, automatic cross feed. The spindle, arbor, lead screw, and cross screws should be made of hammered steel, the spindle bearings of best brass, and all tap bolts, set and cap screws, of best quality of iron casehardened. A lathe such as we have described would produce true work of all kinds, it would afford the workman pleasure in running it, and although its first cost might seem high, it would be the cheapest in the long run. "*Observer*" in *Age of Steel.*

## OXYGENATED WATER.*

SINCE Schönbein's researches, the process of "grass bleaching" was attributed to the influence of ozone, but the new and very exact experiments of Emil Schoene, together with the earlier labours of Houzeau and Goppelsroeder, have proved that the reactions formerly attributed to ozone really owe their origin to oxygenated water. Repeated quantitative analyses showed that the richness of the air in peroxide of hydrogen varies according to the seasons of the year, the hours of the day, the direction of the wind, &c.; but Schoene attributes a predominant influence to the light. Rain, but especially dew in certain cases, contains a considerable proportion of oxygenated water, namely 0·04 mgm. to 1 litre of liquid; the quantity which the soil receives in this way amounts to 62·9mgm. per square mètre. Although "grass-bleaching" has been known and practised for centuries, and there was plenty of time and labour employed to its improvement, it cannot be denied that this procedure has its many great drawbacks. The success of a bleach upon the meadow can never be foretold to a certainty in a given time; the bleaching always requires a long time, and "time is money." These considerations show what profit would be derived from replacing the natural bleaching by the preparation of a more concentrated form of oxygenated water.

Chemistry offers a numerous series of combinations in which the oxygen is but feebly held, and which easily surrender it to other substances. These oxidising agents can be used instead of the air in bleaching, and those which are practically employed for that purpose are nitric and nitrous acids, permanganic acid, chloric acid, chlorous acid, and finally chlorine, either in a gaseous form or in combination with bases. But all these products, however different from each other, have the inconvenience of more or less attacking the fibres; oxygenated water alone has not this fault; it contains in a more concentrated form the active principle of the best kind of bleaching—that is, of grass-bleaching; it is superior, therefore, to all those products, and may be considered as the bleaching agent that is to rule in the future.

Thenard, in 1818, discovered the peroxide of hydrogen; it was obtained by the action of acids upon barium peroxide in the presence of water. Since then, oxygenated water has been the subject of investigations by Pelouze, Duprez, Balard, J. Thomson, E. Schoene, &c., but without achieving an improvement in the manner of its production; only very dilute solutions were obtained with possible 5 per cent. peroxide contained in them. The pure product $H_2O_2$ is hardly obtainable on account of its utter decomposibility. There are but two ways of concentrating the solutions; either by freezing, or by evaporating in a vacuum at 59°—68° F., over sulphuric acid.

Pure peroxide of hydrogen is a syrupy liquid, of 1·453 density, whose decomposition yields 475 times its own volume of oxygen. Its dilute solutions are

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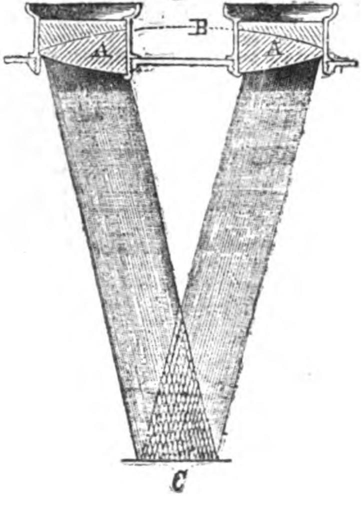
* Professor Harkness, in the September number of the *American Journal of Science*. See also English Mechanic, page 316.

* From a lecture delivered by Dr. P. Ebell at Hanover.

1



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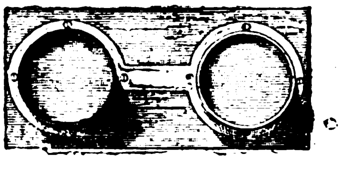

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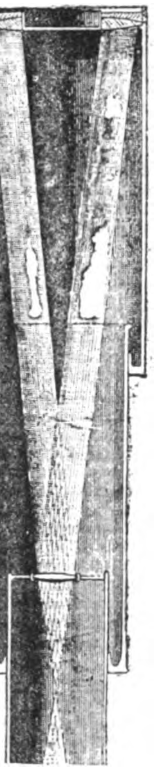


analogous in their action to chlorewater, and can be preserved for months, if kept in the dark at a temperature not above 77° F. They keep better still if a trace of acid is added to them; while alkalies or liquids of alkaline reaction promote decomposition. This inclination of oxygenated water to set oxygen free places it among the oxidisers. There are many substances which provoke this decomposition without undergoing themselves any modification, such as alum jelly, oxyhydrate of iron, charcoal, some metals in a condition of extremely fine division, silver, gold, and platina. With another class of bodies, the oxygenated water behaves like many other oxidising agents—that is to say, it surrenders its oxygen; for instance, with arsenious acid it produces arsenic acid, and transforms the metallic sulphides into sulphates. Upon certain peroxidised substances, finally, the oxygenated water can act reducing; for instance, upon the peroxides of lead and of manganese, which are reduced by its presence to the oxide state.

All chemists who have occupied themselves with this subject are unanimous in predicting a brilliant future for the employment of oxygenated water. Dumas, in 1830, recommended it for cleaning old paintings, because the lights of paintings become black by the transformation of the white lead into sulphide of lead, which being retransformed into sulphate by the action of oxygenated water, the light colours must be restored to their original appearance. Oxygenated water, however, was ignored for a long time, until in 1870 a perfumer availed himself of its bleaching properties, to introduce a 3 per cent. solution of it as a hair dye under the names of "Auricome" or "Eau de Fontaine de Jouvance dorée." About the same time A. Von Schroetter, R. Boettger, Geiger, and Hagen directed the public attention to the therapeutic properties of oxygenated water.

The difficulties of preparing pure oxygenated water on a grand scale, causing its formerly high price, have been at present overcome, so that a 3 per cent. (by weight) aqueous solution can be had at a moderate price and in any quantity. With its excellent bleaching properties and safety of application the road seems to be opened, therefore, for its extensive utilisation in industries.

## OBJECT-GLASS FOR TELESCOPES AND CAMERAS.

THIS invention has a twofold object: to obtain the effect of a lens of large diameter without the labour and expense required for the production of large lenses; and to improve photographic pictures by the use of lenses which serve to intensify the image and produce a stereoscopic effect in the picture. The lens is of compound or double form, each portion being ground to the curvature of a solid lens of the required diameter, and the two parts being held in their support so as to be retained in the same relative position with regard to each other that they would sustain in a solid lens of the same diameter and curvature. The lens is composed of the two parts, A, which are constructed by securing two discs of glass in the same plane, and then grinding them to the curvature of a solid lens of like diameter. These are then secured or set in a frame made of any suitable material. For telegraphs the setting may be of some inferior glass, or it may be, as shown in Fig. 2, similar to those used in opera glasses. The same effect may be obtained by taking an ordinary lens, and by diaphragms or other means, rendering it opaque, except at diametrically opposite portions. It will be understood that in cameras this construction applies to the front or object lens, the condensing lens, C, being applied as usual. This invention has been patented by Messrs. J. A. Smith and A. J. Athay. Further particulars can be had by addressing the latter, at Sparland, Illinois, U.S.A.

## ATMOSPHERIC ELECTRICITY.

THE following notes on atmospheric electricity are given by L. Palmieri in *Biedermann's Centralblatt*:—

1. *Electricity with a Clear Sky.*—When within a circle of about 140 kilomètres in radius, neither rain, hail, nor snow is falling, the electricity at the place of observation is always positive. If negative electricity is observed with a clear sky, downfall at some little distance may be inferred. As regards the daily periodicity of atmospheric electricity in calm, bright weather, two maxima and two minima may be recognised. The first maximum appears at the ninth hour of the morning; the second, which is more decided, a little after sunset. It often continues during a great part of the night. Toward daybreak a minimum appears, and a second, less distinct, in the afternoon. This daily period is easily disturbed by movements of the wind, by a cloud appearing on the horizon, by a mist rising from the somma, and by other causes often hard to determine. It may be asserted that when the maxima are very considerable, or when decided maxima appear at unusual times, the sky on the following days will scarcely be serene. If the sky begins to be overcast, the electric indications grow stronger, and if at the time of the evening maximum the relative moisture increases with a heavy dew, maxima of special intensity and duration may be expected. The general assumption that atmospheric electricity becomes stronger with the altitude has not been confirmed by the observations made simultaneously on Vesuvius and at the observatory of the University. The values obtained on Vesuvius were generally smaller. As regards the yearly periodicity, lower tensions are generally observed on hot summer days. In spring and autumn the indications are stronger. In winter the values are uncertain.

2. *Electricity with a Cloudy Sky.*—In the absence of distant rain, &c., the atmospheric electricity on cloudy days is always positive. It is less intense, more variable, and without a decided daily period.

3. *Electricity in Time of Rain.*—During rain, atmospheric electricity increases considerably, both at the place of observation and at some distance, even though no lightning occurs; this increase begins and disappears along with the rain. Sometimes, if rain is falling at a certain distance, the atmospheric electricity changes its sign once or repeatedly. When the rain is falling, the electricity is positive; this region is surrounded by a zone of strongly negative electricity, upon which again follows a second zone of strongly positive electricity.

4. *Thunder-Rain.*—Between ordinary rain and thunder-rain, the only difference is the more abundant development of electricity in the latter. The raining cloud must be regarded as a constantly flowing source of electricity. There can be no lightning without rain and thunder. The so-called "harvest lightning" is merely a distant storm. The sound of thunder cannot be heard beyond 21 kilomètres (13 miles), while lightning is perceived at a far greater distance.

## DIMENSIONS AND MOVFMENTS OF WAVES.

THE ships of the United States Navy have been engaged for some time in making observations of the dimensions and speed of deep-sea waves. These recorded observations are not so complete and numerous as is desired, and any assistance in this respect will do much to advance one important branch of the science of naval architecture. The observations made where a ship falls in with a single series of approximately regular waves are most valuable, and should be accompanied by full records of the attendant circumstances.

One method of measuring the wave lengths consists in towing a log line astern of a ship, and noting the length of line when the chip floats on the wave crest next abaft that on which the stern of the ship momentarily floats. The ship should be head-on, or allowance made for the departure of the log line from the head-on position. To measure the wave heights, when the ship is in the trough of the sea, and for an instant upright, the observer takes up a position such that the successive average wave ridges, as viewed by him from the trough, just reach the line of the horizon without obscuring it. The height of the eye above the water level correctly measures the height of the waves. To measure very high waves the observer may have to ascend the rigging, while for waves of less height a station on one of the decks may suffice, or some temporary expedient devised for placing the observer near the water level. It is desirable to select a position as nearly amidships as possible, but if it becomes necessary to take a station near the bow or stern, allowance must be made in estimating the height of the eye above water for the deeper immersion which may be caused at the instant by pitching.

The longest recorded wave measured half a mile from crest to crest, with a period of twenty-three seconds. Waves having a length of 500ft. or 600ft., and periods of ten to eleven seconds, are the ordinary storm waves of the North Atlantic. In regard to the heights of waves, the most trustworthy measurements show from 44ft. to 48ft. to be a remarkable height. Waves having a greater height than 30ft. are not commonly encountered. The U.S. Hydrographic Office has blank forms for recording these observations, and would be glad to furnish them to any shipmaster who takes sufficient interest in the subject to make observations whenever the opportunity occurs.

**New Reaction for Digitaline.**—The difficulty of distinguishing by chemical methods between various alkaloids has always been very great. This difficulty, where forensic matters are concerned, necessitates in many cases the employment of vivisection in order to subserve the ends of justice. Digitaline may be certainly recognised chemically by the following method, according to M. Lafon: If a trace of digitaline be treated with a mixture of sulphuric acid and alcohol, of each one part, and if to this mixture a drop of ferric perchloride be added, a beautiful greenish-blue colouration is developed, which lasts for several hours. The most favourable conditions for the reaction are the following:—Use a very small quantity of digitaline; dry the substance with a very small quantity of the mixture of sulphuric acid and alcohol, and warm slightly until a yellowish tint appears; then add the drop of ferric perchloride, which should be allowed to spread out. This reaction is peculiar to digitaline, for M. Lafon has tested the whole of the alkaloids and glucosides usually employed in therapeutics. Morphine produces with ferric perchloride the blue colour, but this only occurs where the reagents are neutral. Digitaline prepared at Darmstadt by Merck, neither in its crystalline nor in its powdered condition, gave the above reaction; so that there is a marked difference between some German digitalines and the French alkaloids, a difference which is said to be shown in the varying solubility of the alkaloids as well as by the physiological effects. Chloroform dissolves but little of the German alkaloids. MM. Laborde and Duquesnel have recently pointed out the different physiological effects of digitaline according to the source of the alkaloid.—*Lancet.*

# SCIENTIFIC NEWS.

FROM Dun Echt Circular, No. 95, we learn that the elements and path of Barnard's new comet (see p. 426), as computed by Mr. S. C. Chandler, jun., from three observations made at Boston, U.S., are as follows:—T May 16·72 G.M.T.; $\pi$ − ☊ 150° 8′; ☊ 91° 28′; $i$ 84° 27′ (mean equinox 1885); log. $q$, 0·39340). The ephemeris for G. midnight, July 25, is R.A. 16h. 52m. 12s.; S. Dec. 14° 32′. The brightness is decreasing.

A year's rainfall at Ben Nevis observatory (including melted snow and hail) amounts to over 152in.—that is, for the twelve months ending with June last. The measures have been taken as carefully as possible at every hour, and the average of the monthly returns since June, 1881, gives a mean annual rainfall on the summit of the Ben of 145·73in., the largest observed at any spot in Scotland. Falls of an inch a day are of common occurrence—about one day in seven; but the largest fall in a month was 25·30in. in December last, and the smallest, 4·85in., in April last.

At the Albert Palace, on Monday last, the electric signalling balloons of Mr. Eric S. Bruce were tried for the first time. These balloons are exhibited in model at the Inventions in Group 25, No. 1913. The invention consists of an ordinary balloon made of a material as translucent as possible (in the case of the one at present on exhibition the material is cambric) in which are fixed a number of incandescent lamps. The balloon is a captive one, and the rope which secures it is also utilised for conveying the electric current to the lamps inside the balloon. The system of long and short flashes of light is adopted, and the experiments were completely successful. It is proposed to continue the exhibitions of signalling for a month. The chief obstacle to be overcome in introducing the electric light into the balloon was that occasioned by the highly inflammable nature of the gas with which the balloon is inflated. Mr. Bruce lectures on the signalling balloon every night before the ascent, and will also lecture on it at the Crystal Palace this afternoon. Mr. Bruce is in communication with the military authorities, who will probably order a trial of the balloons.

The Irish Lights Commissioners, who are making a tour of inspection, visited Mew Island, Belfast Lough, last week. The lighthouse is at the entrance to the Lough, and has an illuminating power of over 2,600,000 sperm candles. Under the superintendence of Dr. Ball a series of interesting experiments were proceeded with. The illumination with the first or ordinary supply, and also with the additional or second quantum, of gas was tested; but the full strength used in very thick weather could not be shown, as the glass reflectors, &c., had been lent to the English authorities for kindred experiments at the North Foreland Light. Those tried were found to be in admirable condition, and the results were in the highest degree satisfactory. The light is one of Mr. Wigham's patent triform group-flashing gas-lights. The Board of Trade directed that oil should be used as the illuminant, and not gas; but the Commissioners of Irish Lights insisted that gas should be used not only as the illuminant in the lighthouse, but also as the motive power for the fog signal, and in the end they carried their point. However, if the gas should fail at any time, there is a very complete set of appliances for illuminating with oil, and these were also experimented with. The gas was turned off, and in a few seconds the lightkeepers had a brilliant illumination with oil.

What is a diaphragm? is a question which has been engaging the attention of a number of experts recently; but judgment, at the time of writing, is deferred. The question arose in connection with a telephone case.

The Council of University College, London, have instituted a professorship of electrical engineering, and have appointed Dr. J. A. Fleming to the chair.

The International Telegraph Congress will meet in Berlin on August 10, and will be attended by delegates from nearly all parts of the world, and by representatives of all the great cable companies. The principal subject for discussion, so far as the public are concerned, is a general reduction of tariffs.

Details of an important geographical discovery in the shape of another great African waterway have been received from the Rev. G. Grenfell, who has proved that the Mobangi, which enters the Congo on its right bank, is probably the greatest tributary of the latter. Mr. Grenfell navigated the Mobangi in the little steamer *Peace*, on a mean course of north by east, from the equator to 4° 30′ N. lat., and left it still an open waterway. At 4° 23′ N., just below the second rapids, he found it 673 yards wide; at no point lower was it less in width. Its mean depth is 25ft., and although the current runs not more than 80 to 100ft. per minute, it means an immense volume of water to find running south at a point so near the supposed sources of the Binué, the great affluent of the Niger. The Mobangi is probably the lower part of the Welle, a river whose course is one of the unsolved problems of African geography. From the notes sent home by Mr. Grenfell it would seem that the Mobangi is navigable the whole way from the Congo to 4° 30′ N., a distance of probably 400 to 450 miles, taking account of the bends. A large map, in ten sheets, of the explored part of the river has just been received at the Royal Geographical Society. This map will appear in an early number of the society's proceedings, and a long narrative of Mr. Grenfell's recent work will probably be published in the next number of the *Baptist Missionary Journal*. It is hoped, moreover, that a full narrative of Mr. Grenfell's explorations will reach England in time to be read at the Aberdeen meeting of the British Association.

The death is announced of Mr. N. W. Posthumus, secretary of the Dutch Geographical Society, and one of the editors of its *Journal*. He was also one of the founders of the Society. Mr. Posthumus was only forty-seven.

On Tuesday last week the steamship *Carrier* made her first trip from Langston to Brading, a distance of eleven miles, carrying a train of twelve railway waggons, weighing, with their loads, about 160 tons. That is the first time in which a train has been carried by a steamship in England.

A trial trip of the *Nashua* took place in New York bay recently, and everything was deemed satisfactory. The *Nashua* is a side-wheel steamer, and has the first compound oscillating engines ever put into a paddle steamer. The cylinders are 42in. and 78in. diameter respectively, with a stroke of 10ft. 6in. They are set below the shaft at an angle of 90° to one another, and both piston-rods are connected to the same crank-pin.

At a meeting of the Coalville Branch of the Amalgamated Society of Railway Servants held last week, after full discussion and consideration, it was unanimously resolved that *iron* crank axles are better and safer than steel.

**New Hygrometers.** — M. Bourbouze has devised two interesting and novel forms of the dew-point hygrometer. It is well known that when water vapour condenses on a plate of glass held between the observer and a luminous point, there appear concentric rings round the point, similar to the halo sometimes seen round the moon in cloudy weather. These hygrometers are based on this fact; and consists of a rectangular tube having panes of thin glass closing the parallel ends. A very sensitive thermometer is plunged into the liquid to a small depth, and when evaporation of the liquid is set up by a current of air, the dew halo forms on the panes, and is observed by looking through them at a luminous point. The halo is red outside and violet inside.

**Menthol as a Substitute for Cocaine.**—Dr. Albert Rosenberg, of Berlin, has found in menthol (*Berl. Klin. Woch.* No. 28), in etherial or alcoholic solution (20 to 30 per cent.), a useful substitute for the expensive cocaine, in cases where local anæsthesia of mucuous membrane—e.g., of nose, pharynx, and larynx—is required. The effect of menthol is not so lasting as that of cocaine, but it appears to have somewhat of a cumulative action; for, when repeated, even after a long interval, the later application produced a longer period of anæsthetics than the earlier.

IT is said that a rich find of silver chlorides has been made on the surface of the Broken Hill claim at Silverton, New South Wales, which is said to run through a lode over 20ft. wide. The chlorides have been found for a distance of nearly half a mile. A great many claims have lately been pegged out along this line of country for miles.

# LETTERS TO THE EDITOR.

*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

*All Cheques and Post-office Orders to be made payable* J. PASSMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does' and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

### ASTRONOMICAL — DOUBLE STARS — 53 OPHIUCHI—SELENOGRAPHICAL.

[24503.]—I FEEL truly very much obliged to Mr. Sadler for his kind and prompt answer to my last letter on double stars. I am sorry, however, that through a wrong reading of my declination circle I gave a wrong position of the supposed new double. It is XVh. 32m. + 34° 47′, and this brings it so near to the place of Σ. 1959 which Mr. S. mentions, that I have no doubt but it is the same star. What surprises me is that this star should be considered as of the 8·7 mag., and its *comes* of 10·2 mag. Last night, between clouds, I again looked at it, and I would still have called it, for the least, of the 7th mag., and as its *comes* shone brightly at its side it appeared to me near the 8½ for the least. The distance seemed greater last night; but its position is somewhere between 250° and 260°.

I will try what I can do with the list of doubles kindly given by Mr. S., and report; but I must wait for the absence of the moon and for fine weather, for I suppose they are difficult objects.

The very evening I received the "E.M.," No. 1,059, I looked up 53 Ophiuchi, and saw many more stars than those represented in the sketch of Mr. K. T. Tarrant. I felt sure Mr. T. would add others, and that the following issue would say so. I see that he has found six more. In the diagram I made I find 11 more; but three are out of the line joining G to the *comes* of C, and two others are preceding E. The six remaining are doubtless the six he has seen. My diagram shows four other stars as suspected. One is preceding H, and the three others are between H and the N. companion of K. There are, besides, other glittering points in various parts of this field; but so fugitive, that I found it impossible to take their exact positions.

Has any one observed a darkish spot on the S. extremity of the floor of Cyrillus? That spot contains two small craters of equal size. Schmidt gives only one, and yet his map contains internal evidence that he has closely surveyed this region.

**C. M. Gaudibert.**

### THE DAYLIGHT OCCULTATION OF ALDEBARAN.

[24504.]—I AM much pleased that the communication which appeared from me in a recent number of the ENGLISH MECHANIC had the effect of drawing out from two correspondents very exact accounts of the observation of this phenomenon. At Fleetwood a slight haze was sufficient to prevent its being seen. It is by means of such interchanges of scientific work that amateurs learn to place a value on their performances, and are encouraged to prosecute their researches more diligently. Assuming that Mr. Peek takes his sidereal time from Lyme Regis in accordance with its longitude, I find that the time of immersion, as he observed it, differs by 1m. 43s. slow of that which I calculated for Greenwich by the partially graphic method, and the time of emersion slow by only 26sec., but I feel sure, if he will make the computation for himself according to the principles of my method he will arrive at results still more accurate.

"A. H. S." appears to have been extremely fortunate in his opportunity, and I trust he may favour us with equally interesting details of the daylight occultation of Aldebaran, which occurs on Sept. 29, 1885.

**James Pearson, M.A., F.R.A.S.**
Fleetwood, July 17.

### 100 TO THE INCH — MAGNIFYING POWERS OF A BY-GONE AGE—FAST TRAINS—ERRATUM.

[24505.]—MR. HOLMES (letter 24481, p. 430) in trying to get me on the right path falls into the ditch himself. My quotation from a private correspondent was logically sound as applied to planetary and other objects having a sensible area; for, in this case, it is the intrinsic brightness of the image that is in question—not the total amount of light forming that image. Granting that the image of Jupiter, as seen with a power of 100 on a 2in., is just equal in brightness to the same image with a power of 200 on a 4in. it would be a *reductio ad absurdum* to infer that, therefore the smaller glass shows the same amount of detail as the larger one. The diameter of the image would be, of course, twice as much (and superficial area four times as much) with the 4in. as with the 2in., and it cannot need much reflection to show that the eye would be more vividly impressed with the larger image. But the case of a star is totally different; for here, beyond the enlargement of a flashing point of light into a tiny spurious disc with surrounding diffraction rings, magnification has no other effect than that of increasing the angular distance between the separate components of a double or multiple system. Consequently, the intrinsic brightness of either a bright star or faint *comes* depends upon the aperture of the object-glass or speculum, and nothing else. Further, does Mr. Holmes ignore the quotation from Prof. Newcomb, relative to the size of the emergent pencil of rays, when he says that he finds a 9in. to stand 900 easily enough on stars? Also, I must maintain my argument that the atmosphere does enter into this question; because the atmosphere is always magnified to an equal extent with the object, and its disturbing effect is a factor in the ultimate result—a variable one, truly, but one which can never be eliminated. And I venture to assert, with all conceivable deference to Mr. H., that his dictum respecting "the failure of a 26in. to stand 1,300 (on planets, please) on a steady night as a proof it was defective" is one which few astronomers would be disposed to accept, *experto crede.*

Mr. A. Mee (letter 24477, p. 428) would do well to peruse the following, by Prof. Newcomb, before believing in ancient "giants":—"It has sometimes been said that Sir W. Herschel employed a power as high as 6,000 with one of his great telescopes, and, on the strength of this, that the moon may have been brought within an apparent distance of 40 miles. If such a power was used on the moon we must suppose, not merely that the moon was seen as if at the distance of 40 miles; but that the vision would be the same as if he had looked through a pinhole $\frac{1}{25}$in. in diameter, and through several yards of running water, or many miles of air. It is doubtful whether the moon has ever been seen with any telescope so well as it could be seen with the naked eye at a distance of 500 miles. If such has been the case, we may be sure that the magnifying power did not exceed 1,000."—"Popular Astronomy," 2nd edition, p. 145.

In letter 24487 (p. 432) there appears to be several serious errors. "M. R." is omitted over the section relating to the Midland, and "1h. 0m." cannot be the correct time of four expresses between Kettering and Nottingham. The distance, too, between Nottingham and Kentish Town, via Kettering, is surely not 142½ miles? From Nottingham to London, via Leicester, the distance is only some 126½ miles, and my impression is that the new line was to shorten this—instead of which, it appears to make it 16 miles further.

In my letter (24478, p. 429) there is a slight misprint, occurring in the last line, where "lat." should be "est." **W. S. Franks.**

## 100 TO THE INCH.

[24506.]—I AM inclined to be rather sceptical about the high powers said to have been used with advantage on telescopes in former times. Probably the observers were not very careful in verifying the nominal powers of their eyepieces. Browning, in his "Plea," mentions having a telescope brought to him with an eyepiece engraved 70, which only magnified 13 diameters, and my own experience leads me to believe that the powers marked on eyepieces are generally more or less exaggerated. It seems easy to find the power by dividing the diameter of the object-glass or mirror by that of the bright spot seen at the eyepiece, but it is very different to measure the diameter of this spot. The dynameters of the Berthon type are of little use, unless the straight-edges are absolutely true, and this, I fear, is seldom the case with the instruments generally sold. I have tried four, with most discordant results, one making the high powers nearly double what another made them. Moreover, the screw for the dark head keeps the dynameter some little distance from the eye lens, and this renders it difficult to be quite certain that the diameter of the spot is accurately measured. I believe that the power can only be accurately measured by the use of an instrument made on the principle of a micrometer, and unless we have good evidence that the powers which Kitchener and others are said to have used were measured in this way, we may well believe it more likely that the powers were much lower than stated, than that their telescopes were so far superior to modern ones as to bear 300 or more to the inch, even in the steadiest air.

I have seen it stated that at least about 35 to the inch is required to show star discs. From this it would appear that large apertures would scarcely ever show them, as 35 to the inch on 30 inches would mean a power of upwards of 1,000. I should be glad to know the experience of those who have worked with large apertures. **T. Perkins, M.A.**

## ERRATUM.—PAIR NEAR δ CEPHEI—VEGA.—70 OPHIUCHI.

[24507.]—IN letter 24474, *for* Bode (Lalande 28500) *read* Coronæ 26 Bode (Lalande 28500.)

The triple near δ Cephei, referred to by "H. D." (letter 24479, page 429) is evidently ♅. iv. 31. Through some strange oversight I have identified this with O.Σ. 473 in my Notes and Corrections to ♅. ♅ says of it, "Treble, the nearest about 20″." The principal star is Arg. (+ 57°) 2542, 8·3 mag., 45 seconds of time exactly *p.* δ. I see I examined it in 1881, and identified it with ♅'s triple then; but I will look it up again on the next opportunity. It has never been measured.

If "H. D." will do me the honour to refer to a note of mine in the ENGLISH MECHANIC for Oct. 19, 1883, he will see that I there refer to the most distant (misprinted "distinct" in letter 21924) companion of Vega at 40° 140″ ± as being probably variable, as well as the nearer *comes*. In October, 1870, it was a full magnitude fainter than the nearer *comes*, which Dembowski has measured less than a quarter of an hour after sunset with 7½in. I am obliged to Mr. Franks for the date of his observation of the colours of the components of 70 Ophiuchi in 1876. De. saw them "gialla, rosea; bene." 1876·566, 1876·613. **H. Sadler.**

## THE DOUBLE TELESCOPE.

[24508.]—I AM able to report some progress in following up the suggestion of "W.T.N." (23850), page 539, Feb. 20th, to bisect a large object-glass and mount the halves binocularly. Opticians in Paris divided a 2in. lens, and found the two sections to give the desired results. I have, consequently entrusted them with an 8in. object-glass to divide into two, and mount for me in a 12in. tube of 8ft. focal length, to be furnished with the three movements for the independent adjustment of o.g. and e.p.'s, as already fully described in the account of my 5ft. binocular (23670), page 368, on Dec. 26th, 1884, of 3⅜in. object-glasses.

This will, of course, take some time to accomplish, and, in the interval, I hope to elicit from our readers all improvements which may occur to them on the following device for making a perfect stand for binoculars.

The suggestion of the observing floor being constructed on the equatorial plane was thought too cumbrous. Mr. H. Ritchie's counter proposal and sketch (24228), May 15th, is, he will see, not equatorial, but only an inclined stand, with alt.-az. motions. I have not, however, been able to find a flaw in the following—viz., the "Philip Vallance" stand with an equatorial motion. I start with his centre tube firmly attached to base; within it, the second tube revolving on pivot point at bottom, and within brass bearings at top, ending in the T-piece, through which runs a third tube some 24in. long, on to each end of which I propose to screw (and make fast with bolt and nut) a 3-socket piece, one socket to screw on the end of the 24in. tube, one to receive A, a 6ft. horizontal tube, and the third to receive B, a 3ft. vertical one, which, having a right-angle socket at end to carry a 3ft. tube C, at right angles to B, completes the Vallance stand as applicable to binoculars.

The two horizontal tubes, A, suitably fastened together at intervals, will form a ladder-shaped cradle, on which the 12in. tube will be fastened with a sliding attachment. The two other horizontal tubes, C, will carry two counterweights, aggregating a few ounces less than the binocular plus its cradle.

The object in raising the counterweight tubes C 3ft. above the level of the cradle by means of the upright B tubes, is to keep them clear out of the way of the observer, who will sit at the eye end of the cradle with the centre pillar tube between his knees, thereby insuring the unvarying position of the eyepieces and of the observer, whatever direction the telescope may be pointed to.

The binocular will slide on its cradle, in order to preserve that unaltered position of the observer when used terrestrially, which will lengthen the instrument from 8ft. to 9ft. 6in. The counterweights will be also adjustable on their tubes C, with rack and pinion to correspond with the increase of weight incurred by the terrestrial position of the telescope.

This completes the description of the stand, leaving the telescope a few ounces heavier than its counterpoises, and resting on a section of a circle in metal, with a rise and fall motion by rack and pinion, attached to a stout pillar about 2ft. from, and fastened to, the centre tube.

Now comes the equatorial idea: the revolving tube has a toothed circle attached to it, moving instrument in az.; one single fixed rod, with a convenient wooden handle in the centre of it, has an endless screw at the observer's end of it which gives the movement in az.; it has also a toothed pinion at the other end of it, which *at the same time* gives the movement in alt., by raising the metal section of a circle on which the telescope rests. And if the sizes of the two wheels which are revolved by the one fixed pinion rod are calculated of the relative sizes proportionately, which alt. and az. motions bear to each other in the composition of equatorial movement, I ought to produce equatorial motion by clamping the two actions together, and alt. and az. motions respectively by ungearing them. The telescope cradle must of course run on a small wheel where it rests on the supporting metal circle-section, to facilitate the application of the az. motion simultaneously with the alt.

Perhaps our "F.R.A.S." would kindly tell me the relative proportions of alt. to az., say, in number of teeth in each wheel to produce equatorial results, and at the same time inform me of difference of teeth needful for change wheel to gear for lunar vice sidereal rate, if both are desired to be attained from the use of the same driving clock. **Montmartre.**

## SHORT-FOCUS REFLECTORS.

[24509.]—IN answer to "B. R. W." (24499), I may just say that that proportion of focal length to diameter of mirror is the best that gives the best balance of advantages with least disadvantage for the object for which the telescope is intended to be used. A short focus has the disadvantage of requiring a larger flat, and thus the loss of more of the best part of the mirror, and of light, too, as well as requiring a higher power eyepiece to get the power the amount of light will bear. Its great advantage lies in its shortness, which allows more convenience in using and less cost in mounting, and if in an observatory less cost for building. Now, these disadvantages and advantages each observer must find out the balance that for his purpose and means is the best in his estimation. I have often thought over this subject, and could only wish the Cassegrain could be made as perfect as the Newtonian, and then with a flat interposed between the two mirrors to throw the image to the side of the tube at its lower end we could get a very short telescope, which would require very much less for mounting and observatory than for a Newtonian of equal power and light. This saving could be employed in getting a larger Cassegrain and observatory than a Newtonian and observatory for the same money.

I believe, for Newtonians, eight diameters is best for small mirrors—say, up to 12in.—and seven diameters, or a little under, for larger mirrors, which can be better used on nebula where light is the great desideratum. This is, of course, only my opinion of what, for me, is the best balance of the advantages with the disadvantages of longer and shorter telescopes.

"B. R. W." says he finds no difficulty in parabolising a 5in. mirror of only 25in. focus. I hope his judgment of the figure of his 5in. is dependent on something more than a trial of it in the telescope tube with an eyepiece. By this means he cannot be sure that every zone is of the right focus or curve to form with all the others a true parabola. Even tested zonally in the telescope only a comparatively rough estimate can be formed of the focus and figure of each zone, and the figure as a whole. The zonal test at so-called centre of curvature is at least four times as exact, besides giving the figure of each part of the zone. If he would like to have it tested, I will do it for him with pleasure; it will only cost him the carriage to and from me, and then he will know exactly what he has done. But I hope he has mastered the zonal and shadow test for himself; it is an immense advantage to every worker of mirrors.

I am glad the Cassegrain has fallen into two such good hands as Dr. Pigott and Mr. W. Bradbury; we shall have all that is at present known about it, which will, I hope, lead to some improvement. I am sincerely glad that the illness in the doctor's house has so far abated as to allow him to resume this interesting subject. **H. A. Wassell.**

Addenbrook-villa, Love-lane, Stourbridge.

## THE CASSEGRAIN.

[24510.]—I WAS indeed sorry to see by his letter in to-day's "E.M." that illness in his family had been the real cause of the interruption in Dr. Royston-Pigott's interesting letters. Now that he has returned to the subject, I trust he will do for the telescope what he formerly did for the microscope in making it proclaim its own defects, and thus indicate the path of progress towards perfection.

If the mathematicians will give the means of determining the aberration measurements at centre of curvature for the figure that should be given to the great mirror, Mr. Wassell's method of testing would soon settle the matter as regards its accuracy, and then there would seem no great difficulty in working a truly spherical small mirror to match it.

I fear it is of no great value practically, but I would throw out the suggestion that it might be possible to work and test the small mirror (especially the convex of a Cassegrain) as a lens before silvering it. As Dr. R.-P. has doubtless observed, there are several printer's errors in his letters which rather obscure his meaning at times. **A. S. L.**

## BINOCULARS.

[24511.]—I CAN hardly agree with "Montmartre" that "two eyes see more than twice what the single eye sees." When you shut one eye you see just as well as regards definition and illumination as if you were using both. A one-eyed man sees every whit as well as a man with two. In the same way, an object-glass does not feel any warmer or colder by touching it with two hands instead of one. So much for the $A + A$; now about the $x$. There is a distinct advantage gained by two eyes when viewing near objects, because of the stereoscopic effect; but when objects are a few yards off there is no difference, whether one or two eyes are used. Binocular, Galilean, and twin telescopes restore the stereoscopic effect, whatever the distance. Example: the moon, with one eye, without optical aid, appears the same as the moon with two eyes; but look at it with a binocular instrument, and it will appear as spherical as an orange on a table before you.

There is another quantity which has been overlooked by "Montmartre"—viz., a term to represent that imperfection of definition which is inseparable from the Galilean telescope; this we may call $y$.

I am quite ready to allow $A + x - y$, but cannot admit $2\ A + x$. The whole question turns on whether $x >$ or $< y$. If $x > y$, then a binocular has a pull over a telescope; but if $< y$, then the reverse is the case. It is to a great extent a matter of personal equation, therefore everyone must put in values for $x$ and $y$ for themselves, and draw their own conclusions.

Testing eyepiece diaphragms.—The diminished image being at the eyepiece end will not alter the results. If the diaphragm in the erector is too small, the blue patch will come over the disc all the same. If you wish to get rid of the diminished image, hold the telescope up to the sky.

The field of my 2⅛ binoculars is 2°. They are aluminium, of French manufacture, with a Bond-street name on them, and cost £17. I bought a similar pair in brass, ten years ago, abroad, at a reasonable price. The name on them was Ch. Avizard à Paris.

Shetland, July 13. **Edward M. Nelson.**

## DYNAMO MACHINERY.

[24512.]—MR. J. SUTCLIFFE (letter 24469) will find that Professor Thompson's calculation is correct under certain conditions, which are fully specified in his book.

The horse-power produced in a dynamo is well known to be expressed by—

$$\frac{EC}{746} \text{ (E in volts, C in amperes.)}$$

Thus H.P. of large dynamo is to h.p. of small dynamo, as $EC$ is to $ec$, using small letters when referring to small dynamo.

Now, $E$ is to $e$ as the number of magnetic lines of force cut by the revolving coils of the large dynamo is to the number cut by the revolving coils of the small dynamo in the same time, and if we make the large armature revolve as many times per second as the small, we shall have—

$$E : e :: N : n$$

where $N$ and $n$ are the total number of lines passing between the poles in the large and small machines respectively.

What is the relation between $N$ and $n$?

First, suppose the magnets are independently magnetised, and let the magnetising current be supplied from the same battery in both cases; then the current through the larger coils will be twice that through the smaller, and this will produce an equal intensity of magnetisation in both large and small magnets; whence, since the cross section of the larger core is four times that of the smaller, $N$ will $= 4n$, and therefore $E = 4e$. This, again, will make $C = 8c$, and $Ec = 4e \times 8c = 32ec$, whence H.P. : h.p. :: 32 : 1.

We have supposed all the linear dimensions of the large dynamo to be double those of the small dynamo, and therefore the resistance of the large coils to be half that of the small coils.

This result can hardly be looked for in practice unless special arrangements are made to render the large magnets more susceptible to magnetisation than they would be if of the same construction as the small magnets.

Other arrangements may be adopted with the same result, the fundamental requirement being that the larger magnets shall be magnetised with the same intensity all through as the smaller magnets. If the dynamos be both shunt-wound, the desired effect may be obtained by winding the large magnets with the same gauge of wire as the smaller and with the same number of layers; the resistance of the larger coils will then be four times that of the smaller, and if $E = 4e$ the same current will run through both coils, and this will produce the same intensity of magnetisation in both magnets. As we have seen, the E.M.F. thus produced will be $E = 4e$, and will, therefore, be just sufficient to keep up the required current, and the arrangement will therefore continue to work.

In this case the H.P. wasted in the larger coils is only four times that wasted in the smaller, while the total H.P. produced in the larger dynamo is 32 times that produced in the smaller.

In the former case, the H.P. required from the battery which magnetises the large magnets is only twice that required from the battery which magnetises the small magnets. Hence, in both arrangements, the larger machine scores heavily in that respect.

M. Marcel Deprez compares the large and small machines under a different set of conditions. He requires that in both machines the current shall be the same per square centimètre of cross section of the conductors. That is, $C = 4c$, and if we produce in the large magnets twice the intensity of magnetisation produced in the small magnets, we shall, by similar reasoning, obtain $E = 8e$, and

$$\text{H.P.} : h.p. :: 8e \times 4c : ec$$
$$:: 32 : 1.$$

In this arrangement the total resistance of the main circuit, including the armature, must, in the large machine, be twice that of the corresponding circuit in the small machine.

Mr. Sutcliffe seems to have satisfied himself that the statical attraction is increased in the ratio of 16 to 1. It follows immediately that since all distances are doubled in the larger machine, the distance through which the larger attraction acts is twice the distance through which the smaller attraction acts, and thus we get the ratio of *work done* to be 32 to 1.

Clevedon. **W. M. M.**

## EDER'S DEVELOPER.

[24513.]—IN your No. 1,060, under "Experiments with Gelatine Emulsions," a very important error appears, which calls for instant rectification. You give Eder's admirable formula for development as—I. Pyro. 10, sulphite amm., 30, water 100. II. Brom. amm. 5, water 150. II. should be instead: Brom. amm. 5, ammonia (·880) 50, water 150.

In your formula the ammonia has been omitted, and anyone trying it, then, would naturally get no picture at all.

This developer is quite admirable, producing very soft yet vigorous pictures at will, and appears to work equally well with every make of plate, and with Morgan and Kidd's negative paper.

British Legation, Darmstadt. **N. Jocelyn.**

## PYROLOGY.

[24514.]—YOUR readers will welcome the reappearance of Mr. A. H. Allen in the columns of the ENGLISH MECHANIC, and none more than myself, although his first revived contribution appears to contain an unfavourable critique on my own work. Mr. Allen generally remembers what some modern English chemists seem to forget, or rather, not to be aware of—viz., that society expects them to show by their polemical writings that they are gentlemen as well as chemists: his chemical criticisms, therefore, usually exhibit the (in England) peculiar anomaly of being courteous as well as laboratorical.

If Mr. Allen's logic and acquaintance with his present subject (the heading of this letter) were only equal to his knowledge of chemistry and courtesy, he would doubtless prove a formidable antagonist, if, in that event, he remained an antagonist at all; but as nothing is more painful to me than giving a direct contradiction in print to the statements of so polished a chemist as Mr. Allen, I wish that in his future publications he would pay more attention to the truth of his premises before allowing his chemical zeal to hurry him to such rash and wrong conclusions. For, I am sorry to tell him that, in my portion of his contribution to the "E. M." (page 45[illegible]) the first position, which he assumes as a well-known fact, and thereupon bases his entire argument, is so false and exactly opposed to the truth, as to appear (for a man of his sagacity) in the last degree childish and absurd. He assumes that accuracy of analysis is in inverse proportion to the minuteness of results revealed, and states *ex cathedrâ chemicâ* (let us hope he is only speaking for Yorkshire or Sheffield, and not for England, Germany, and America here) that "chemists cannot direct their serious attention to the matter"—*amoto quæramus seria ludo*—"unless the subject of analysis is operated on in reasonably large quantities."

Now, it is surprising to find a clever and, generally speaking, well-informed man so far behind the information of his own time as not to know what the microscope and spectroscope (not to mention the blowpipe) have long since shown us, that extreme accuracy in the estimation of the nature of a compound is only compatible, and in a direct ratio, with the minuteness of the revelation of constituents. But why should Mr. Allen draw the line at a platinum crucible full of material in his definition of "a reasonably large quantity"? Other operators, working in a different line from Mr. Allen, might call this quantity unreasonably small. The distiller would say: "Operate on a bucketful if you want to have a correct knowledge of the subject." The smelter would contend that "you could do nothing with less than a ton of material."

On the other hand, the rapidity of results obtainable with the blowpipe enables the operator to confirm or displace the revelations of his first analysis by those of half a dozen others in a not fatiguingly long space of time, and even Mr. Allen will scarcely assert that if you obtain the same weight of result in your assay balance by six different analyses of the same materials, you have not reasonable ground for concluding that result to be correct.

I have, far more than six times, found quicklime to combine with boron trioxide (or anhydrous boric acid) before the blowpipe, to form calcium pyroborate in the invariable proportions of 25 per cent. of the former to 75 per cent. of the latter; yet Mr. Allen reiterates the absurd objection that this invariable result might be merely accidental. "You have not proved (says he) that some of the lime was not dispersed about the bead." If Mr. Allen had ever tried to perform this simple operation (for it takes far less time to perform than to write long-winded letters about) himself, he would have found that "You" *have* proved it—*ipso facto*—by the operation itself. For, if any lime were "dispersed about the bead," it would, in each or any of its localities, form calcium pyroborate in that locality before the blowpipe, and as such be at once discovered as a ball with the lens, capable of being boiled out and weighed with the rest of the calcium borate; but he would be a very clumsy operator with the blowpipe who could allow such a *contretemps* to take place, and a very foolish and untrustworthy one not to make a fresh analysis in that case, for separate lime-balls always coalesce into one, in a bead of boron trioxide, B.B.

But the fact is, this clever chemist has never tried these things practically himself, and therefore—to call a spade euphemistically—remains slightly unacquainted with the matter in hand, and should not, therefore write about it at all until he has removed this disadvantage. If Mr. Allen will go into the subject practically at his leisure, and start a small blowpipe apparatus in his laboratory—he is not far from Warrington, where he can get a first-class footblower from Mr. Fletcher—I will ask my publishers to send him a copy of my last little work for his guidance at first. It is really painful to see such a writer as Mr. Allen sliding into the ranks of those chemical boobies who presume to write and publish on a difficult subject, without any practical knowledge of it whatever, deeming "wet" methods of analysis, in which they are doubtless proficient, all-sufficient for everything else, however different. One never finds German, French, or American chemists doing this, and although I am not aware that they possess, like those English chemists of whom Mr. Allen speaks, any power of "attention" which is not "serious," some of the most celebrated have long ago "directed their serious attention" to this matter. Professor Bruno Kerl, of Berlin, has sent me original articles he has contributed to his own paper, the *Berg und Hüttenmännische Zeitung*, upon it, and Professor Cornwall, of New Jersey College, the well-known translator of Plattner's "Probirkunst," has written to tell me he has procured my last work on the blowpipe, and considers my system of anhydrous analysis worthy of his profound (and now being applied) attention. **W. A. Ross.**

## EXAMINATION OF MINERALS BEFORE THE BLOWPIPE.

[24515.]—No. 6 seems to be a soda feldspar, containing also potash. If there was no water, or very little, found in it, I should be apt to think the mineral what Des Cloizeaux, after the French mineralogists, calls "Schorl Blanc" or Albite; which is classed by Dana among the "unisilicates," and analysed (by Brooks) as follows:—$SiO_2$ 67·39, $Al_2O_3$ 19·24, Mg 0·61, CaO 0·31, $Na_2O$ 6·23, $K_2O$ 6·77 = 100·55.

No. 7, "An alkaline (soda) aluminous silicate," probably containing water, as the "icelike mass" contained in the boric acid bead, dissolved so rapidly before the blowpipe; in which case we should have to look for it in a mineralogy under the head of the soda-zeolites, probably analcite; but really, in the absence of all indications derived from crystalline form, and the presence or absence of water, it is hard to say where one should look for the particular species of such minerals. An analysis of "zeolite dure" (or hard zeolite) of Dolomieu—i.e., analcite—from Giant's Causeway, is $SiO_2$ 55·60, $Al_2O_3$ 23·00, $Na_2O$ 14·65, $H_2O$ 7·90 = 101·15 (Thomson).

No. 8 I should say was Heulandite (?), which has a peculiar "shade of white passing into red" colour, and a hardness of only 3·5; but it again has a large percentage of water and a considerable amount of lime, neither of which are mentioned by Colonel Ross: $SiO_2$ 59·64, $Al_2O_3$ 16·33, CaO 7·44, $Na_2O$ 1·16, $K_2O$ 0·74, $H_2O$ 14·33 = 99·64 (Damour).

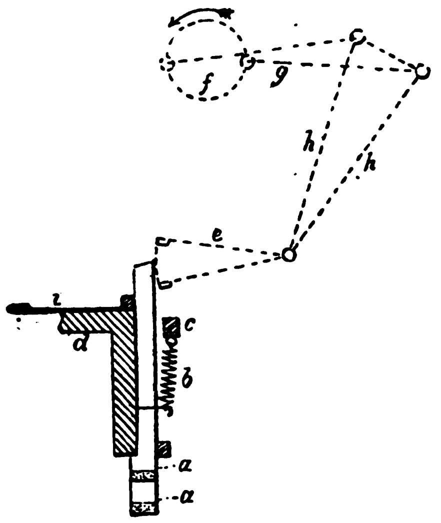
No 9. "A crystalline-fibrous, soft, white, opaque, soda-alumina silicate, with between 10 and 20 per cent. of soda, a considerable proportion of alumina, and a trace of lime." This description appears to me to tally almost exactly with that of "Natrolite": $SiO_2$ 47·76, $Al_2O_3$ 25·88, $Na_2O$ 16·21, $H_2O$ 9·31 (Fuchs).

No. 10. "A phosphate of iron, with a little manganese and lithia, and a trace of soda." Looking in Dana, under the head of "Anhydrous Phosphates" for an iron phosphate with lithia (I should think a solution of this mineral useful medicinally), I came across the very one, "Triphylite," page 541. Analysis by Fuchs: $P_2O_5$ 41·47, FeO 48·57, MnO 4·70, LiO 3·40, $SiO_2$ 0·53, $H_2O$ 0 68 = 99·35.

**Mineralogist.**

## AUTOMATIC MUSICAL INSTRUMENTS.

[24516.]—I GIVE an outline diagram of the movement of my pianoforte player reduced to half size. Further particulars are shown in the specification, No. 5024, 1884. A A are the plungers, long and short, to suit the raised keys, placed in a row; they are wooden rods, square in plan, with pads of thick felt at the base, which projects backwards for a stop to limit the rise in the sockets. They are drawn upwards, clear of the piano key, by coiled springs of very thin silver wire, *b* (008), attached to the plungers, and the fixed rail, *c*, above. As the pull is out of the centre, the plungers are thrown back against the base-board, *d*, so lightly that the mere force of the breath passed along the tops is sufficient to deflect them against the stop-rail, *c*, and, being caught by the vibrator, the notes are sounded in succession. This is all the work that the music bands have to do, and consequently the paper is free from strain in sounding the notes. The dotted lines represent the path of the vibrator and crank movement. *e* is that of the vibrator or finger piece, consisting of a wedge-shaped strip of mahogany, 3ft. 4½in. long, extending backwards over all the plungers. It is armed with a strip of felt under the thin front edge, at which the tops of the plungers are caught. The circle *f* is the path of the crank-pin, situated mid-way over the length of the vibrator, *e*; *g* is the connecting rod; *h* is the arm or lever, from *e* to *g*, made of a blade of elastic steel, so as to yield slightly when a note is struck. It will be seen by the diagram of the angle lever-motion that during the sounding or down stroke the crank pin recedes from, and in the up-stroke approaches to, fulcrum of *e*, so that the speed of this is increased during the rise, giving what is known as a "quick return" to the vibrator. The crank spindle makes 600 revolutions per minute. This exceeds the shortest interval between the notes in musical composition, and the very quickest passages are rendered with clearness and accuracy. *i* is the thrusting wire. The pulling wires running the length of the base-board are of annealed copper, No. 21, passing at intervals under guides or bridges, so that the instrument can be carried in any position without derangement.



The width of my music bands is 9½in.; there are 75 keys or notes, spaced ⅛in. asunder. The length of the instrument is 3ft. 9in.; width of the box, 11in.; depth, 4in. The total weight is 24lb., so that it may be easily carried about.

In reply to "Vulcanite," I have to state that, although my vibrator is something similar in action to that of the "Organo piano" of Metzler and Co., yet the intention and effect are different. The beautiful sustained tones of their instrument are produced by the vibrator acting directly on the strings and making about 1,500 strokes per minute, giving a continuous sound. In mine there is a distinct repetition of sounds.

I have also to inform "A. S. L." that I abandoned the use of skew or silent gear for driving my crank spindle, for, however well made, some noise from the rubbing of the teeth occurred; I therefore use a gut band in the same way that it is adapted in some watchmaker's bench or hand lathes —viz., with the driving axle at right angles to the mandrel, and as my instrument is almost frictionless, and the power required to turn the handle is scarcely felt, a small gut suffices; this is only ·06in. in diameter, and is ever-enduring.

I should have stated that in Prof. Gally's "Orchestrone" although the circular holes in the paper music band are only $\frac{1}{10}$in. in diameter, in long-sustained notes or line, they are placed in a series very close together, and the "wind" is drawn through two at the same time, so that the reed orifices are not closed during the note. This leaves cross-ties between the slit in the paper, which would otherwise, for the sustained tones of organ music, be cut nearly into ribands and materially weakened.

**F. H. Wenham.**

[24517.]—I AM much vexed that Mr. Ray should have been troubled by "Gray's-Inn" in connnection with information courteously given to myself in the course of private correspondence, nor did I think "Gray's-Inn" was justified in taking such a step, even though the result has been to confirm my own statement.

I do not propose to follow all the fanciful names, and changes of names, subsequently adopted by the dealers in these instruments; but as the organette, as originally imported by Mr. Ray, had levers, and in the orguinette, as imported by Metzler and Co., had none, I have always used (and shall continue to use) these names as conveniently distinctive of the two classes of instruments. In reality, the late Mr. Croger gave the name of organette to a miniature harmonium long before the date of the automatic reed instruments.

Would it not be better if "Gray's Inn" were to send to (or induce Mr. Fryer to send up) a working drawing of the lever instrument in question, instead of "squabbling" about the name by which he thinks it ought to be called, and continually carping at me who am simply endeavouring to give practical information to those who have asked for it.

I fail to understand the remark about the large circulation of the "E.M." I myself have read it in places many thousands of miles from 332, Strand; but what has that got to do with the question of "levers or no levers" in an organette?

**A. S. L.**

[24518.]—HAVING recently noticed a revival of the subject of automatic musical instruments in "Ours," I beg leave to correct "A. S. L.," page 365, with regard to the non-fulfilment of my promise of sending instructions how to make one of the above-named instruments. My intention was not to send a sketch of the mechanism of the "organette," as "A. S. L." seems to imagine on page 365, but to furnish instructions how to make an automatic musical instrument to contain three chromatic octaves (37 notes or reeds). This would be the smallest compass that could be allowed in order to produce an unlimited number of melodies of various strains and character, with a certain limited amount of harmonious accompaniment, which could be varied in character, like that of the melody, as far as the limited compass of notes employed would allow. There is one thing in connection with automatic musical instruments that requires improvement, and that is to lessen the grinding character of the music produced from them. In those instruments in which the paper strips are employed the notes do not sound prompt enough, and in those instruments which have levers the notes appear to be cut too short by the irregularity of the action of the pallets, which soon makes itself manifest after the instrument has been used much. I could better explain my meaning by the agency of a diagram. "A. S. L." does not seem to have properly studied the mechanical arrangements of the various classes of automatic musical instruments; but his knowledge of cutting out the holes in the paper bands or strips I think may be said to be perfect, as I must give him credit for being one of the most competent writers in "Ours" on the making of paper bands. Our friend Mr. Wenham goes further into the subject, and explains some matters in connection with the higher and better class of automatic musical instruments. If that gentleman could find time to explain how to make a simple automatic musical instrument that could be constructed without any particular or elaborate ingenuity, I think it would interest a large portion of the readers of "Ours." If I sent instructions for making one, I should merely describe the mechanical arrangements, but should not attempt to instruct readers on the making of perforated bands or discs. The latter is a subject which, up to the present time, appears to me somewhat incomprehensible, in consequence, I suppose, through my loss of interest in that matter. I am nevertheless always willing to help any of "Ours" in any way I possibly can.

In reference to the letter of "Gray's Inn," p. 433, that gentleman is quite correct in stating that "orguinettes" and "organettes" are practically identical, which means, I presume, that they are similarly constructed. There is a little instrument made, which is called the "organina," constructed with levers, which are actuated by the employment of perforated paper strips or bands. The music produced from this little instrument is superior to that of the organette, as the notes speak promptly, and are minus of that drony speech so prominent in the action of the organette.

**G. Fryer.**

## GLASS DISCS FOR SPECULA.

[24519.]—I AM not able at present to give Mr. Wigmore, of Melbourne, any further information on the above, except to say that Messrs. Chance, in their reply to me, express their willingness to communicate direct with Mr. W. if he will write to them. I believe there is no parcel post with Australia, and a 9in. disc would weigh considerably more than the present limit in use in this country. I am told the charges for freight are principally based upon the cubical content of the packages. I should think it would not be very high, and Mr. W. might inquire of the shipping agents at Melbourne.

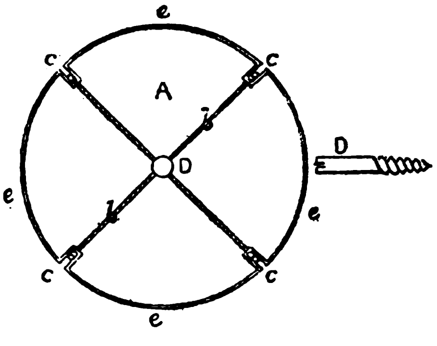
**J. C. L.**

## POLISHING OR GRINDING WHEEL.

[24520.]—I INCLOSE drawing of a grinding and polishing wheel, easily made and kept in order.

A, a wooden disc mounted on a commen wood screw, D, whose head has been sawn off or turned down. The disc secured firmly in this can be mounted in a concentric chuck in the lathe.

Being turned true, three or four saw kerfs, *c*, *c*, *c*, are cut into its edge. Strips of Canton flannel, woollen flannel, cloth, or buckskin, *e*, are wrapped around the circumference of the disc, and tied tight by cords, *b*, *b*, *b*, *b*.



Charge the cloth with rouge, rottenstone, putty, or use emery cloth or sandpaper. The faster it moves the more effective and rapid the work. The clothing can be removed and others substituted.

**M.**

## SPURIOUS BUTTER.

[24521.]—IN a recent number of our "E. M." a method is shown of detecting adulteration of butter by observing the colour produced in true and spurious butter on the addition of sulphuric acid; but though a less valuable test, still deserving of attention as being rough and ready and easy of application, is to grease a piece of paper with true and suspected butters. Roll the papers up, and set them on fire. The smell of the pure butter is pleasant, that of butterine has distinctly a tallowy smell, quite easily to distinguish from the honest article. I would earnestly urge on my friends to have nothing to do with spurious butter; the probability is that it is made up with mixtures of fat which are full of germs of tapeworm and trichina. The genuine article is now cheap enough; insist on having it—only it.

**E. B. Fennessy.**

## OVERFLOW IN WATER-WASTE PREVENTER.

[24522.]—IN 56404, No. 1015, I described a cure for the above trouble by forcing down the feed ball-cock so as to lower the level of the water supply to the W. W. P. by half an inch. I deceived our readers and myself. After two months' obedience to the treatment the troubles recommenced spontaneously.

On examination, it was found the obstinate ball-cock—taking "Resurgam" for its motto—had regained the mischievous level, and was causing an overflow in all directions beyond the ability of the waste and warning pipe to deal with.

I thereupon procured a copy of Mr. Davies' new work on "Plumbing," recently advertised in "our" columns; but though I found most ample descriptions of varieties of W. W. preventers, with diagrams of same, including the identical offender, I could meet with no instructions for regulating the ball-cock anywhere. I therefore wedged a piece of wood firmly between the iron sides of the W. W. P. directly over the ball of the ball-cock, at such a height as will preclude the water level ever rising to within ⅜th of an inch of the overflow. As this is an item which affects every water company, as well as every householder, W. W. P.'s being now a necessity by Act of Parliament, proper provision should be devised and promulgated to remedy this defect.

Since writing the above, I see that Mr. Davies had kindly advised on the case on p. 239; but neither of his two suggestions meet the circumstances. **Montmartre.**

### ORGAN DESIGNING.

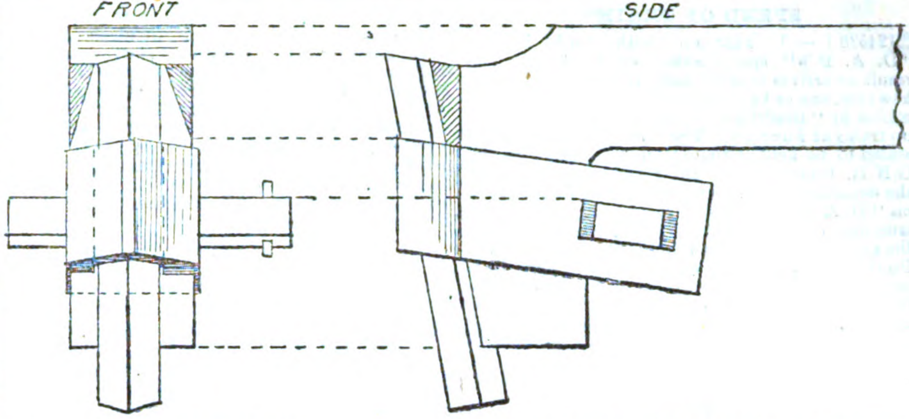
[24523 ]—Amongst the various registers which go to make up the contents of an organ, one always finds a number of stops which are never drawn singly, and which, moreover, are always drawn in certain combinations. Amongst those registers of more acute pitch, such as furniture, cymbals, &c., this principle is always recognised, and three or more ranks of pipes placed under the control of one stop handle.

But there are, in addition to these, stops of the mutation class 5⅓ft., 2⅔ft., 3⅕ft. &c., and stops of 4ft. and 2ft. pitch which are never used singly. And what I want to know is, Would it not simplify the work of an organist immensely to have all such registers as these under easier control than at present? For instance, on the great, one never uses the principal without the open, nor the twelfth without both fifteenth and principal. What I suggest would apply chiefly to those large instruments wherein fifty or more stop handles confront the player, on not more than twenty of which perhaps he ever lays his hands, all the rest coming out in groups under the direction of composition pedals or pneumatic pistons. Let there be on the great organ a stop containing ranks of pipes of 8ft., 4ft., 2⅔ft., and 2ft., and if there be an open 16ft., insert a 3⅕ft. rank. The same will apply to the swell and the pedals, and in this way no less than four useless stop handles in each organ will be eliminated. As it is just possible that in the swell a 2ft. may be used for special effect, a wooden stop of that pitch might be added. In this way an instrument with thirty-six visible stop handles would have as many pipes perhaps as one of sixty, and there would be far less to perplex a strange organist. Of course, by many people the size of the instrument is gauged by the number of stops without any reference to the number of pipes, and thus it comes to pass that builders desirous of making a "thin" specification as imposing as possible, will split a V.-rank sesquialtera into two of II. and III. ranks, and divide the double into Tenoroon and Bourdon; also have a stopt diapason Bass and "clarionet flute" treble, and put in a number of stops such as tierce and twenty-second, which ought properly to be contained in a mixture. I only know of two organs where the method I have indicated is carried out—viz., in the pedal of the large instrument at Boston, U.S., and at in the great organ at Edinburgh University, N.B., or the Edinburgh Music Hall, I forget which, there is a harmonic mixture of XIV. ranks, beginning at 8ft. It used to stand on the soundboard of the solo till the latter was inserted. This principle of combination might be carried still further if it is remembered that in the pedal the 32ft. never are drawn without the unisons, nor in the manuals the 16ft. without the 8ft.

Perhaps someone will say if the large organ by Cavaillé-Coll in St. Peter's, Rome, is yet opened, the specification of which was given in these pages some years age. **John T. Lawrence, B.A.**

### ELECTRICITY IN MACHINE ROOMS.

[24524.]—Electricity is sometimes very troublesome in machine rooms, where the belts and other parts run at high speed, and especially so in dry weather, when there is little moisture in the air: temperature seems to have little influence. A friend writes me that in his shops last January, the saws, planers, &c., in the pattern-room became heavily charged with electricity, which at times developed great intensity, and rendered working the machines quite unpleasant, if not dangerons. The pattern-room is in the second story, and as live steam is used for heating, the floor was dry as tinder, insulating the machines as completely as if they stood on a glass plate. The frictional electricity from the belts charged the machines so heavily, that sparks ½in. long could be obtained by presenting the knuckle. To overcome the difficulty, a small wire was driven into a crack in the floor and connected to each of the machines, and to the water pipes, thus allowing the electricity to pass off gradually without acquiring intensity. This plan was perfectly successful, and can be applied in a few minutes. **E. A. M.**



### CUTTER-BAR.

[24525.]—I have read with much pleasure the letters of "O. J. L." on cutter bars, &c., in the "E. M." I herewith send drawing of one I have had in use for some time. If you should think it worth engraving and publishing, please do so, as I should like to have opinions upon it. I will not now speak of any advantages it possesses over those now in use, as I think the drawing will explain itself. I may just add that I use various sections of steel for tools in different bars, and that in my hands the bar is very satisfactory.

**G. Cordon.**

### NEW TRAINS, &c.

[24526.]—The companies' working time tables and those offered to the public differ in many ways, and though I am not in possession of this month's N.E.R. official time tables, I conclude that they grant an extra stop between Newcastle and Edinburgh for water, as was, I believe, the case with the up Limited Mail of the G.W.R. as it ran a year or two ago. According to Bradshaw, it ran without stop from Bath to Paddington (106¾ m.) in five minutes under the three hours. Again, during 1882, the up Highland express by the West Coast Route was timed on Sunday mornings to run continuously from Crewe to Willesden (152½ m.) on all published bills, but, I believe, it always stopped at Rugby.

The above suggests a query concerning that historical train journey from New York to San Francisco in 3½ days, performed, as far as I recollect, in 1876. A pictorial account of the trip in the *Illustrated London News* of the period states that the longest piece of continuous running was 444 miles! Did they couple two or three extra tenders to the engine or engines that drew the train, and so convey the necessary water and fuel?

In answer to J. T. Lawrence, I may say that several Compounds and Precedents are now in regular running from Crewe to Euston and back in the same day, and *vice versâ*; but the L.N.W. engine, doing the largest daily mileage, and, I should say, also the hardest worked loco. on any line, is No. 955, Charles Dickens. She is a 6½-foot Precendent, and bears the date Feb., 1882. Since first put on she has regularly worked the same trains, going from Manchester to London and back in the same day. She takes the 7.45 out of London-road, arriving in town at 12.10 noon, and returns at 4 p.m. with the 4¼ hours express. Both trains run *viâ* Colwich and the Potteries, making two journeys of 182½ miles, which, with 5 miles of shed to platform runs, brings her daily total to 370 miles. As this engine goes out every week-day, I understand that alternate sets of men work her, and all turning up of wheels and slight repairs are done at Longsight on Sunday.

That typically competitive service between London and Manchester has once more been "improved and revised" by the three catering companies; the prayer of a Midland shareholder at a recent meeting for a uniform and non-competing service by all three routes in 5 hours has been disregarded; and, though last year's minimum time of 4¼ hours has not been surpassed, the number of trains completing the journey in that time has been more than doubled. The North-Western has been the first to quicken throughout this competition, because, having by far the shortest route, it has been, and is running, well within itself. Next year we may expect a further acceleration of a quarter of an hour, judging by the past.

Surely the "special expresses" of the G.N. and M.S. and L. companies cannot pay their way: six coaches and usually a dozen through passengers at a speed entailing extreme wear and tear of both rolling stock and permanent way does not seem like "good business."

The G.N. 5.15 a.m. Newspaper is better than "D. A. P." supposes; it is allowed (as "C. P." notes in the case of an up train) one minute at Finsbury, so that it should run to Peterboro' in 84 minutes, or 52⅔m.p.h.

Again, the 60 miles 24 chains between Northampton and Willesden in 70 minutes is the work of an up Manchester express on Sundays—viz., that due into Euston at 4.30 p.m.

Would it not be advisable for the G.N., on which steadiness of running appears to be decreasing in proportion to its present increases in speed, to take a hint from the North-Western and Midland, which have attained such smoothness of travel by means of radial and bogey carriages respectively?

It would interest many if one of our railway contributors would publish the working time table of the two new special mails between London and Scotland by the West Coast Route—*i.e.* the 8.30 p.m. ex Euston, and 4.10 a.m. in Euston. As neither carries passengers, no account of them appears in the public tables and time books. **L. N. W.**

### RAILWAY SIGNAL RETURNS.

[24527.]—Last week, p. 435, I gave a summary of the block system returns. The following table gives in detail the facts relating to the more important railways, from which it will be seen that some of the principal lines are in a satisfactory position:—

| Railway. | Total length of Line open for Passenger Traffic. | | Distance worked upon the Absolute Block System. | |
|---|---|---|---|---|
| | Double | Single | Double | Single |
| | Miles. | Miles. | Miles. | Miles. |
| Cheshire Lines, joint.. | 125 | — | 92 | — |
| Furness ...... | 72 | 34 | 71 | 34 |
| Gt. Eastern .. | 494 | 473 | 494 | 208 |
| Gt. Northern . | 570 | 169 | 556 | 91 |
| G.N. and G.E. joint... | 111 | 5 | 111 | 5 |
| Gt. Western .. | 1,041 | 988 | 889 | 753 |
| Lancashire and Yorkshire .. | 423 | 17 | 423 | 9 |
| L. and North-Western .. | 1,363 | 311 | 1,347 | 280 |
| L. & N.W. & G.W. joint.. | 111 | 27 | 111 | 16 |
| London and South-Wstrn | 523 | 225 | 523 | 200 |
| London, Brighton, and S.C. | 339 | 118 | 339 | 118 |
| London, Chatham & Dover | 167 | 10 | 167 | 10 |
| Manchester, Sheffield, and Lincoln .... | 266 | 3 | 185 | — |
| Midland...... | 988 | 278 | 951 | 215 |
| North-Eastern | 921 | 426 | 916 | 412 |
| North Staffordshire ...... | 149 | 19 | 143 | 19 |
| South-Eastern | 333 | 37 | 333 | 37 |
| Somerset and Dorset, joint | 2 | 89 | 2 | 89 |
| Taff Vale .... | 52 | 12 | 6 | 1 |
| Caledonian .. | 426 | 354 | 421 | 203 |
| Glasgow and South-Wstrn | 218 | 112 | 211 | 70 |
| Gt. Northern of Scotland. | 23 | 275 | 23 | 269 |
| Highland .... | 6 | 408 | 6 | 408 |
| North British . | 400 | 469 | 353 | 139 |
| Gt. Northern, Ireland .... | 136 | 371 | 3 | 14 |
| Gt. Southern and Western | 206 | 301 | 21 | 17 |
| Midland G.W. | 149 | 275 | 68 | 9 |

**Clement E. Stretton, C.E.,**
Hon. Mem. A.S R.S.

Assize Court, Manchester.

## SPEED OF TRAINS.

[24528.] — I PERUSED with much interest "D. A. P.'s" speed-table (letter 24487). The result he arrives at is certainly remarkable. I note, however, one or two errors. "D. A. P." has been misled by "Bradshaw" in taking the times of the up trains at Finsbury. The times there given are stated to be arrival times; but a reference to the G.N.R. time-bills will show that they are really the departure times. The run which stands No. 8 on "D. A. P.'s" list is No. 2 on mine (24489), the true time being 1.3, and not 1.5. Probably through the same error two runs between Peterborough and Finsbury, in 1.27 and 1.28 respectively, have been omitted, and also the 6.15 down express to Grantham in 2 6 = 50.24. Introducing these changes, and omitting the runs which are only made on certain days of the week, we get the following result:—

| Company. | Train miles daily at 50 miles per hour and upwards. |
|---|---|
| G.N.R. | 2,354 |
| L. and N.W.R. | 908¾ |
| M.R. | 606¾ |
| G.W.R. | 499½ |
| M.S. and L.R. | 360 |
| N.E.R. | 44¼ |

In other words, the G.N. runs very nearly as many miles at this speed as all the other lines in the kingdom put together. **C. P.**

## GAS LOCOMOTIVES.

[24529.]—"PROGRESS No. 3," on page 415, is, in my opinion, undoubtedly working in the right direction, inasmuch as he proposes to substitute gas for steam in the working of steam tramways and carriages. Unless, however, he proposes to dig holes in the road at every step with his pedal arrangement, I must confess I cannot see where the advantage over driving through the tire of a wheel comes in.

In any case, even when travelling at only a moderate speed, it would impart a very unpleasant jogging motion to the carriage.

I suppose he is aware that in the early days of the steam locomotive driving by means of feet was tried, also that it proved utterly unpractical.

If only we could get an efficient high-speed gas-engine, which would be light for the power it developed, the days of steam on tramways would be numbered. For it is obvious that no matter how much we reduce the weight of the *engine* in a steam loco., the boiler must always be the bulk of the dead weight to be carried.

Ashton-on-Mersey. **Stud. Inst. C.E.**

## THE TREATMENT OF BALDNESS.

[24530.]—FROM time to time queries and letters appear on baldness and its prevention; so perhaps the following from the pen of Dr. George H. Rohe, in the Atlanta *Medical and Surgical Journal*, may be acceptable:—

Having been himself a sufferer from seborhœa and consequent alopecia for six or seven years, the writer tried a great many remedies with a view to its alleviation and cure. Arsenic internally, stimulating washes or oily applications, containing in the one case corrosive sublimate, in the other quinine, or tannin, in still another some of the stimulating oils, were used with no appreciable effect either on the formation of scales or the depilation. Finally, about two years ago, an item went the round of the medical journals to the effect that a French physician had found that the local use of a 5 per cent. solution of chloral hydrate was a sovereign remedy for the trouble under consideration. Rejoiced that at last I could appropriately shout "Eureka!" I began to use the chloral wash assiduously for about three months, following the directions given as accurately as possible. At the end of the three months the production of scales was more rapid and the fall of hair greater than ever. Disgusted with the failure of all the therapeutic measures which had been so highly lauded, I almost decided to let the affection take its own course, and run the risk of a shiny bald pate at thirty. About that time the second volume of Hebra's classical treatise on diseases of the skin came to hand, and one of the first things I read was Kaposi's thorough article on alopecia. Impressed with the reasonableness of the views put forth by Kaposi, I determined to give his plan of treatment a trial, with the result of checking the fall of hair and diminishing the production of scales in a reasonably short space of time. I have since then recommended the plan in a considerable number of instances, and when it has been faithfully carried out with uniform success.

The success of the method depends upon the use of an agent which, while mildly stimulant, removes the scales and thoroughly cleanses the scalp. This agent is the German or French soft soap (green soap, schmierseife, savon vert), in alcoholic solution. This soap is now imported in large quantities, and prescribed daily by the dermatologists of Boston, New York, Baltimore, Philadelphia, and other cities. The soap, containing an excess of alkali, saponifies the fatty matter of the sebaceous secretion, and it is thus easily removed. The alcohol greatly assists this action, and seems also to have an alterative action—if such an indefinite term is excusable—on the glands. The two may be combined as follows:—

Saponis viridis (Germ.)........ 2oz.
Alcoholis .................... 2 „
Dissolve, filter, and add from 20 to 30 drops of oil of lavender.

The oil of lavender is added to cover the disagreeable fishy odour of the soap. The above makes a very handsome orange or wine-coloured preparation, with a pleasant odour, to which the most fastidious will hardly object.

This is used as a shampoo every morning or evening, pouring one or two tablespoonfuls on the head. Upon the addition of water, and smart friction with the fingers, a copious lather is soon produced. After keeping up the shampooing process for four or five minutes, all the soap must be washed out of the hair by the free use of warm or cold water, and the hair thoroughly dried by means of gentle friction with a soft towel. The immediate effect experienced is a disagreeable feeling of tension of the scalp, as if it were stretched too tightly over the skull. To obviate this effect, and to keep the scalp from getting too dry, and thus, perhaps, set up a true pityriasis, it is necessary to follow up the shampooing with some fatty application, which may contain some mild stimulant, thus:—Castor oil, one part, to alcohol, three or four parts, with a little oil of rosemary or cinnamon, or the elegant pomades and oils of Bazin and other manufacturers may be used. But the best, as well as the neatest preparation that I have employed for this purpose, is the hydrocarbon known in commerce as cosmoline. This is a product obtained from petroleum. It is entirely bland and unirritating; never turns rancid, and is comparatively cheap. It may be obtained in the fluid form or as a soft solid.

This procedure, shampooing, drying the hair, and applying the greasy preparation must be repeated daily for three or four weeks. In the course of that time it will be discovered that the production of scales and the falling of the hair has been very markedly decreased. It will then suffice to repeat it two or three times a week for a month or two longer, after which a good shampooing once a week will usually succeed in maintaining a permanent cure.

Most patients will be alarmed after using this method at first, because the hair comes out in greater quantity than before. This is due to the fact that a large number of hairs are dead and only retained in their follicles by the plugging of the sheath with the accumulated sebaceous matter. The patient should, therefore, always be prepared for this result, and the cause of the increased falling of the hair explained to him.

It is not necessary, though more convenient, to cut the hair short during the treatment.

When the alopecia has lasted so long that the hair bulbs have become atrophied, nothing will restore the hair on those spots. Our endeavours must be directed to saving what remains. A prognosis favourable to the restoration of the hair must therefore be given with caution.

Atlanta, June 29. **J. T.**

## CASTING IRON ON WROUGHT SHAFTS.

[24531.]—IT is not an easy matter to cast iron on a wrought bar, and the following method, which I found in an American paper, may be useful to your readers. The writer says that the best way he has found is to turn the ends of the iron to be cast in the mould, and cut a thread or screw, and then tin the the part that goes in the mould. "This can be done by mixing muriatic acid and rain-water together. Melt the tin, heat the ends of the iron to be tinned; then put the ends in the pickle for 10 or 15 minutes, and then dip into the melted tin slowly, and let remain in the melted tin about five minutes. Next take out moulds made with wrought-iron shafts cast in. Done in this way, the rolls will be solid and clean and free from vibration. I make about four thousand such castings every year, and for the benefit of my friends I give this information. I cast a roll a few days ago 5in. in diameter, 6ft. long, with a shaft 4in. in diameter running through the entire length of the mould, thus leaving only 1in. of cast iron. In casting this roll, I poured, and made to flow through the mould, about 200lb. of hot melted iron, so as to make the shaft red-hot, and make the cast iron adhere to the wrought. The roll was solid and free from blow-holes. As the roll had to be turned all over the outside, I had to make that amount of iron flow, so that the cast part would not be chilled."

Would some one say if it would be possible to cast brass on iron in a similar manner?

**Foundry Man.**

## 100 TO THE INCH ON TELESCOPES.

[24532.]—As the highest magnifying powers of any telescopes are used chiefly on stars, and especially on double stars, I thought it might interest Mr. Franks and others who are writing on the question of 100 to each inch of aperture, if I extracted from the chief double-star catalogues of the present century such details as to the powers and apertures employed as seemed to bear on this question. I have, therefore, given below the approximate number of *sets* of measures on each night (inclosed in brackets) in each catalogue, counting sets in which only one element has been measured as whole ones; the aperture of the telescope employed; the highest magnifying powers of the micrometers used; and the number of occasions on which such highest powers were used, relative to the whole number of measures. It is quite possible, that in counting so many thousands of figures I may have overlooked a few instances in which high powers have been used, though I have taken some care in counting, and I have not tried as a rule to determine the number of times when the highest power has been employed if that did not exceed 60 to the inch. I have omitted such catalogues as Miller's and Nobile's, in which the total number of measures is very small; catalogues in which the magnifying powers are not clearly stated, as in Cincinnati I.; catalogues made with heliometers; and catalogues now in progress of printing. Of course, in several cases, e.g., that of O.Σ.'s, many more measures than I have given have been made, though they have not as yet been published.

Herschel and South (800). 3¾in. Dollond, usual power 133, occasionally 303; very occasionally, 381; once or twice 571, single lens. A few measures were made, chiefly towards the close of the observations, with the 5in. Tulley, power 179, occasionally 273. Herschel and South's measures were made in the Borough, not far from Guy's Hospital. (No driving clock).

South (1000). The 5in. Tulley was generally used, observing power 181; occasionally a power of 787 was employed. The micrometer of the 3¾in. was used on this instrument after April, 1825. (No driving clock).

Herschel (Sir J.) (6500). A power of 180, single lens, usually employed in the sweeps with the 20ft. reflector, "front view" construction; occasionally 320 was used, and in very rare instances 480, the aperture being then generally contracted to 12in. The total number of measures made with the 5in. Tulley after it was purchased from Sir J. South was (2200); a power of 400 used after March, 1830 (the o.g. previously was pinched in its cell), 500 employed almost always later on, and 400 at the Cape (no driving clock).

Dawes. (627). 3¾in. Dollond. 420 and 460 often used, 625 occasionally (no driving clock).

Struve. (10600). 9·56in. Fraunhofer. A power of 848 used frequently on close pairs after October, 1832. Most of Struve's pairs were discovered with a power of 198. Powers of 1150 and 1500 were supplied in 1832; but Struve says "quanquam in optima aëris conditione imagines fixarum offerunt bene definitas, ad mensuras nunquam usus sum."

Mädler. (10000±). Same telescope. Power never given. I have not taken the trouble to count Mädler's observations, which, indeed, would not be an easy task, but the number made is certainly not below 1000.

Smyth. (1200). 5·9in. Tulley. Powers not usually stated. The highest power of the micrometer was 850. "The telescope bears its highest magnifiers with remarkable distinctness;" the highest power was said to be 1200.

Jacob. (800). 3¾in. Dollond; power 152.

Jacob. (1628). 6·3in. Lerebours and Secretan. Power usually 200. Two object-glasses; the first one bad.

Fletcher. (282). 4·1in. Cooke. Usual power 300, occasionally 420 and 600.

Dembowski. (2100). 5·3in. Plössl (Dialyte). Highest power 300, always used. (No driving clock.)

Dembowski. (18400). 7·5in. Merz. 500 and 670 usually employed on close pairs.

Wrottesley (Lord). (1350). 7¾in. Dollond; usual power 450, 600 and 820 occasionally.

Secchi. (2900). 9·6in. Merz; power not stated, but the observations were usually made when the air would bear 760, and 1000 was frequently employed.

Ferrari. (125). Same instrument.

Powell. (1056). 4·0in. Simms; powers 170 and 280.

Knott. (309). 7⅓in. Alvan Clark; a power of 610 used seven times, 835 once.

Dawes. (2150). The 7·0 Dollond belonging to Mr. Bishop, on which 600 was used very frequently; the 6⅓in. Merz, powers 658, 690, 780, 870; the 7¼in. Alvan Clark, powers 722, 815, 860; and the 8¼in. Alvan Clark, powers 714, 772, 835, 970 (once), were the telescopes chiefly used by Dawes. He also used an 8in. Alvan Clark, powers 697 and 909 (once), an 8in. Cooke, a 7¾in. and a 7⅓in Alvan Clark.

Leyton Obs. (1050). 10in. Cooke ; powers 250 and 430 usually employed.

Dunér. (2700). 9·6in. Merz ; 940 very frequently employed. A power of 1370 was procured at the end of the observations in 1876 ; but though it gives very distinct images, it was never used for double-star work.

Harvard Obs. (1000). 15in. Merz and Mahler ; 1243 and 1560 used sometimes, 2004 on two or three occasions.

Rugby Obs. (3500). 8¼in. Alvan Clark (formerly Dawes's) ; a power of 400 almost invariably employed in the two first series ; in the two last this has been almost doubled by the use of a Barlow lens.

Gledhill. (484). 9⅓in. Cooke ; usual power 400, 750 used on fine nights.

Hall. (1570). 26in. Alvan Clark ; powers 400, 606, 888 ; 1282 used seven times.

Schiaparelli. (1200). 8·6in. Merz and Mahler ; the highest power 690, almost always employed.

Struve (O). (6000). 15in. Merz and Mahler. 858 and 1169 frequently on close pairs, 1458 in extraordinarily favourable states of the atmosphere ; 1822, the highest power, is never used.

Doberck. (700). 13·2in. Cauchoix ; usual powers 300 to 600 ; object-glass not very good, frequently stopped down. Driving clock bad.

Jedrzejewicz. (1560). 6·4in. Steinheil (no clock). 480 frequently used in the first series ; 760 and 800 often employed in the second.

Cincinnati. (371). 11·0in. Merz and Mahler (no driving clock). Usual power 230, 500 on a few occasions.

Cincinnati. (3930). Same telescope. Object-glass refigured by A. Clark and driving clock employed. A power of 1320 used fourteen times, 1500 eleven times. Usual power 450.

Burnham. (460). 460 new double stars *discovered* by him with 6in. A. Clark, powers 212 and sometimes 400 (no driving clock).

Burnham, Chicago. (3900). 18½in. A. Clark. Most of the close pairs were measured by Mr. Burnham with the highest power, 925.

Burnham, Washburn. (1050). 15½in. A. Clark. Close pairs measured usually with highest power, 750.

Perrotin. (330). 13·9in. Henry Bros. 750 and 1000 almost always used.

Sydney Obs. (1400). A 7¼in. (?) Merz, usual power 159, occasionally 580. Later on 11·4in. Schroeder, powers (?) – 800 sometimes used on close pairs. I am unable to understand the observations.

July 21st. **H. Sadler.**

## WHY DOES NATURE GROW TREES IN GROUPS?

[24533.]—The question has often been asked why immense areas are sometimes found covered with trees of one species, and here and there in the midst of a varied vegetation we occasionally find considerable patches of ground occupied exclusively by trees or plants of one species. One cause of this phenomenon may possibly be found in the facts related by Mr. J. S. Campbell, in the *American Naturalist*. Some have ascribed the phenomenon to a peculiar fitness of the soil to particular kinds of vegetation, which he does not find to exist. His own explanation is very simple, and is to the effect that the matter lies wholly or mainly in the fact of the ground being in a fit condition to receive the seeds of the various species when they fall upon it. Seeds of different kinds fall at various seasons, and when the ground is in various conditions as to moisture, &c. Those that find the ground in good condition sprout and grow, if no accident occurs to remove the plants when very young. Mr. Campbell has tested this view in his surveys in the occasionally flooded bottom-lands of the Wabash River, and illustrates it by following the futures of the seeds of three species of trees. The balls of the sycamore or button wood begin falling early in the spring months, and if a flood is receding at the time, they stick to the soft, moist banks wherever they touch them, and particularly along the highest parts of the sand bars. Were it not for the subsequent floods in the same spring, no other trees could grow, for these would occupy the ground. But they are easily killed during their infancy by overflows, and this is what happens to most of them. The cottonwood is the next in order of shedding seed, and if another flood is receding while this is taking place it will have killed all the sycamores which it has covered, and sprout the cottonwoods. These in turn may be killed by the next floods. It is the turn of the maples next to shed their seed and try for the ground. If either of these species succeeds in making wood without a flood, it will hold the ground, and its rivals will not be able to get a place. Last spring the edges of the successive plantations escaped the next floods after the seeds fell upon them, and Mr. Campbell could see along the river banks three belts of young trees, and distinguish them by their general appearance. The upper belt was of sycamore, the second (downward) of cottonwood, and the third of soft maple. In June a bigger flood came than any that caused the seeds to sprout, and killed all the young trees. Probably there are other reasons. If so, I should be pleased to read them. **E. G. M.**

## MELTING STEEL IN AN ORDINARY CUPOLA.

[24534.]—I noticed recently in your excellent paper some remarks about cupola blast and steel melting. I send you some notes I have made on the method adopted by Mr. R. E. Masters, one of our foreman moulders in the railway shops.

As soon as the last charge of cast iron begins to settle away from the charging door, in melting 2,000 pounds of steel in two charges in the 30in. cupola, we put on 200 pounds of coke and 1,200 pounds of steel, then 100 pounds of coke and 800 pounds of steel, melting at the rate of 6⅔ to 1. We keep the cupola full of steel up to the charging doors until the last has been put on; this gives it the benefit of a longer heat, and when it reaches the melting point it comes down—to use the expression of a moulder here—"hot enough to run a needle with the point up." It is very fluid when it first comes from the cupola. While it does not remain fluid as long as cast iron, I am satisfied a very large piece could be poured with it. I notice by agitating it in the ladle it "gums up" around the ladle quicker than cast iron.

Charging in this manner, the cast iron all melts down ahead of the steel. Then there is a cessation in the melting for a few minutes before the steel starts; once started, it melts very fast. The appearance of the metal is so different from cast iron in the fluid state, that we can tell it as soon as it starts from the cupola. This steel scrap is of a class known as "slab or agricultural steel," and we have melted 60,000lb. out of 75,000lb. I stated we had on hand, besides using up all the scrap that has been made since then. We are going to try a part of the heat of steel rails as soon as we work up what scrap we have on hand. By itself the steel runs porous. By adding one-sixth cast iron to the charges we find it runs the castings very close and solid, and harder than the steel alone. For furnace liners, back plates, grate bars, brake shoes, &c., it is superior and more serviceable than cast iron. In light castings annealed I feel sure it would make stronger castings than malleable iron.

Last Fall J. C. Albrecht, M.M. of the railway shops here, complained about the chilled truck wheels shipped him here for section masters' hand-cars, cutting out and getting flat places in them in a short time. We asked him to let us make a set of steel rim wheels for a trial. He placed an order with us for two sets of wheels, steel rim, 26in. dia., 3½in. face, ¾in. thick, 1in. flange, ten ¾in. round wrought-iron spokes, set zigzag in hub, hub of cast iron, weight of wheel 120lb. They have had to stand the test through the most severe winter we have had in the South for years. Having filled orders for 150 since then is evidence of the satisfaction they are giving.

Chicago, July 11. **J. C. B.**

## LIFE WITHOUT OXYGEN.

[24535.]—In the *Revue d'Astronomie* for July, 1885, M. C. Flammarion writes:—"The bacillus Amylobacter, which is found in butter, not only does not require oxygen for the support of its life, but this gas actually kills it when brought in simple contact with it. The Amylobacter is the ferment of butter, and attacks substances the most diverse, always producing butyric acid. It develops itself in situations most adverse to other forms of life, and is found most profusely in nature."

**W. B. Kennan.**

## KING'S CROSS ACCIDENT.

[24536.]—"Nun. Dor." (letter 24490, p. 432) is right: there was the usual "blunder" and the everlasting "goods" train; but I think we had better not say whose fault it was before the inquiry.

**Midland.**

**Tobacco and Cholera.**—The Anti-Tobacco Society of France has offered a prize for the best essay bearing upon the question of the liability or otherwise of smokers to contract cholera. As the object of the Society in offering the prize is stated not to be the condemnation of tobacco in the face of facts, but to ascertain the facts as they are, the essays must not be based upon theories, but must be supported by actual occurrences, although the anti-tobacconists would very probably not be displeased to find themselves supported in their hobby by statistics. If a healthy stomach be a safeguard against cholera, it is possible that excessive smoking may dispose to the disease by disordering digestion.—*Lancet.*

# REPLIES TO QUERIES.

*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[56620.]—**Steam-Carriages.**—On p. 437, near end of letter, "Progress (4)" a small compositor's error crept in, which rather destroys the meaning. For 87½ per cwt.," read 87½ per cent. "Nun. Dor." seems lost in "wonder" on the subject; but he must "move on" with the times, or stand on one side. The piston's pressure on the road, as spoken of, is not a long, but a short stroke, a few ounces of h.-p. quickly repeated, a mere throbbing motion, such as you might conceive to be at work in an elephant when locomoting. We want now a family carriage for the newly-enfranchised—useful and cheap—such as will be required by the thousand when the system of iron bearing on roads is generally adopted. The new Coventry tricycle chair is approaching the style, but requires to be enlarged as a four or six-wheel carriage, and fitted for all its occupants to assist in applying motive-power, either by hand or foot. "Thrift" is my motto, in all its parts and workings. The weight of vehicles now generally used is double what will in future be required, and the present waste of motive-power, both mechanical and animal, is, in many cases, as much as that advantageously used. For the storage and transmission of power is a wide field open to mechanical genius, and any person who can in a simple way store the power supplied by a fixed steam-engine, and transmit it for locomotive purposes, would secure an easy fortune. Electricity at present does not satisfactorily perform the operation. I spoke of a competition having commenced between tram-cars and a new style of omnibus with wheels fitted to gauge to run on the rails. The omnibus when on the rail is admitted as decidedly of easier motion than the car. The car's fares are reduced one-half, and the result is the cars keep fully loaded, and the omnibuses also have a satisfactory share of patronage. During the week ending July 4th the tramway company carried no fewer than 140,425 passengers, by which, at one penny each, they would net the respectable sum of £585 2s. 1d. for their week's work. When the iron bearing is generally provided by the road authorities, the charges will probably settle down to one halfpenny per half mile, and people will at most all times ride instead of walk, either short or long journeys, as they please, and thus pay for the distance they ride, and that distance only.—Progress (5).

[56650.]—**Lead Burning.**—To W. Man.—Seeing your letter headed "Lead Burning," readers would naturally suppose that you have tested the apparatus there mentioned for lead burning, although your letter does not in the least state that you have done so. If you have, I shall feel obliged if you will refer me to any place where you have done lead burning with this apparatus, as I should like to compare it with the work done with the ordinary lead-burning machine. I may mention that I shall test the machine myself, but should prefer to see the work of others, especially that of another professional lead burner. Please reply.—P. J. Davies.

[56650.]—**Lead Burning.**—I cannot speak in favour of Briggs's machine for lead burning, especially as I cannot get one to test; but will write its merits after I have tested the same. The specimens of lead burning in the exhibition are not what they should be, and if they are fair samples of what the machine can do I should say that the old system of generating gas, &c., is decidedly the best plan. I have written to Messrs. Briggs to send the machine for testing, but they have not sent one, although I told them that I would not detain them more than an hour in making the test.—P. J. Davies, 78, Earl's-court-road, Kensington.

[56676.]—**Free Reeds.**—I cannot follow Mr. Fryer in his remarks on p. 437, because I know nothing about his private correspondence. I referred merely to a query which appeared in these pages and to a so-called reply. The querist on p. 268 (56676) asks clearly enough how he can make a "tuning apparatus for harmonium reeds," and towards the end of his query he implies that he wants to use it for tuning other reeds as well. Now, Mr. Fryer notwithstanding, this apparatus is perfectly well known as a "tuning bellows," and certainly every reed-tuner who has to do with American organs has one: hence the reply on p. 288 was, and is, simply nonsense, whatever private correspondence may have passed. I think Mr. Fryer is mistaken in asserting the identity of two querists, for the second querist gives unmistakable evidence that he knows a little more about harmoniums than a gentleman who, on p. 220, appears to be undecided as to the price of reeds, though he "retains an unalterable opinion that 18s. is a very moderate charge for a set of reeds of good quality" —why not best? Mr. Fryer's way out of the blunder is to answer the query without reference to his private correspondence.—G. L. B.

[56796.]—**Boiler.**—"W. W." will find the error of 2oz. instead of 2lb. was duly corrected and explained on page 416.—INVICTA.

[56797.]—**Lamp Wick.**—Some carefully selected samples of Italian asbestos will answer well for lamp wicks; but I have generally found that it has not the lifting power of the cotton wick. That is remedied by keeping the oil nearer the seat of combustion.—ESSAR.

[56799.]—**Sand for Cores.**—"G. G." had better procure the "sand" from those who deal in foundry materials. The sand he finds in plenty "in the country" is not exactly the material to use, without examination by an expert. Moulding sand should be nearly all pure silica, with about 3 per cent. of alumina, and, say, 1 per cent. of oxide of iron. Sand containing lime, magnesia, and oxides of metals will not do. If "G. G." has plenty of sand, he should wash it thoroughly, and temper it with clay water when moulding up his cores.—E. G. M.

[56801.]—**Organ.**—Might not this querist just as well ask how much water it takes to blow an organ with a polished pine case, as with three rows of keys? It depends on the number of pipes and the pressure on which they are voiced, and to be safe he must allow wind enough for all the stops at once. I would recommend "A. H. F." to inspect Willis's organ at the "Inventions," and then, perhaps, he will conclude that it is much cheaper to use a gas-engine. Willis's organ is blown by hydraulic engine, but it is fitted for working by a belt from a motor, while the high-pressure chests are supplied by hand.—N. E. CHILD.

[56805.]—**Torrigelli Barometer.**—Perhaps this querist will explain where the Torrigelli dial can be seen. Surely he cannot mean the Torricellian barometer. That is without a dial.—NUN. DOR.

[56808.]—**Alcohol.**—An alcoholometer or hydrometer will read the proportions of water and spirit accurately enough for a "rough test."—INCISE OFFICER.

[56810.]—**Stamp Duty.**—"J. C." seems to imagine that the stamp on a cheque is the equivalent of a receipt stamp. The payer of a cheque pays for the stamp on that, and the giver of the receipt pays the penny for the receipt stamp. The stamp on the cheque has nothing whatever to do with the receipt of the money; but is a means of raising revenue in a very satisfactory manner.—INCISE OFFICER.

[56838.]—**Telescope.**—Thanks for the advice given; and, although I cannot do the job myself, I should be glad of more. I have an ordinary eyepiece by me. It has been tried with the erector in a paper tube, shortened by degrees until objects were seen, but not clearly; hence the idea of cutting the brass-drawer accordingly. I am afraid a Barlow lens would cost too much.—EYEPIECE.

[56948.]—**Gas-producing Apparatus.**—Many thanks to "Invicta" for his reply to my query. I have referred to the back numbers as directed, and think that the apparatus you there describe would answer my purpose very well, but would be obliged for a little more information from you as to (1) the dimensions of the apparatus (my engine-cylinder is 4in. diameter, 7in. stroke, 180 to 200 revolutions per minute). (2) Would the generator and pump do to be square instead of round, as I think the patterns would be more easily made? (3) Are benzoline and gasoline different names for the same thing; if not, which gives the best gas? (4) What would be the probable cost of this gas per 1,000 cubic feet, and what is its strength as compared with coal-gas, for driving a gas-engine? If you could get me a set of castings for one of these generators, I will advertise my address: it would save me the trouble of making patterns, &c.—GASEOUS.

[56949.]—**Aluminium.**—In a reply under this head, I read with astonishment that "F.W.G." has obtained Ca from CaO, and found it to be a "beautiful white metal," which "will not oxidise." Has "F.W.G." a specimen to spare?—S. R.

[56949.]—**Aluminium.**—I would strongly advise "F. W. G." (page 438) to patent his process for obtaining aluminium without delay, and get it into operation as soon as possible. He is incorrect in stating that calcium does not oxidise, as it rapidly tarnishes in moist air, and decomposes water in the cold readily. Aluminium costs about 100 francs per kilogramme. What has become of "A. E. S." and his process? We have been promised cheap aluminium so often, and it has never come.—WM. JOHN GREY, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[56956.]—**Ball Bearings.**—F. J. Ganard says I am mistaken about gun-metal bearings, and says the grit on an ordinary road would cut gun-metal bearings to pieces in a week. He is evidently not at home on the subject: he says, in ball bearings the grit gets between the balls but not on the bearing surfaces. Now, the fact is this: the ball bearing box becomes full of so much macadam, and when you work your machine you are using your best to grind up this material. Now if you look at the action of the balls when the wheel is running, you will find that the balls don't run in harmony with each other, but run in a contrary way that is rubbing against each other, and not rolling together as they should do. Furthermore, I know several first rate riders who are thoroughly opposed to ball bearings.—CHAS. HOSKEN.

[56956.]—**Ball Bearings.**—"Secundus Haud Ulli," on p. 438, thinks I am wide of the mark in comparing the bearings of a bicycle or tricycle with those of a steam-engine, and says, in the one case you have steam as a great force, and in the other the slight power exerted by a man's body, therefore requiring only very small bearing surface. He seems to forget that whether you have steam or manual labour as a motive power, that all machines should be arranged to produce as little friction as possible, because with unnecessary friction in machinery driven by steam the consumption of fuel will be greater than it need be; so also with a tricycle: if your friction is greater than necessary, you will have to expend more labour to drive your machine. Because you have driven your tricycle 5,000 miles this is no proof that ball bearings are better than I have advised. Try both arrangements, and then I shall be glad to have your opinion. I can quite understand when you renewed your ball bearings you obtained the same result as before the bearings wore out; this is only reasonable, but no proof in favour of the ball bearings. Again, he says if proof is wanted, take out the balls and run the machine on the collars. Now this is no proof, because the collars are not broad enough to hold the lubrication. I still advise all bicycle or tricycle riders to have nothing to do with ball bearings unless you are prepared to exert more labour than is necessary. I look upon the ball bearings only as a new-fangled idea.—CHAS. HOSKEN.

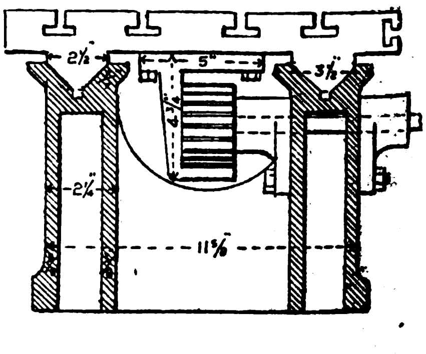
[56961.]—**Boating.**—Mr. Hundel's explanation is not as clear to me as might be desired. But a little consideration at once made the whole theory clear to me. Whilst the motion in question would produce in a boat motion and by means of the differential motion as well, it is competent to make one wheel go ahead whilst the other goes astern, or vice versâ, which is no doubt the novel point in the arrangement, yet I must confess I don't like the idea of having a handle athwart ships to get motion. It is so very like an organ-grinding motion. By the apparent sizes of the wheels the paddles must be either very small or they must go far too slow to get much speed out of the boat. Like all other matters, mechanical speed means power; and power is lost at each right angle of the arrangement. I have seen in London more than one trial of paddles driven by man power; and the most successful of all was a boat in which the wheels were driven by winch handles on the wheel shafts themselves. These being just long enough to grasp with one hand, allowed a free passage to pass fore and aft. The power was applied directly to the wheels; whilst almost a tyro could go ahead one wheel and back the other. An arrangement was subsequently proposed by myself so that two human motors could be applied, or even four; the handles being made to give a long or short throw, and to—by means of a sliding motion—couple both wheels. The way a powerful aquatic friend of mine propelled me along on one occasion was simply immense. The action being so much like rowing, he seemed to propel the boat quite easily after starting, with very little exertion. If the particulars or sketch would be of interest generally, I would look up the drawings made at the time.—INVICTA.

[56967.]—**Deafness.**—In my reply to this query which appears on p. 439, I find that I have unintentionally used a wrong term, as the word "tumour" has been written instead of the term "abscess," but the reply, being written in a hurry, will perhaps be a sufficient excuse for the mistake made. I may here inform the querist that any obstruction in the transmission of sounds of any kind through the external cavity of the ear will cause deafness. All sounds are conducted to the ear through the air which enters through the eustachian tubes and the external cavity of the ear. When the eustachian tubes are blocked by inflammation, through the effects of a cold, the internal cavity of the ear is deprived of the air which is necessary to produce the action of the various parts of the mechanism of that portion of the ear. The intensity of the deafness from this cause will depend on the amount of air which is prevented from entering through the eustachian tubes. Accumulation of wax causes deafness, because it obstructs the necessary amount of air which passes through the external portion of the ear to the drum. If air enters freely through the eustachian tubes, and there is also nothing to obstruct the entrance of air through the external portion of the ear to the drum, then the cause of deafness would probably result from the perforation of the drums, or some other organic disease of the ear, the existence of which could alone be ascertained by personal examination, and that only by a competent medical man, skilled in the treatment of diseases of the ear.—G. FRYER.

[56969.]—**Hydraulic Ram.**—"Invicta" is quite wrong in supposing that "the valve is made in itself heavy enough to more than balance the permanent head of water." Such a valve could not work. Let him just consider what weight this would imply for, say, a 3in. valve with an ordinary fall of 10ft.; or let him add weights to any ram he can find, until "the permanent head of water is more than balanced." The valve will fall, but he will wait in vain for it to rise again. There is, of course, a recoil, as "Invicta" goes on to say, removing the pressure from below the valve. In this lies the whole gist of the thing. But why does the water recoil? I searched in vain for a reply to this question until I came across a French work, Gen. Morin's, "On Machines for Raising Water," which gives in substance the explanation which appeared in my reply last week. I should like to answer "R." (57071), but I am afraid too much space would be required. Let him consult Morin. No English work on the subject that I know of, and I have seen most of them, will give him any help. The reason why rams have not been in favour with engineers I take to be this: that, until lately, as made by some makers of repute, they have been liable to frequent vexatious stoppages. This is simply a result of the neglect with which the theory of the machine has been treated. There is no difficulty in constructing rams, and they are now constructed by some makers to work on continuously from month to month without so much as being looked at or requiring one drop of oil, and all the time returning 60 per cent. or more of the power. Is there any other machine of which this could be said?—W. A. S.

[56978.]—**Engine Query.**—To "BACCHUS."—Would you please say how you get the throw of valve 4½in. and eccentric 120° in advance of crank? Please make it as clear as possible and oblige—A. B.

[56985.]—**Planing Machine.**—The annexed sketch will furnish the dimensions you require. In answer to your first question: the carriage would lift under heavy cuts, hence the reason why I put Vee strips to it in Fig. 8, page 468, of Vol. XL. For the second, I have drawn the loose flanged sleeve as you suggest, and if you look at Fig. 62, page 161 of the present volume, you will see a simple boss cast on the bed as an alternative to the plummer blocks, and this is the more common way of carrying the spindle in small machines. Of course, having the flanged sleeve loose for bolting permits of more exact adjustment of the spindle centres in case of inaccurate marking out and fitting. Employing that also, I should dispense with the inside bracket, and simply put a second sleeve bearing within the frame cast from the same pattern as the one on the outside, as shown in the figure.



I see no advantage, but extra trouble, entailed by adopting the double Vee grooves in preference to the flat and Vee method. The mutual fitting must needs be very accurate, and I do not know of any very small machines fitted up in this way, though there are plenty of moderate size, say of 3ft. or 4ft. travel and upwards. However, I have shown how the pattern requires modification. If the sides were formed of a single rib only, as in Fig. 55, page 161, the overhang of the Vee'd edges would be a source of weakness, since an accidental blow might easily knock out a piece. Hence, the sides should be boxed up to support the edges which lean over. The machine looks all the stiffer for the alteration, but is not any more efficient. If you do not mind the extra trouble, you will find the thicknesses given neither too thin to cast well, nor wanting in rigidity. In reference to the suggestion you make respecting the advertising of the cost of a set of castings partially machined, I can render you no assistance, but make no doubt the Britannia Company would be willing to answer any queries addressed to them on that matter.—J. H.

[56986.]—**Pansies.**—The expression "plants eaten off" leads to the question: Are you sure wireworms did the mischief? For wireworms work underground, and eat the roots. Petroleum-and-water is no protection, for if you asked them, wireworms would doubtless say they rather liked it than not. The best traps are, certainly, carrots and potatoes placed in the ground, the latter with little signal sticks stuck in them to mark their positions. These are to be taken up every two or three days and examined, when the wireworms will be found sticking in them. I suspect, however, that you mean woodlice, the little fellows that curl up into a ball when touched. Wireworms are very tough, and resemble bits of brass wire.—Nun. Dor.

[56988.]—**Siphons.**—If the outside and downward limb of the filled siphon is made short, so that its open end is above the level of water surface in tank, the water will flow back again into the tank, because the pressure of the water at the open end of the pipe is less than that of the atmosphere at the same point. If the end of the limb is held level with the surface, the water is in equilibrium and consequently at rest. When, however, the limb is lengthened so that the pipe really becomes a siphon, the atmospheric pressure is less than that of the water, because the water has *head* plus atmospheric pressure; consequently flow is created in the downward limb, inducing vacuum, which is satisfied by corresponding flow in upward limb, through outside atmospheric pressure. The greater the length of the downward limb, or, rather, the greater its *fall*, the greater the velocity. This is, however, limited by the capacity of the pipe in respect of friction, and the amount of atmospheric pressure due to the height of the siphon above sea level, and also the "weather."—Surveyor.

[56989.]—**Willesden Canvas.**—"R." will find a fairly full account of the process in No. 1,002, in an article entitled "Cuprammonium as a Waterproofing Agent."—S. R.

[56994.]—**Lobster-back Cowl.**—I have seen chimney cowls made with alternate laps. Large steel cowls I have seen beaten out of the plate; but these would scarcely be called "lobster-back." Please give number and page of query about copper band, and I will reply if I am able. It is always as well to refer to the page when speaking of a former communication.—Glatton.

[57001.]—**Carbon.**—I am afraid that the carbon and zinc plates immersed in "chloride of sodium" would be no use to ring bells, drive motors, &c.; if, however, they are immersed in a solution of bichromate of potash in dilute acid, he will be able to use them for those purposes. If he wants a battery for bell-ringing he should have a Leclanché.—Accumulator.

[57003.]—**"J. K. P.'s" Gas-Engine.**—I believe the quantity of gas consumed in the engine that I fitted was 18ft. per hour when doing all it could. About 9ft. of gas when running free; rest of question cannot say. Sorry for delay in answering; had not measured the gas myself.—J. K. P.

[57014.]—**Watch Jobbing.**—The best tool for your purpose will be a pair of ordinary Swiss turns (steel), with a good assortment of brass and steel runners. These turns can be adjusted to any size, according to the size of the work which you want them for.—C. A. W.

[57015.]—**Steam Canoe.**—If this querist will take a word of advice, which has certainly not been asked for, he will not attempt to drive an 8ft. canoe by means of a steam engine; for he is sure to be disappointed.—R. T. Y. C.

[57020.]—**Piano Repairs.**—To Mr. Davies.—So much depends upon the size of the holes in the wrest-plank, and their relation to each other. If they have not been bored more than $\frac{1}{16}$in. too big, and are ranged in alternate rows, it will answer very well to plug them with a beech dowel, and, in boring for the fresh holes, to leave the crescent-shaped piece of wood at the top of the hole. If the holes have been bored in only two rows, it will, perhaps, be better to strengthen the plank with an iron face plate, about No. 17 B.W.G. For this purpose it will be necessary to take a pattern of the holes as they now are by fitting a piece of brown paper above the bridges, and rubbing over the holes with black heelball. The cost of this would not much exceed 7s., and will greatly increase the strength of the plank. If, after all, it should be found necessary to chip away the plank, it is no use attempting to do it simply above the bridges; but the whole of the plank must be taken away, and the bridges removed with a hot iron first. Such pieces of wood as may be found here and there adhering to the pine plank should also be burned off, or the pine would be liable to tear.—W. H. Davies.

[57024.]—**Dead Centre.**—The setting of the slides may be all right; but sticking on centre may result from one of many causes. It may be from the lap of the valve causing excessive cushioning, thus pulling up the engine; or it may, and very likely is, due to an insufficient balance weight, the same being not accurately counter-weighted to balance the weight of crank, connecting-rod, cross-head, &c., so that the piston tends to go to the bottom centre and stop there. Is the stern tube stuffing box too tight? I prefer these to be as easy as practicable, as a slight leakage inboard is an advantage. If you cannot see your way out from what I have stated, the only other suggestion I can make is that you should take accurate templates in, say, stout drawing paper, of the slide valve and cylinder ports, at same time stating bore of cylinder, stroke, and pressure of steam, and revolutions per minute. If you can tell me the approximate weight of parts, I would also tell you if the counter-weight was sufficient. I suppose your engine is a single cylinder high-pressure? I wonder how long amateurs will still ignore the benefit of making even single engines on the compound principle.—Invicta.

[57025.]—**Midland Scotch Express.**—The number of the ill-fated driver's engine was No. 819, one of the far-famed 800 class.—Piston Rod.

[57025.]—**M R. Express.**—The engine was 819 that that poor driver was killed upon. He had to go to top of tender to see how much water there was in the tank. Why can't all tenders have a gauge glass and taps to save this dangerous practice?—Midland.

[57026.]—**Problem.**—Let $x$ $y$ $z$ be the number of gallons of 16s. whisky, 19s. whisky, and water. Then—

$$x + y + z = 51 \quad \ldots\ldots\ldots\ldots\ldots (i.)$$
$$16x + 19y = 12 + 51 = 162 \ldots\ldots (ii.)$$

But $16 \times 6 - 19 \times 5 = 1$ ∴ from (ii.) we get

$$16 (x - 6 + 612) + 19 (y + 5 + 612) = 0.$$

$16 (x - 6 + 612) + 19 (y + 5 + 612) = 0$. ∴ $x = 6 \times 612 - 19\,t$. $y = 16t - 5 \times 612$. where $t$ is any integer. The values of $t$ giving +ve integral solutions are $t = 192$ or $193$. If $t = 192$, $x = 3{,}672 - 3{,}648 = 24$gals., $y = 3{,}072 - 3{,}060 = 12$gals., and ∴ $z = 51 - 24 - 12 = 15$gals. If $t = 193$, $x = 3{,}672 - 3{,}667 = 5$gals., $y = 3{,}081 - 3060 = 28$gals. ∴ $z = 51 - 5 - 28 = 18$gals.—T. H. L.

[57026.]—**Problem.**—Let $x$, $y$, $z$ represent the several quantities of 16s. whisky, 19s. whisky, and water; then—

$$x + y + z = 51,$$
$$16x + 197 = 12 \times 51 = 712;$$

whence, by eliminating $x$, we get $3y = 16z - 204$; an indeterminate equation, which may be solved thus—

$$y = 5z + \frac{z}{3} - 68, \text{ a whole number.}$$

$$\therefore \frac{z}{3} \text{ is a whole number; let } \frac{z}{3} = s;$$

hence—

$$z = 3s.;\ y = 16s. - 68;\ x = 119 - 19s;$$

and $s$ must be such that $16s. > 68$ and $19s. < 119$. The only whole numbers fulfilling these conditions are 5 and 6; so the answer is $x = 24$ or $15$; $y = 12$ or $18$; and $z = 15$ or $18$.—J. P. Bidlake.

[57026.]—**Problem.**—The following is a solution of "Bogie's" problem. (N.B. Water is supposed valueless. Is this one of Bogie's "unknowns?")

51 gallons at 12s. per gallon = 612s.
Let $x$ = number of gallons at 16s.
and $y$ = " " 19s.

$$\text{Then} \quad 16x + 19y = 612 \quad \ldots\ldots\ldots\ldots (i.)$$
$$\text{Divide by 16, } x + y = 38 + \frac{4 - 3y}{16} \quad \ldots\ldots (ii.)$$

Equation (i.) is integral, therefore equation (ii.) must be. Assume

$$\frac{4 - 3y}{16} = t, \text{ or } 4 - 3y = 16t \quad \ldots\ldots\ldots (iii.)$$
$$\text{Divide by 3, } \frac{4}{3} - y = 5t + \frac{t}{3}$$

As before

$$\frac{4 - t}{3} \text{ must be an integer} = s \text{ (say).}$$
$$\therefore t = 4 - 3s.$$
$$\therefore \text{From (iii.) } 4 - 3y = 16 (4 - 3s)$$
$$\text{or} \quad y = 16s - 20 \quad \ldots\ldots\ldots\ldots (iv),$$
$$\text{and from (i.)} \quad 16x = 612 - 19y$$
$$= 612 - 19 (16s - 20)$$
$$\text{or} \quad x = 62 - 19s \quad \ldots\ldots\ldots (v).$$

If in (iv.) $s = 2$, we have $y = 12$, $x = 24$, and, ∴ 15 gallons of water are required. If in (iv.) $s = 3$, we have $y = 28$, $x = 5$, and ∴ 18 gallons of water are required. (Any other integral values of $s$ are impossible). I fail to understand what "Bogie" means by "elimination between three unknowns." There are only two unknowns, and but one relation between them; hence no elimination can take place.—L. N. W.

[57026.]—**Problem.**—Any quantity of either whisky you please, with enough of the other to make up the value of 51 gallons at 12s.; then add water enough, at nothing a gallon, to make 51 gallons. There are not three unknown quantities, and the number of solutions is indefinite. 17 gallons of each would be a correct answer.—J. K. P.

[57026.]—**Problem.**—The problem is indeterminate; that is, admits of any number of solutions, for there are three unknowns, but not three independent equations connecting them. Evidently we may assume $x$, the cheaper lot of whisky in the mixture, to be anything we please, then equation $16x + 19y = 612$, gives us $y$ the other lot of whisky; the remainder of the 51 gallons is water.—W. A. S.

[57026.]—**Problem.**—No wonder that "Bogie" cannot eliminate his unknown quantities in this problem, for, as he has put it, it admits of an infinite number of solutions. 51 gallons at 12s. per gallon come to 612s. Now, 612s. may be made up in a good many ways by multiples of 16 and 19, and as the water costs nothing, there will be clearly an infinite number of answers. If he likes to see it algebraically expressed, here it is: taking $x$ as the number of gallons of 16s. whisky, and $y$ of 19s. $16x + 19y = 612$; and by giving any value he pleases to $y$ he can solve for $x$.—Garrison Gunner.

[57026.]—**Problem.**—This may be solved algebraically with *two* unknowns, and as an indeterminate equation, thus—

Let $x$ = No. of gallons of whisky at 16s.,
$y$ = " " 19s,
$51 - x - y$ = " water.

$$\text{(I.)}\ 16x + 19y = 51 \times 12s. = 612,$$
$$\text{dividing by 16, } x + y + \frac{3y}{16} = 32 + \frac{4}{16}.$$
$$\therefore \frac{3y - 4}{16} \text{ is integral.}$$
$$\text{Multiplying by 11, } \frac{33y - 44}{16} \text{ is integral}$$
$$= 2y - 2 + \frac{y - 12}{16}.$$
$$\therefore \frac{y - 12}{16} \text{ is integral.}$$
$$\text{Let } \frac{y - 12}{16} = t.$$
$$\therefore y = 16t - 12.$$

1st. Let $t = 0$, then $y = 12$ = gallons at 19s., and from (I.) $16x = 612 - 19y = 384$.

∴ $x = 24$ = gallons at 16s.,
$51 - x - y = 15$ = " of water.

2nd. Let $t = 1$, then $y = 28$, $x = 5$, $51 - x - y = 18$.
∴ there are two solutions, viz.—

(1) 24gals. at 16s., 12gals. at 19s., 15gals. of water.
(2) 5 " , 28 " 18 "

—J. Bartlett, Woking.

[57026.]—**Problem.**—No wonder "Bogie" cannot eliminate the three unknown quantities in his problem, seeing that he has but two equations to work with. Let $x$ and $y$ denote the number of gallons at 16s. and 19s. respectively. Then—

$$16x + 19y = 612 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (i.)$$

There are an infinite number of solutions to this equation, any one of which will satisfy the conditions of the question. We may assume any value for one unknown, and by substitution find the corresponding value for the other. Thus, if $x = 4$, we find $y = 28\frac{16}{19}$, and we shall require $18\frac{3}{19}$ gallons of water to make up the full measure of 51 gallons. Though there are an infinite number of solutions to equation (i.), there are only a finite number of positive integral solutions. Possibly these are what "Bogie" wants. Divide (i.) by 16,

$$\therefore x + y = 38 - \frac{3y - 4}{16}$$

The fraction $\frac{3y - 4}{16}$ must be integral. Let it $= p$, so that $3y - 4 = 16p$, from which we have—

$$y - 5p - 1 = \frac{p + 1}{3} = q \text{ (say).}$$

From these equations we can at once write down $x$ and $y$ in terms of a single integer $q$—

$$x = 43 - 19q$$
$$y = 16q - 4$$

We see at once that the only admissible values of $q$ are 1 and 2, from which we obtain these two solutions—

| | At 16s. | At 19s. | Water. |
|---|---|---|---|
| | 24 gallons. | 12 gallons. | 15 gallons. |
| or, | 5 " | 28 " | 18 " |

—C. Planck.

[57027.]—**Pure Phosphorus.**—Phosphorus has a tonic and stimulant action on the nervous system, repairing the waste of tissue: but the highest authorities on therapeutics (Ringer and Farquharson), and the greater part of the members of the medical profession, are strongly of opinion that no more overrated remedy has ever been introduced into practice, that its action as a general tonic is most uncertain, if it exists at all. There is a good preparation, "Fellow's Syrup of Hypophosphites," which has been found efficacious in severe cases of mental depression and nervous exhaustion; but I should strongly advise "Phos" not to take this or any other form of phosphorus, unless he takes it in the form it exists in eggs, oatmeal, &c., except under the advice of a medical man. If, however, "Phos" feels inclined to experiment on himself with "pure unoxidised phosphorus" for his own sake, or for that of his fellow-sufferers, he should dissolve pure, well-washed amorphous phosphorus in almond oil or ether, and have this made up by a chemist into pills each containing 1-30th gr., and to take one twice or three times a day.—Medicus.

[57027.]—**Pure Phosphorus.**—Let me advise "Phos." to be very careful about taking phosphorus. It is a very dangerous drug, and should be taken with great caution. I suppose "Phos." knows that the dose is only $\frac{1}{40}$gr. to $\frac{1}{20}$gr. For nervous exhaustion "Phos." had much better try the effect of safer tonics, as quinine and iron, with suitable food, outdoor exercise, and, if possible, change of air.—Medicus.

[57027.]—**Pure Phosphorus.**—Will Mr. Alfred H. Allen forgive me if I reply to this? Pure phosphorus may be readily obtained from ordinary commercial phosphorus, by redistillation in an atmosphere of carbon dioxide. But let me earnestly caution "Phos" against making experiments upon himself with phosphorus. It is a most violent poison, 1-30th of a grain being a good dose even for allopaths; while our friends the homœopaths give it in doses which rarely exceed 1-1000th of a grain. The effects of phosphorus in nervous disease are, to say the least, problematic; it has been supposed, because phosphorus is found in the brain (in the form of an organic acid), that, therefore, brain food should contain phosphorus, and this had led some medical men to prescribe phosphorus. But phosphorus *per se* is insoluble in water, and must be dissolved in oils, in ether, &c., and then, owing to its irritant action when pure, can only be employed in the most infinitesimal quantities, quite insufficient to keep up the supply required. Our natural source of phosphorus lies in bread, the cereals, fish, and such soups as are made by boiling down bones in a digester. All these bodies contain phosphorus in a highly assimilable form—viz., as calcium phosphate, which in the presence of gelatinous matters by which it is accompanied in these foods, is quite soluble in the fluids of the stomach.—S. Bottone.

[57028.]—**Stamping in Relief.**—For the purpose of stamping your brass tickets you will require a steel die, which will have to be cut by a die engraver. The brass is then stamped in a machine made for the purpose. It is perfectly possible to strike them up with a hammer, but you would run a risk of injuring the die. Whoever makes them, you will have to pay for the die, although you will not get it unless an arrangement is made to the contrary. The press is always saleable, and can generally be bought second-hand.—Os.

[57029.]—**Turbine.**—Such a small quantity as about 25·823 cubic feet per minute would do but little for you. Very much would depend on the class of wheel, as the best ones only utilise about 80 per cent. of the gross power. To make a turbine would be a very difficult matter, as it means many calculations carefully gone through before the best form was found. It is not often I so advise; but, in this case, I believe you would do far best to buy one of a maker who makes a speciality of such motors. The necessary data could be calculated out; but it means going over a lot of ground.—Invicta.

[57031.]—**Soap Analysis.**—This is conducted as follows: 1st. Fat. Weigh out about two grams of the soap in a beaker, add distilled water, and warm until all the soap is dissolved, add a few drops of methyl. orange solution, and titrate with standard sulphuric acid until a pink colour is obtained; the mixture should be warmed from time to time. 2nd. Water. Weigh out about two grams into a flask and warm over a sand bath until the soap just begins to give out the peculiar pungent odour of burnt soap; then allow to cool and weigh again: the loss of weight is the water which the soap contains. 3rd. Fat. This, if the soap be pure, is best determined by difference, that is, subtracting the percentage of alkali and water found from 100. To determine the fat weigh out about five grams of the soap into a beaker, dissolve in warm water, add sulphuric acid until the water solution is distinctly acid, allow the mixture to cool, when the fat acids will collect on the top of the liquid; if these form a solid cake they can be washed by pouring off the water from them, adding distilled water, boiling up, then allowing to cool, again pouring off the water, adding fresh clean water, boiling, and then allow to thoroughly cool, when the fat cake can be separated from the water, dried between filter papers and weighed. If the cake of fat acids is soft or liquid, a weighed quantity of white wax should be added, and the acids washed and weighed as described, from this the weight of wax is subtracted, leaving the weight of fat acids. As thus obtained, the percentages of alkali, water, and fat will exceed 100, by an amount varying from 2 to 3 per cent., according to the character of the fat from which the soap has been made.—George H. Hurst, Salford.

[57033.]—**Refining Gold.**—Take the gold you wish to refine and melt it in a burnt bone crucible; this will extract the baser metals and leave only the gold and silver. Pass this piece through a flatting mill, then put it in a glass bottle containing nitric acid, and boil it over a small gas jet. This will extract the silver, thus forming nitrate of silver, and leave the piece of gold (now pure) in a porous condition.—A. A. E. Lecluse.

[57033.]—**Refining Gold.**—Break the articles up into small pieces, treat with excess of aquafortis (nitric acid), which will dissolve out the copper and silver, but leave the gold untouched. When the addition of fresh nitric ceases to act on the alloy, pour off the fluid, which contains all the copper and silver as nitrates, along with free nitric acid. The silver may be precipitated from this acid solution by placing in it a strip of clean copper. The copper will precipitate the silver as a black powder, which may be washed on a filter, dried, and redissolved in nitric to produce pure silver nitrate, or fused to reduce it to the reguline state. The gold may now be dissolved in aqua regia (nitro-hydrochloric acid), and evaporated till fit to crystallise, to produce chloride of gold.—S. Bottone.

[57033.]—**Refining Gold.**—Dissolve the alloy in nitro-muriatic acid with the aid of heat. The silver will precipitate itself as chloride of silver, and can be reduced to metal by fusing in a crucible with a mixture of the carbonates of soda and potash. To the clear solution which remains above the chloride of silver add a little sulphate of iron in solution; this will precipitate the gold as a black powder, which must be collected on a filter or at the bottom of glass, and (to make chloride) redissolved in nitro-muriatic acid, and evaporated to just the melting point. The remainder of the original solution can be rejected, as it now contains only copper. If you have sufficient gold to warrant all this trouble and expense, and are accustomed to chemical manipulations, by all means try it; but if neither one nor the other of these conditions obtain, sell your gold for what it is worth, and purchase the chloride. —Os.

[57033.]—**Refining Gold.**—To separate the silver and copper from gold of any quality, proceed thus: Melt the gold and granulate it, or roll it out very thin and clip it into small pieces. Put the pieces into a Florence flask containing nitric acid, with one-third water. Place the flask on a sand-bath, and apply heat till all fumes disappear. Pour off the liquid carefully, and add a little more nitric acid and water, and, if there be no further ebullitions, this proves that all the gold is separated. Pour off the liquid again, and the resultant mass at the bottom of the flask is pure gold. To make gold chloride, pour upon the pure gold thus obtained (which is still in the flask) nitric acid one part, hydrochloric acid two parts; place upon the sand-bath, as before, till the gold is all dissolved. Then pour the solution into an evaporating dish, and evaporate to dryness. The mass that remains is chloride of gold, which may be used for photographic purposes, or for electro-gilding. Great care must be exercised in evaporating to dryness, because if too much heat be applied the gold is re-formed into the metallic state, and the operation requires to be performed over again. To obtain the silver, place a plate of copper in the liquid that was first poured off, and the precipitate is silver. Then pour off the liquid carefully, and place a plate of iron in it, and the copper is thrown down. If all this is carefully done, not a grain of any of the metals is lost, as may be seen by weighing the alloy before beginning.—Bobadil.

[57035.]—**Bicycle Spring.**—I have made such a spring from the ordinary steel wire obtainable from the wire-drawers or wire-shops. You must bend it to shape at a dull red heat, not cold on any account, and be very careful not to overheat it. When to shape, having allowed the requisite amount for spring, harden the whole right out. Then temper to spring temper: and that is the difficult part. There is no difficulty to a good smith in bending into shape and hardening; but the tempering all over is quite another matter. I have for a similar job tried a lot of plans; but the best to suit me was an arrangement of sand bath; but at the best it is a troublesome job. Springs made by a first-class smith and tempered with the utmost care were nothing so satisfactory as the same kind bent to shape here and hardened and sent to Messrs. Salters to be tempered.—Invicta.

[57038.]—**Wimshurst Influence Machine.**—"Aurora" will find it quite possible to construct a multiple plate machine of this type. I already know of two machines, each with six plates. I should be glad to help him with any detail; but to comply with his request, and to give him the full details for a twelve-plate machine would be something beyond reasonable. He should either plan out the machine for himself, or he should, as a matter of business, engage some scientific instrument-maker to do it for him.—James Wimshurst.

[57039.]—**Firing Mines.**—Your coil is no use for this purpose. Get half a dozen small bichromate cells; these will make a piece of platinum wire red hot, and ignite your powder.—Os.

[57040.]—**Voltaic.**—An electric bell or a helix of wire wound round an iron core will demonstrate what you want.—C. D. R.

[57041.]—**Battery.**—Surely the querist does not call the Leclanché or Daniell small, or mean that powerful acids are required in them. These are the principal cells used for bells, telegraph, and telephone work, as they are constant in operation and require but little attention, and action only takes place whilst they are doing work. On the other hand, batteries that are suitable for large coils, lighting, and for motors, must be of a kind suitable to the work required, and, therefore, should generate a large amount of current with a high E.M.F. This cannot be obtained by the use of weak acid solutions and large surfaces. As the E.M.F. of a particular cell is the same be it large or small, there is no advantage to be gained in this particular by increasing its size. It is only the quantity of current that will be increased by the enlargement of the cell. If, therefore, a cell of small dimensions will give the desired E.M.F. and current, a larger will be wasting energy, in the same way that horse-power would be thrown away by employing two horses when one would do.—C. D. R.

[57042.]—**Spark Coil.**—This would require much more space than the query warrants. Several books are published on this subject. "Intensity Coils," by Dyer, price one shilling, will suit you.—C. D. R.

[57042.]—**Spark Coil.**—If anyone could stand a shock from your coil, the spark got from it must be so very small that few experiments could be successfully performed. Any experiments really worth trying must be performed with a coil which produces a spark of some length, and this means more shock than anyone could stand. I could help you with a few experiments if your coil has sufficient spark. What is its length?—Bobadil.

[57042.]—**Spark Coil.**—The experiments I have tried are not very varied, yet may suggest some others to you. I have, for instance, tried the effect of altering the surface and form of the discharging points, thus modifying the nature of the spark, or sending a spark over a partial conductor, and thus getting another form of discharge. Another was sending a spark through, or rather over, metal filings. The inflammation of ether was another; also of hydrogen gas. Then there is the electric cannon or pistol, and firing of gunpowder; whilst a detonating or series of thunderpanes afforded another experiment. I am afraid this is about all I can think of as being performable outside shocks and vacuum tube illumination.—Invicta.

[57044.]—**Silver-Plating.**—Use a Daniels' battery and a rather weak bath solution for German silver. You speak of cyanide of mercury: I suppose you mean nitrate of mercury. I never found it necessary to use anything of the kind. I wrote three long papers in these pages about two years since, if you have the back volumes.—Os.

[57044.]—**Silver-Plating.**—Articles of German silver should always be dipped in one of the mercury solutions before being suspended in the depositing vat. The coat of mercury causes the deposit to adhere. The simplest mercury solution to use is the nitrate, which is made by dissolving a small quantity of mercury in nitric acid diluted with three times its bulk of distilled water; and when the mercury is quite dissolved, diluting still more with water. The proportions of mercury and water in the prepared solution are, respectively, one ounce to one gallon. The articles which most require this solution are those of copper, brass, and German silver. They must first be thoroughly cleaned by being boiled in potash, then dipped in the mercury solution and kept in it till a coating of mercury appears, then washed and immersed in the depositing vat while still wet. The batteries you have been using seem to have been working satisfactorily; but for your purpose most authorities recommend a Smee or a Daniell.—Bobadil.

[57044.]—**Silver-Plating.**—If "A Beginner" tries the following solution I think he will succeed: —German-silver articles are first cleansed in boiling alkali, washed, then dipped in a mixture of two-thirds parts of sulphuric and nitric acids; then into a quickening solution, and from this into the plating bath, which, if in good order, should give good results. For a long time the following bath has held the place of acknowledged superiority for silver-plating. It is composed of: Water, 1,000 parts; cyanide of potassium, 50 parts; pure silver, 25 parts. This bath is prepared as follows:—A porcelain dish or capsule, of the capacity of a quart, receives pure granulated silver, 25 parts; pure nitric acid, 50 parts. The whole is heated over a charcoal furnace or gas-lamp, the dish being supported upon an iron triangle, and protected by a strip of wire gauze from direct contact with the flame. The acid rapidly attacks the silver with the production of abundant nitrous vapours, which one should be careful not to inhale. When the reddish vapours have disappeared, there remains in the dish a liquid more or less greenish, blueish, or colourless, according to the proportion of copper contained in the commercial silver employed, which is seldom entirely pure. The heat is then increased in order to evaporate the excess of acid, which escapes in the form of white fumes. The material in the dish dries, swells up, and with a further increase of heat, fuses like wax. The dish is then removed from the fire, and protecting the hands with a cloth, the fused mass is made to flow upon the sides, where it soon solidifies. We have thus obtained the fused nitrate of silver (lunar caustic), which is more or less white or grey, according to the purity of silver employed. When the whole is quite cold, the dish is turned upside down upon a clean sheet of paper, and by a gentle tap on the sides, the mass is detached. 2. The nitrate of silver is dissolved in ten or fifteen times its weight in water, and treated with a ten per cent. solution of pure cyanide of potassium, which immediately produces an abundant white precipitate of cyanide of silver. A sufficiency of the reagent has been employed when, after allowing the precipitate to subside, the addition of another drop to the clear supernatant liquid produces neither turbidity nor precipitate. The whole is then thrown upon a linen filter stretched upon a wooden frame, and the cyanide of silver remains upon the cloth, while the nitric acid and the excess of cyanide pass through. The precipitate left upon the filter is washed two or three times with pure water. 3. The cyanide of silver thus prepared is placed in the vessel intended for the bath, and stirred into the 1,000 parts of water prescribed in the formula. The cyanide of potassium is then added, which after solution, also dissolves the cyanide of silver. The silver bath is therefore ready for use, and is a solution of the double cyanide of potassium and silver.—JOHN T. DEWAR, Antwerp.

[57045.]—**L. and N.W. Compounds.**—The number of *Engineering* for May 1st, 1885, contained a full list of compounds. The following should now be added:—509, Ajax, March, 1885 (Crewe); 687, Himalaya, May, 1885 (Rugby); 2798, Marchioness of Stafford, 1885 (at present the Inventions Exhibition is where this engine is stationed, as I daresay "Cotswold" is aware). According to the attendant, its present high number will be changed on the engine commencing regular work.—L. N. W.

[57046.]—**L. and N.W. Manchester Express.**—Nearly always a 6½ft. four-coupled or "Standard passenger engine."—L. N. W.

[57049.]—**Dynamo.**—Can you send me a sketch of the arrangement of the field-magnets and pole pieces? I must confess I am considerably muddled by your explanation "that the field-magnets all bolt on one side of the pole pieces," and yet are "arranged in a circular form."—S. BOTTONE.

[57054.]—**Cleaning Stationary Boiler.**—To "INVICTA."—To keep such a boiler clean is a difficult job. If one asked many of the boiler-fluid vendors they would all offer a remedy; but these are not so reliable in use as in theory. With large tubular boilers I have had under my control we used nothing but ordinary carbonate of soda, or the common soda of every-day use, and we found that a moderate quantity was sufficient. Most probably about 1½lb. per day would be sufficient for your purpose. With the use of soda you would need to use the scum cock, and blow off frequently as well as at regular intervals, or the water will be found to thicken, and you would get into mischief. I should dissolve the soda and pump it in with the feed. Another point is never to blow all the water out of the boiler when she is hot. When you mean to clean out after stopping, blow off the steam quietly at the safety-valves, the fire being, of course, drawn, and let her cool down quietly. Next day let the water run out quietly; take off the mud doors, and the deposit will be found as a soft mud that very little washing with the hose will clear out. Too much soda will cause foaming, so do not err on that side. It is with a loco. type boiler I know a difficulty in keeping it quite as free from scale as one would wish; but a good feed heater would help you as well. When in the States I saw one very good form of boiler cleaner, the theory being that the scale was thrown down in the quietest part. That this was so the apparatus in question amply proved. It did not remove old scale, but no new scale formed, whilst bit by bit the old fell off the plates. If your feed is very bad, I should think it would amply pay to have a deposit catcher fitted—not on the usual bungling system, but on a really scientific plan, and thus keep the deposit out of the boiler altogether.—INVICTA.

[57055.]—**Electric Bells in Series.**—This appears to be a quotation from a description of something intended to be new, and therefore can best be answered by the writer. It sounds like a clipping from an advertisement.—C. D. R.

[57055.]—**Electric Bells in Series.**—This double winding of the coils was suggested by Jolin, of Bristol. I fail to see any advantage over the old plan of the armature short-circuiting the coils. To my mind it introduces complications in the way of resistances and counter-currents, without any compensating advantage; for instance, the cores should be of the softest possible kind, or there would be residuary magnetism, and the reversed or secondary coils would have to be exactly suited to their work, or the current would pass through without demagnetising. In that case, it would be simply the shunt circuit plan before alluded to, saying nothing of the extra expense of double winding.—G. J.

[57056.]—**Problem.**—I suggest that Mr. Fryer should turn his attention to something more scientific than the problem given. The existence of Adam is, to put it mildly, very doubtful, and the 6,000-year chronology is utterly discredited.—WM. JOHN GREY, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[57056.]—**Problem.**—Might I suggest to G. Fryer another way of putting his question to himself? All those that are born die, therefore the population cannot increase at all. This is about on a par, so far as reasoning goes, with that contained in his query. Without going into the matter, I expect that he would find that the deaths in the last 200 years would more than equal the number of those now alive.—GARRISON GUNNER.

[57057.]—**Transmission of Power by Belts.**—Let

$T$ = tension in lbs.
$v$ = velocity in ft. per min.

$$T \times v = n \times 33000.$$

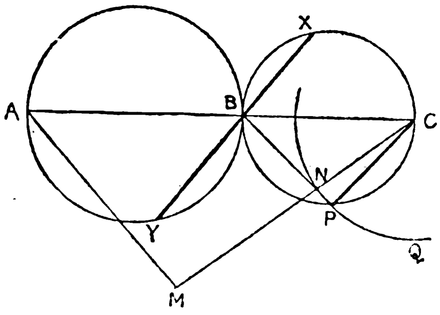
$$T = \frac{n \times 33000}{v}$$

$$v = \frac{n \times 33000}{T}$$

$$n = \frac{T \times v}{33000}$$

If this is not clear I will correspond with him, if he will publish his address.—S. S. N.

[57058.]—**Science Examination.**—Let the two circles touch at B, and draw the common diameter A B C. Draw from C a straight line C M in any direction equal in length to the given straight line. Join A M, and draw B N parallel to A M. With centre C and radius C N describe circle N P Q, cutting circle B P C at P. Join C P, and through B draw X B Y parallel to C P—X B Y is the line required. Proof: Join B P and C X, then the figure B P C X is a rectangle. ∴ B X = C P, and by similar triangles—



$$\frac{XB}{BY} = \frac{CB}{BA} = \frac{CN}{NM}.$$

Also $CN = CP$ (radii of same circle).
$\therefore CP : NM :: XB : BY.$
But $CP = XB$. $\therefore NM = BY$.
Hence $CM = XY$. Q. E. F.

—C. PLANCK.

[57060.]—**Theoretical Mechanics.**—A knowledge of the differential calculus is not absolutely necessary for the honours examination in this subject; but it is very desirable. The querist should study Yates's book, price 4s.—WM. JOHN GREY, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[57061.]—**Platinotype Process.**—The price is about the same, but the results are far superior, more artistic, and absolutely permanent. The process is certainly much easier than ordinary silver printing.—S. BOTTONE.

[57061.]—**Platinotype Process.**—I began to work it before the Inventories opened, simply following the printed instructions sent by the company. The process is so extremely simple that I mastered it at once, and when I saw it at the exhibition I found that I had been doing it exactly right. The platinotype paper is rather dearer than the ordinary sensitised paper for silver prints, but the chemicals used—oxalate of potash and hydrochloric acid—are cheap, and one of them, the oxalate, may be used over and over again, whilst the acid is used but very sparingly. I can strongly recommend Mr. R. A. R. Bennett to become a licensee of the Platinotype Company, as the time saved by their process, and the beautiful and artistic results obtained by it are well worth the license fee and other small preliminary expenses.—J. GUARDIA.

[57061.]—**Platinotype Process.**—I would strongly recommend Mr. Bennett to try the platinotype process. I have been using it as an amateur for several months. There is a little difficulty at first in judging whether the prints have been sufficiently exposed or not; but when by practice this difficulty is overcome, the process is a most delightful one to work. The prints print much more rapidly than silver prints, and when the printing is finished and we proceed to development, the pictures are developed, cleaned, and washed in as short a time and with as little trouble as it takes to wash the silver from silver prints before putting them in the toning bath. On the whole, I do not think there is much difference in expense. The sheets of platinotype paper are 26in. by 20in., and are good up to the edge, and cost 1s. 4½d. each if bought by the quarter-quire. The developing bath can be used over and over again, and only one of the three clearing baths need be new for each batch of prints, and hydrochloric acid is very cheap.—T. PERKINS, M.A.

[57063.]—**Specific Heat.**—Let $x^\circ$ be resultant temperature of mixture. Specific heat of snow = 79—

$$\therefore 5\,(79 + x) = 25\,(30 - x).$$

$$\therefore x = \frac{5 \times 30 - 79}{5 + 1} = \frac{150 - 79}{6} = \frac{71}{6} = 11\tfrac{5}{6}^\circ$$

—T. H. L.

[57066.]—**Reducing the Amount of Lime in Chalk Water.**—Clark's process is founded on the fact that free carbonic acid in water dissolves carbonate of calcium. If, therefore, the exact amount of quicklime per gallon of water treated (to be determined by a preliminary experiment) necessary to absorb the carbonic acid is added to the water, the chalk so produced, as well as that previously held in solution, will be pricipitated; and, from the flocculent nature of the precipitate, the water will be at the same time filtered.—PI.

[57066.]—**Reducing Amount of Lime in Water.**—Chalk, or as chemists call it, calcic carbonate, or carbonate of lime, is almost insoluble in water, if it (the water) contains no free carbonic acid. Most waters do contain a considerable quantity of carbonic acid in solution. Lime has the power of absorbing carbonic acid, and forming with it chalk, or carbonate of lime; hence, if a little freshly-prepared milk of lime (slaked lime mixed with water) be added to water holding chalk in solution by means of carbonic acid, the lime seizes on this latter, and the chalk thus formed, along with the chalk originally contained, will fall to the bottom, when the clear liquid may be decanted off.—S. BOTTONE.

[57066.]—**Reducing the Amount of Lime in Chalk Water.**—The temporary hardness of water is due to calcium carbonate dissolved in excess of carbonic acid, probably forming some sort of a double carbonate. On the addition of lime to a water containing this compound the carbonic acid combines with the lime, forming normal carbonate, which, together with the carbonate already in solution, precipitates, and the water consequently softens. A quantity of milk of lime slightly in excess of that needed is mixed with the water, and allowed to stand twenty-four hours, the excess of lime being afterwards destroyed by adding more unlimed water. I believe the process is worked at Canterbury and Tring. It has, of course, no effect on the permanent hardness of the water, due to calcium sulphate, &c.—WM. JOHN GREY, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[57066.]—**Reducing the Amount of Lime in Chalk Water.**—"C. H. D." has been correctly informed with regard to Clark's process of softening water, excepting that it is not a patented process. It is carried out as follows: the water to be softened is stored in large tanks, whose capacity is known; by means of a standard soap solution, as has already been described in the "E. M.," the amount of temporary hardness is ascertained, and from this the quantity of carbonate of lime in the water in the tanks; then milk of lime is added—this is made by slaking quicklime in water, using 56 parts of quicklime for every 100 parts of carbonate of lime in the water. The water is agitated during the time the lime is being added; it is then allowed to rest, when the precipitated lime settles to the bottom, leaving the softened water clear and ready for use. A patented modification known as the Porter-Clark process is in use in some places where the large storage capacity required in Clark's process is not obtainable. In Porter's process the water and lime are conveyed by pipes into a common pipe, in such proportions that the lime conveyed by one pipe shall be just sufficient to combine with the carbonate of lime in the water conveyed by the other pipe. The mixed waters carrying precipitated carbonate of lime are now passed through filters. I refer "C. H. D." to the *Journal* of the Society of Chemical Industry for February, 1884, for details.—George H. Hurst, Salford.

[57069.]—**Hot Water.**—The boiler specified by "Les Dents" is far too small for the required work, and gas would be an exceedingly costly fuel for so large an arrangement. A coil of 1¼in. iron steampipe, seven turns on a 9in. mandrel, used as an upright boiler, set in brickwork with grate bars 4in. below the bottom coil, would, if fired with coke inside the coil, do all that is required easily at a cost of one-tenth that of gas. To get at the cost of gas for the purpose, calculate the whole pipe and cylinder surface to be kept, say, at 180° Fahr., and allow one cubic foot of gas per hour for every 1½ square foot of surface. Add to this two cubic feet of gas for every gallon of scalding-hot water required during the day. For the cost of coke take the cost of gas at 3s. for 1,000 cubic feet and divide it by 10; this will give the approximate cost of coke at 4d. per cwt. The above rule is the result of 12 months' working of each of the two systems with a circuit of 80 square feet of radiating surface, kept hot continuously night and day.—T. F.

[57069.]—**Hot Water.**—Your hot-water boiler is altogether too small for the demands you make on it. The faults, so far, are that the heating surface is insufficient, and this is made worse by the great length of flow and return pipe. The hot-water cylinder should be as close to the boiler as possible, and I prefer, if it be possible, to place them in a cupboard by the side of the fireplace. The heating and storage of hot water does not as yet seem dealt with in anything like as scientific a way as many other things. I consider, for the length also, the ¾in. pipes are too small. The amount of heat lost in the length of pipe alone is considerable. Then the boiler, having no doubt the fire on the one side only, has little more than one half the heating surface it might make available. My remedy would be to increase the heating surface and the storage capacity, and at the same time I would in some way clothe the hot-water cistern, by either roughly lagging and filling up with sawdust, or some equally simple plan. By inference I understand that unless the fire be well kept up the temperature of the water rapidly decreases. This is bound to be so, as the storage capacity is so small that the volume of hot water, when the whole contents of the cylinder are hot, would very quickly be exhausted, this being increased by the cooling of the water due to passing through a long length of small pipe. To get a plentiful supply of hot water, a good and steady fire must be kept up, and even then there must be ample storage.—Invicta.

[57070.]—**Telephone.**—As you say that the telephones give a click on being connected with a battery, there should be no difficulty in getting them to act properly, provided you get the right adjustment. Of course, I need not tell you not to use a battery with them for actual work. Screw up the magnets until they just touch the diaphragm—this you can tell by the peculiar tubby noise given on tapping with the finger nail. Now screw back until the magnets just clear the diaphragm: this is the best position. Be sure to put your ear close against the bell of the mouthpiece, and be sure also to place the speaker at such a distance that you cannot hear his voice direct when he speaks. No. 40 wire is very fine, No. 30 would have been better.—S. Bottone.

## UNANSWERED QUERIES.

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*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

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## QUERIES.

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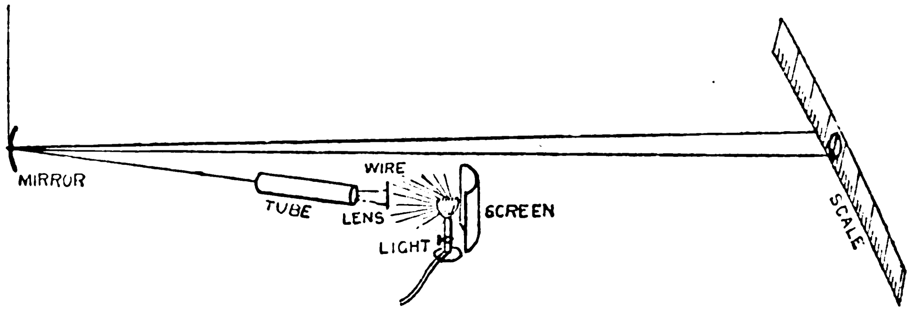
[57072.]—**To Mr. Bottone.**—It is the armature of the Siemens-Alteneck pattern that I should like a description of. Many thanks for your reply.—Accumulator.

[57073.]—**To Mr. Rogers.**—Many thanks for your reply to my query concerning the am-meter, but the kind of instrument you describe is of no use to me. I am in want of a more substantial instrument that will stand moving about. I should be very much obliged if you could give me any further information concerning my query.—Accumulator.

[57074.]—**Lens for Mirror Galvanometer.**—Can any of our optical correspondents give me a few hints about the proper lens to use for a Thomson mirror galvanometer? When working with the lamp and scale at the common 3ft. distance from the mirror it is easy enough with a little dodging to get a reasonably bright ½in. spot and clear line, with almost any lens (convex). When working, however, as I always prefer to do, with the scale some 15ft. to 20ft. off, and a 3in. spot, it is by no means so easy; in fact, the amount of dodging required seems to vary as an unpleasantly high power of the distance. What I want, in short, is this:—1. Given *a* the distance between the lamp and mirror, and *b* that between mirror and scale, what focus lens will give a good bright spot *c* inches diameter on the scale, and what distance should the lens be from the lamp? N.B.—The mirror is generally figured—*i.e.*, concave; what is the advantage of this, and how is it to be allowed for in the above? 2. A sharp black line is required across the spot. At the 3ft. distance, it is sufficient to paint a fine line on the lens itself, but for long distances this does not seem to answer. What is the correct distance (in terms of focal length, &c.) at which a wire should be stretched behind the lens to give a sharp black line on the spot? If it would take too long to get out a general solution to the above question, perhaps someone would give one for the following data?—

Lamp to mirror ...... 6ft.
Mirror to scale ......... 15ft.
Foc. length of mirror 18in.
Diameter of spot tube 2in.

In case anyone has forgotten the arrangements of mirror, I add sketch.—C. G. S.



[57075.]—**Parchment Paper.**—Will someone oblige by giving plain directions to make the above, and the best kind of paper to use? I want to use it for jam pots and honey bottles?—Turtle Dove.

[57076.]—**Fire, Acid, and Moisture-Proof Card.**—Some friends of mine require for a particular purpose a fire-proof, acid-proof, and moisture-proof cardboard, or other material in thin sheets, and at an expense of not more than 2d. or 3d. per square foot. Can any of your readers tell me whether such a material is obtainable?—J. H. Collins.

[57077.]—**Boracic Acid.**—Is this substance perfectly harmless when used for preserving articles of food, such as milk, butter, soups, &c.? Will it also prevent fermentation in infusions of tea and coffee and juices of fruit? Kindly say what quantity should be used. Is there anything better than this for the purpose? Is it expensive?—Agricola.

[57078.]—**Incubators.**—I have made an incubator for batching chickens, and am at a loss for a regulator to keep it at one heat, from 102 to 105. Will someone that has had experience in such kindly answer and tell me the best way to make one?—D. Blake.

[57079.]—**Windway.**—I have a two-row Monro tube board; I intend only to use three and a half octaves. Will Mr. Fryer, "Organon," Mr. Wenham, or any other kind friend tell me how I can use it for paper valve? Can I build on it, so that the paper will pass over the holes outside, and not under as in the orguinette. Can I cut off one row of reeds at pleasure. A rough sketch will greatly oblige.—A. B. C.

[57080.]—**Siphon.**—Would any of "ours" give the reason why a siphon constructed under the following conditions does not flow continuously, but after being started works well enough for a day or two, and then gradually weakens, until on or about the fourth day it stops entirely? The supply is from a well containing 12ft. of water. The pipe is a 1in. lead, and has its inlet at the bottom of the well, 12ft. under water. Starting from the well, there is a gradual rise, till at a distance of 220 yards, the pipe passes over a summit 21ft. above the bottom of the well, and then descends, and at a distance of 500 yards from the summit it reaches foot of wall of house, with a fall of 51ft. below bottom of well. The pipe then passes up 15ft. inside the house, and terminates thus in a ball cock, 31ft. above bottom of well. The summit is situated at 750ft. above sea level. Granting that silt is kept clear, and with a sufficient supply of water, what causes the stoppage?—Surveyor.

[57081.]—**Watchmaker's Bow.**—Thanks to "Escapement" for his answer to my query last week, and will he tell me how to make a good bow for driving turns, as I cannot make them drive as I should like?—Lever.

[57082.]—**Hydraulic Leather Collars.**—Will some kind reader inform me how to calculate the amount of power absorbed by cup leathers working in iron cylinders? Please do it by simple arithmetic.—G. B. B.

[57083.]—**Freemasonry.**—Will some of your readers who are freemasons kindly say whether the benefits of being one are equal to the great expense?—Z.

[57084.]—**Shunt Dynamo.**—To Mr. Bottone or Others.—Seeing that a shunt dynamo is built up of soft iron cores in the field magnets, from whence and how is the first initial current generated to excite these magnets? I find that I may run the armature of a shunt dynamo for an indefinite time, yet no current or signs of magnetisation till the brushes are brought into contact with the commutator. Does the first generation of current start with this friction? If not, how is it generated?—W. B.

[57085.]—**Heating Surface of Vertical Boilers.**—Will those readers who possess vertical boilers kindly note the arrangement of tubes or flues, the heating surface, and the grate area, and the indicated horse-power of the engine driven? Please give, also, the pressure of steam in the boiler, and, if possible, the water pumped into boiler per hour; and say if there is a natural draught or a blast? I want to collect data as to the heating surface required for this class of boiler, and shall be much obliged to those who will give their experience. If nothing but the heating surface, indicated horse-power, steam pressure, and kind of blast is given, those particulars will be of great use.—Glatton.

[57086.]—**Colliery Warnings.**—To T. J. Murday.—From what data do you know that the dates you name on page 412 (No. 24448) will be highly dangerous to miners?—Ralph.

[57087.]—**Spirit Varnish and Polishing.**—Would some readers kindly say how to make spirit varnish (good body and hard)? Also, quickest method of polishing native timber—elm, beech, &c.?—A Working Man.

[57088.]—**Emigration.**—Will any reader kindly say whether Australia, New Zealand, or Western States of America offer the best opening for a furniture manufacturer on a small scale?—An Anxious One.

[57089.]—**Electric Cement.**—Can anyone tell me of a good electric insulating cement that will stick to glass and metal, will not be affected by moisture or temperature of, say, 150deg. C., can be applied cold, and will not expand or contract much on setting?—Stud. Inst.C.E.

[57090.]—**Copper and Zinc Polishing.**—Will some reader of the "E. M." kindly inform me the best way to face zinc and copper plates ready for etching?—W. M., Bolton.

[57091.]—**Coating Cast Iron.**—What is the best material to coat cast-iron machinery with, so as to resist the fumes of sulphurous acid?—J. S. D.

[57092.]—**Ginger Beer Plant.**—Can any of your correspondents give me any information respecting the ginger beer plant? What is its correct name? To what tribe does it belong? How is ginger beer made with it? Is it perfectly safe and harmless to drink?—Rushallite.

[57093.]—**Beam Engine Slide Valve.**—Engine 6ft. 6in. stroke, diameter 28in., 22 revs. per minute, slide valve 14in. long, 14½in. wide, exhaust 8in. long, steam ports 2in. long, exhaust port 4in. long; has been working with a travel of 6½in., which I have shortened to 5in. of travel. I don't think this valve is anything like what it ought to be; I should think it ought to be at least 1in. longer, and if it was made longer I suppose the eccentric would have to be put faster? If the valve was made 1in. longer and the eccentric put forward, how would it affect the exhaust? Would it be of any use to lengthen the valve, or must I, to get an earlier cut off, have a new valve? It appears to get steam almost, or quite, the whole of the stroke. With steam at 35lb. per square inch, non-condensing, what power ought I to get?—J. G., Bristol.

[57094.]—**Eccentric on Shaft.**—To "Regulator."—I advertised my address as requested in "Ours" of July 3rd, and should be glad to receive the information promised.—S. S. N.

[57095.]—**Photography.**—To Mr. Lancaster.—I am about constructing a small camera, according to your instructions in No. 953, Vol. XXXVII., of the "E.M.," and should feel obliged if you would enlighten me on the following points. 1. Am I right in presuming that the width of the body, when finished, is to be exactly 4½in.? As in that case, the two shorter of pieces of wood would require to be 4⅛in. long, instead of 4⅝in., as directed. 2. How is the focussing slide attached to the back of the camera? I suppose the ground glass must be fitted in a frame. 3. What is the construction of the dark slide, and how is it adapted to the back of the camera? In all the cameras I have seen, the dark slide is pushed in from the top, and slides in grooves in the sides.—Amateur.

[57096.]—**Covering Electric Light Cables with Lead.**—Can any of our readers tell me how this is done, and what kind of a machine is used to do it, and also the plan of the machine, the lead must be no thicker than 3-32 of an inch?—Anxious to Know.

[57097.]—**Tinning Copper Wire.**—I have several miles of small copper wire to tin, I wish to know how this is done, whether the coil is dipped in at once, or passed through singly, also the kind of acid used, and all particulars? The wire is required for electrical purposes.—ANXIOUS TO KNOW.

[57098.]—**Warehouse Lift.**—Would a reader who has a thorough knowledge of lifts, be kind enough to give a plan sketch of a lift, to raise 5cwt. to the height of 35ft. through two floors of a warehouse, and whether a gas engine would do the work, stating the h.p. required, and probable cost including fitting up, and at what rate the lift will travel?—W. J. D., 55, Albyn-road, St. John's, S.E.

[57099.]—**Watchwork.**—To "C. A. W."—I am extemely obliged to "C. A. W." for his hints on polishing, in reply to my query (56972). If it is not giving too much trouble on so small a matter, may I trouble him still further? I have been using red stuff, and only lately tried diamantine, and do not know how this is used. If he will say how this is mixed for use, shall be obliged.—ESCAPEMENT.

[57100.]—**Spectroscope.**—Will some friend who has technical knowledge of this beautiful instrument, inform me if a combination of five prisms, gives enough dispersion to view the red solar prominences with, or is it worth while attaching so small a spectroscope to an astro. telescope.—E. B. F.

[57101.]—**Spectra.**—When I look at a piece of blazing paper with a spectroscope, I see the D line conspicuouly displayed, particularly if I have taken the trouble to shake a pinch of common salt or soda over the paper before setting it on fire. I want to know of a few other experiments, by which I can show in a correspondingly simple manner, the spectra of other substances. I do not care what those substances are, if the experiments are as easy and striking as the exhibition of the D line.—E. B. F.

[57102.]—**Air and Fuel.**—There is one matter in regard to the combustion of fuel, which I cannot understand, and on which I wish to be enlightened. How is it that the enormous pressure of the air does not cause itself to be forced into fires with greater effect, considering the great effect produced by the simple blast of a bellows?—VULCAN.

[57103.]—**Analysis of Copper Wires.**—To MR. W. J. GREY.—I have to test the purity of copper wires from three mils to twenty-five mils, our standard being 96 per cent. This is done electrically; but if the process is not too elaborate, I would rather take the analysis, so as to check one process with the other. Thanks for your kind attention.—EXPERIMENTER.

[57104.]—**Actuarial.**—Will some actuary kindly tell me what half-yearly payment I should receive for thirty years, by sinking £100, calculating interest respectively (compound) at 3½ per cent., and 4 per cent.?—ANNUITANT.

[57105.]—**Street Coil.**—I am about making a coil on the same principle, I believe, as is advertised by King. Mendham, and Co., Bristol; would any of "Ours" kindly assist? A rough sketch would very much please. The base is to be 3ft. by 2ft., upon this a small raised platform; on the base, three pairs of handles, and upon the platform, the bobbin, contact breaker, set of two bells, and a switch for five powers. 1. What size should the bobbin be? 2. How much primary and secondary and sizes? 3. How to make up the connections for the bells with the oscillating hammer between, also for switch contact breaker, and handles? I should also like to have two studs for stopping contact breaker at will, and another for the bells; the wire connections should be all out of sight, and also the bells' electro magnets. I intend using a tube of brass for regulating the power, and the machine to be strong enough that the three strongest persons cannot hold its fifth power out, and providing they all take hold the same time.—YOUNG ELECTRICIAN.

[57106.]—**Galvanised Iron Pipes.**—A certain quantity of these having been laid down to conduct spring water, it is found pipes become coated in interior with a white substance; also after boiling water in a kettle, there is a white appearance. The water at spring has been analysed, and pronounced pure. What is this white deposit, what its cause, is it injurious, can it be obviated?—B. O. D.

[57107.]—**Developing Formulæ.**—In mixing chemicals for photo. purposes, would the solution be correct if I were to weigh the ounce of water by the same ounce as I use for dry chemicals, and will all developers require the same exposure? For instance, if a plate be exposed, and developed with the sodic sulphite, and exposure found to be correct, could good results be expected by giving the same exposure, and using any other developer?—JAY WHY.

[57108.]—**Home Practice for Bicyclists.**—Will any of your numerous readers give me directions how to make home trainer for bicycle to fix into?—A MECHANIC.

[57109.]—**Focus of O.G.**—Many thanks to "Rob. Crvs" for answering No. 56847. I do not intend to make the o.g., because I couldn't, but I have given an order for one of 3in. diameter, and the lens maker has asked me which focus would I like, 40 or 50in. If "Rob Crus," or "Invicta" would be so kind as to correspond with me, I shall deem it a favour.—FOCUS.

[57110.]—**Dynamo for Electro-Plating.**—Could any of your numerous correspondents inform me if it is practicable for an amateur to use a small electric dynamo, driven by hand or foot, for electro-plating on a small scale? If not, could they recommend me a permanent battery, that would continue to act for a lengthened period without replenishing, or one that would require very little looking after, and give me instructions for using same?—AMATEUR.

[57111.]—**Is the Earth a Conductor?**—As it is evident that one of the following questions must be misleading, and many of us who have but an elementary knowledge of electricity are unable to determine, will you or some of your readers kindly reply? First, is it really necessary to use a second earth plate for the completion of circuit of one battery whose terminus is buried in the earth? I should say no; but according to the teaching of some, one is asked to believe the reverse; for instance, Silvanus P. Thompson in his "Elementary Lessons on Electricity and Magnetism," page 404, Art. 424, not only gives a sketch, but declares the current, after having performed its work, enters the earth by means of earth plate, and travels back by the earth to the battery whence it started. Second, can the earth in any case play the part of conductor; is it not rather a receiver or dissipator?—LABOURER.

[57112.]—**Wet Plate Photography.**—Will some of "ours" kindly tell me where I can get a book containing full instructions for this process, stating price? Also, which is the easiest for an amateur to master, wet or dry, for portrait work, and will dry plates keep any length of time?—JAY WHY.

[57113.]—**Photography.**—Can any of "ours," who have tried various plates and developers, recommend a better make for an amateur for portrait work than Fry's and their sodic sulphite? At one time I got on fairly well with these; but my plates now turn a very curious colour when finished, and so are useless.—E. T.

[57114.]—**Cylinder for Reservoir.**—Will Mr. Davies, or any other practical reader inform me what thickness is necessary for a 7ft. cylinder (cast iron) flanged inside for sinking down well for reservoir about 25ft. deep (in about 5ft. lengths)? What is about probable cost per ton?—G. W. B.

[57115.]—**Faulty Telephone.**—I have made a pair of telephones of the following parts: Magnets 4in. by ⅜in., each magnet wound with about ½oz. of No. 36 silk-covered wire, and a pair of ferrotype plates 2¼in. in diameter. After fitting together and connecting up to about 12yd. of double wire, I could not hear the slightest sound when spoken into the one at the farther end. Do you think it would be better for me to rewind the bobbins with a finer wire, say, 38 or 40, and use larger and thinner plates? I forgot to say that when I connected up the ends of one of the telephones with the secondary terminals of a coil and set it in action, I could hear as well as feel the vibration in the telephone similar to that made by the coil. Any suggestion to put me right will oblige—MYSTERIOUS.

[57116.]—**Bell Telephone Circuit.**—To MR. S. BOTTONE.—What I wish to know, query 56990, is how to connect up a Bell telephone and microphone with a similar telephone and microphone at another station, only using two line wires (no earth return), and making one battery serve for both stations? If a small coil be necessary, where is it to be inserted; and how are the ends of the primary and secondary wires connected up? I am sorry for asking you so many questions.—TRANSMITTER.

[57117.]—**East Coast Express.**—Can any railway reader say if the 8 p.m. from King's Cross makes any stop between Newcastle and Edinburgh for water or otherwise? Bradshaw gives none, but it does the same with the 7.40 a.m. Caledonian train from Perth to Aberdeen, whereas that train stops at Forfar.—ABERDEEN.

[57118.]—**Paper Caps for Toy Pistols.**—Will anyone kindly tell me how to make them?—A. B. J.

[57119.]—**Herb Beer.**—I would be greatly obliged if any reader of the "E. M." would tell me how to brew and prepare for drinking tonic herb beer?—OLD SOLDIER.

[57120.]—**The Equation of Light.**—In none of the astronomical books I have is there any description of the method of calculating the correction due to the progressive motion of light in the case of, say, the eclipses of Jupiter's satellites, or the minima of Algol. I have myself worked out the following method of calculating the necessary correction, and would be obliged if "F.R.A.S." would kindly say if the method is a correct one? Knowing the right ascension, and north polar distance of the planet or star, and also of the sun at the moment of observation, we can, having two sides (the polar distances) of a spherical triangle, and the included angle (equal to the difference of the right ascensions) calculate the third side, or the angular distance between the sun and the planet or star. Then the natural cosine of the supplement of this angle (which will be the angle subtended at the sun by the earth and planet) multiplied by the time occupied by light in passing from the earth to the sun (say 8·3 minutes) will give the necessary correction, to be added to the observed time, if the cosine is positive (*i.e.* when the supplement is less than 90deg.) and subtracted if the cosine is negative. The result will give the heliocentric time of the observed phenomenon.—LIGHT.

[57121.]—**Mountain Snow.**—What is the reason the tops of mountains are covered with snow, while the heat of the sun is intense?—IGNORANT.

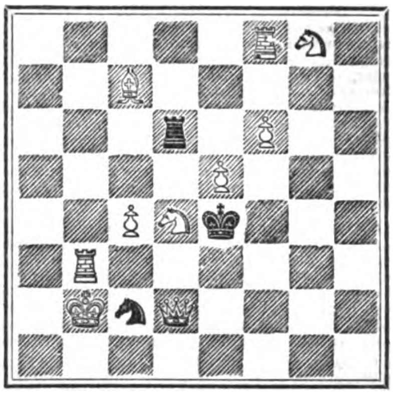
**Experiments with Terpine and Terpinol.**—At a recent meeting of the Société de Thérapeutique, Dr. Dujardin-Beaumetz recalled the fact that in treating turpentine with an alkaline carbonate a substance is obtained to which the name of "terpine" has been given. This substance has been experimented with by Dr. Lépine, of Lyons, who ascertained that it is endowed with very marked diuretic properties, and that it modifies the bronchial secretion in old catarrhal affections. Dr. Dujardin-Beaumetz has since experimented with a derivative of terpine—namely, terpinol, which is obtained by reacting on the former with sulphuric acid. Terpinol is described as being an oily substance, having an odour of jasmine, and being but little soluble in water. Dr. Dujardin-Beaumetz prescribes it in the form of pills as follows:—Terpinol, benzoate of soda, of each sixteen grains; powdered sugar q.s.; to be divided into ten pills, of which as many as ten can be administered daily. Terpinol is eliminated almost exclusively by the air passages, and gives to the breath a strong odour of jasmine. It exercises its action principally on the bronchial secretions, which it rapidly fluidifies.—*Lancet.*

## CHESS.

ALL Communications for this department must be addressed to J. PIERCE, Langley House, Dorking.

### PROBLEM DCCCCXLIX.—BY "PHONO."

*Black.*



*White.* [10+3

White to play and mate in two moves.

SOLUTION TO 947.

| *White.* | *Black.* |
|---|---|
| 1. Q-K B 8 | 1. Anything |
| 2. Q or Kt mates | |

(Ten variations).

### NOTICES TO CORRESPONDENTS.

CORRECT solutions of 946 from F. O'N. H., T. L. Robins, A. A. E. Lecluse,, and V. S. Pochin.

To 947 by V. S. Pochin, T. L. Robins, F. A. V., E. Stanley Follwell (interesting and pretty), Rev. W. Anderson (Old Romney), R. A. Bennett, and N. and F.

To 948 by Rev W. Anderson (but not second move in main play).

"E. M." Tourney game between Messrs. J. H. Blake (White), and W. Nash (Black).

(French defence).

1. P-K 4, P-K 3 / 2. P-Q 4, P-Q 4 / 3. Kt-Q B 3, Kt-K B 3 / 4. B-K Kt 5, B-K 2 / 5. P-K 5, K Kt-Q 2 / 6. B takes B, Q takes B / 7. Q-Q 2, P-Q R 3 / 8. Kt-Q sq, P-Q B 4 / 9. P-Q B 3, Kt-Q B 3 / 10. P-K B 4, P-Q Kt 4 / 11. Kt-B 3, P-B 4 / 12. B-Q 3, Kt-Kt 3 / 13. Castles, Castles / 14. P-Q Kt 3. B-Q 2 (*a*) / 15. Kt-K 3, Q R-Kt sq / 16. P-K Kt 4, P-Kt 3 / 17. B-Q B 2 (*b*), Kt Q sq / 18. K-R sq, K-R sq / 19. R-K Kt sq. P-B 5 (*c*) / 20. R-Kt 3, R-K Kt sq / 21. Q R-K Kt sq, Kt-B 2 / 22. Q-K Kt 2 Q-B sq / 23. Q-R 3, Q-K 2 (*d*) / 24 P takes K-B P, K Kt-P takes P (*e*) / 25. Kt-Kt 4, Kt takes P (*f*) / 26. Q-Kt takes Kt, R takes R / 27. R takes R, B-K sq / 28. Kt-K Kt 5, resigns.

NOTES BY MR. J. H. BLAKE.

(*a*) THE correct line for Black to adopt is to try and break through on the Q side before White has had time to make his attack on the other wing: 14. $\frac{\quad}{P\text{-}Q\ B\ 5}$ 15. $\frac{B\text{-}B\ 2}{P\text{-}Kt\ 5}$ would be good for that purpose.

(*b*) In order to block the Q side by P-Q Kt 4, in case Black now advances his Q-B P.

(*c*) Too late; White does not care about that side now.

(*d*) If 23. $\frac{\quad}{Q\text{-}R\ 2}$ 24. Kt-Kt 5 wins two pawns at least

(*e*) Taking with K P would be better, but White then wins the exchange and a P by Kt-R 4.

(*f*) There is nothing to be done if 25. $\frac{\quad}{R\text{-}Kt\ 3}$ 26. $\frac{Kt\text{-}B\ 6}{R\ \text{takes}\ Kt}$ 27. $\frac{Q\text{-}R\ 4}{\quad}$

THE American Government have forwarded a consignment of catfish to the National Fish Culture Association with a view to their being acclimatised to the waters of this country. They arrived per s.s. *Britannic* in perfect condition, all being alive, which, considering the long voyage they had been subjected to, is remarkable. The catfish is said to be a very valuable food-fish, and would assume a high rank amongst the freshwater fishes of our waters if cultivated; but anglers, or many of them, have great objections to the fish, which they say is destructive to nearly all others.

**Every Workman** connected with the Building Trades requiring a Situation should advertise in "THE BUILDING NEWS." published every FRIDAY, price Fourpence, at 332, Strand, London, W.C.

"THE BUILDING NEWS" is the Principal Journal representing Architects and Builders, and has the largest circulation of any Professional Journal in the kingdom.

Every Workman should insist on seeing "THE BUILDING NEWS" every week at his Club or Coffee House. He will find more "Lists of Tenders" for new work in it every week than in any similar paper, and can thus judge where work is likely to be had. He is also specially invited to make use of "Intercommunication" if he wants to know anything about his trade: to write to the Editor if he has any suggestions to make, and to advertise in the paper when he wants work.

The charge for Advertisements for Situations is One Shilling Twenty-four Words, and Sixpence for every Eight Words after.

## ANSWERS TO CORRESPONDENTS.

⁂ *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

### HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

⁂ Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, July 22nd, and unacknowledged elsewhere :—

R. C. Moore.—Sanitas Co.—W. Wray.—R.—R. Hughes.—B. H.—Hemisus.—C. W. Bourne.—S. R. Bottone.—Bobadil.—A Fellow of the Royal Astronomical Society.—J. E. Gore.—Dr. Royston Pigott.—Fra. Broadbent.—P. E. W.—T. H. Hall.—Accumulator.—Bunsen.—No Chill.—M.I.C.E.—H. L. C.—Norfolk.—F. A. R.—James Stevenson.—B. S. T.—W. H. Eaves.—Werdna.—Young Farmer.—H. B. F.—James McCash Govan.—Farmer.—G. D. Seaton.

Novice. (Without more complete details of the purpose for which it is required, we can only suggest that one of the mercurial amalgams would be suitable—mercury and tin, for instance, which combine in all proportions. Mercury 10, tin 1, remains liquid, but equal parts soon become solid. How would that do? You must procure what is called grain tin, or else melt tin and pour it into a bucket of water so as to give it a slight fall from the ladle to the water.)—A. Tamer. (We do not know how electricity is used to tame wild animals, nor where to get the appliances.)—An Old Subscriber, Hereford. (We do not know that there is one in that district. There is a cable station at Porthcurnow.)—R. Gardiner. (You should apply to the captain of the Steam Reserve at one of the Government dockyards.)—Bazaar. (The "optical illusion" Thauma was described in No. 1024, p. 226.)—Thos. H. Purves. (You can obtain a copy of the patent rules from the Sale Office, Cursitor-street, Chancery-lane, W.C., by addressing Mr. H. Reader Lack, and inclosing 6½d.)—A Constant Subscriber, Indigestion. (The best way would be to consult a medical man, in order to ascertain what is the matter. If indigestion, see that heading and Dyspepsia in back volumes—pp. 503, 506, 529, Vol. XXXV.; pp. 262, 594, 620, Vol. XXXIV.; pp. 466, 513, Vol. XXXIII., and so on.)—Young Beginner. (See back volumes, or any of the guides to the lathe. A 6in. lathe means one in which the centres are six clear inches from the bed, so that work 12in. in diameter can be revolved in the lathe.)—Dulcimer. (Directions for making a dulcimer in Vol. XXXVI. pp. 97, 168; see also Nos. 160, 234, and 522.)—Klinkerfues. (The Klinkerfues hygrometer, which we imagine is the instrument you mean, was illustrated and fully described in No. 963.)—W. E. Lilly. (The best plan is to get a berth as engine-room artificer, and go to sea for one year; then, as you are an engineer, and have had, we presume, three years in the shops, you can sit for the examination, and obtain a certificate. Procure the "Engineers' Handbook," Reed and Co., Sunderland, which will give all particulars, examination papers, &c.)—J. E. Stocks. (The only method of cold brazing that is worth anything at all was given on p. 81, No. 888.)—W. H. (The only reply, besides recommending you to consult a medical man, would be to poultice, bathe, &c. Try frequent washing with permanganate of potash solution, and wear a bandage of pure indiarubber.)—Cyclist. (See the papers on nickel-plating in Vol. XXXVIII. pp. 44, 69, 111, 136; and Vol. XXXIX. pp. 96, 117, 133.)—Pluto. (It might be lumbago or disease of the kidneys, but if it comes on only after standing, it is probably nothing particular.)—D. C. (The *Dyer*, 9d. monthly, 3, Westminster-chambers, S.W.)—P. O. Lineman. (The English Mechanic telephone was described in No. 594, a number long ago out of print. It was disclaimed, and can therefore be used. It consisted of a membrane diaphragm with a piece of steel in the centre, which was attracted by a magnet.)—Virago. (The prior date would protect you; and if the inventions really were identical, both applicants would receive notice from the office.)—M. A. E. (Look through the indices. Described many times. 2. We do not know of such a work.)—F. L. R. (There is no such work. It would fill many volumes.)—A. Boydell. (Why not try? The answer is, Yes, up to a certain amount.)—Little Dorritt. (Can you not find what you require in previous replies about dynamos?)—A. Lowe. (Do you mean bronze powders, or a process to act on the metal. If the latter, it is surely necessary to state of what metal the medal is composed; but you will, no doubt, find a suitable method in back numbers.)—Uncle Rob. (Yes, we believe so; but forget the name of the agent. Apply to the inventor himself through his publishers.)—Beaconsfield. (Do you mean simply a case surrounded by ice, or a refrigerating machine? If the former, you can easily find several patterns at the dealers. They are simply boxes lined with zinc and fitted with ice-chambers.)

G. H., H. S. H., Hemisus, C. W. Bourne, and B. H. B. have replied to queries already similarly or adequately answered.

## USEFUL AND SCIENTIFIC NOTES.

**A Fire in a River.**—A Glasgow newspaper publishes the following:—"The singular sight is at present to be witnessed of a fire issuing from the waters of the river Clyde, a few hundred yards below Bothwell Bridge, and it has attracted to the scene thousands of curious spectators. For some time back, near the mouth of the Auchinraith burn, and not far from the left bank of the river, the water has in one or two places been seen to bubble up, the largest of the agitated parts marking a circle nearly a foot in circumference. Still no heed was taken of the circumstance until Thursday last, when an angler, while wading in the stream, which, owing to the dry weather, is abnormally low, scratched his match to light his pipe, and on throwing it from him the water at once caught fire and emitted a brilliant flame. It is now clear that the gas issuing from the mineral workings underneath is finding its way through a fissure in the strata to the surface of the water, and had been kindled by the lighted match. The boys amuse themselves ineffectually trying to put out the tongue of flame, which at night, it is seen, rises to a height of four or five feet, with branches of trees. A miner succeeded in extinguishing it with a flat stone, but it was at once re-kindled. Such occurrences, though rare, are not unprecedented in Lanarkshire. In 1829, and for some successive years, the gas issuing from the limestone rock on the property of Holms, in Cadder parish, rose through the earth and even the water on its surface. It was easily kindled with a match and burned brilliantly on the surface of the water. At the time of the first Blantyre explosion it was noticed as a curious fact that about 20 years before a bore was made above the fatal workings to a depth of 80 fathoms, when a jet of gas burst up, which on being lighted continued to burn for some time. Again, eight years later, when another bore was put down about the same spot at a much greater depth, the gas issued through the aperture, and after being kindled burned for weeks."

The Queen has granted a pension of £70 a year to Mr. Llewelyn Jewitt, the author of many antiquarian and topographical works.

## CHARGES FOR ADVERTISING.

| | s. | d. |
|---|---|---|
| Thirty Words .. .. .. .. .. .. .. .. | 2 | 6 |
| Every additional eight words .. .. .. .. .. | 0 | 6 |

Front Page Advertisements Five Shillings for the first 40 words, afterwards 9d. per line. Paragraph advertisements One Shilling per line. No front page or paragraph advertisement inserted for less than Five Shillings. Reduced terms for series of more than 6 insertions may be ascertained on application to the Publisher.

ADVERTISEMENTS in EXCHANGE COLUMN—for

| | s. | d. |
|---|---|---|
| Twenty-four words .. .. .. .. .. .. .. | 0 | 3 |
| For every succeeding Eight Words .. .. .. .. | 0 | 3 |

ADVERTISEMENTS in the SIXPENNY SALE COLUMN.

| | s. | d. |
|---|---|---|
| Sixteen words .. .. .. .. .. .. .. .. | 0 | 6 |
| For every succeeding Eight words .. .. .. .. | 0 | 6 |

⁂ It must be borne in mind that no Displayed advertisements can appear in the "Sixpenny Sale Column." All advertisements must be prepaid; no reduction is made on repeated insertions; and in cases where the amount sent exceeds One Shilling, the publisher would be grateful if a P.O.O. could be sent, and not stamps. Stamps, however (preferably halfpenny stamps), may be sent where it is inconvenient to obtain P.O.O's.

The address is included as part of the advertisement, and charged for.

Advertisements *must* reach the office by 1 p.m. on Wednesday, to insure insertion in the following Friday's number.

## TERMS OF SUBSCRIPTION.

PAYABLE IN ADVANCE.

5s. 6d. for Six Months and 11s. for Twelve months, Post Free to any part of the United Kingdom. For the United States, 13s., or 3 dols. 25c. gold; to France or Belgium, 13s., or 16f. 50c.; to India (via Brindisi), 15s. 2d.; to New Zealand, the Cape, the West Indies, Canada, Nova Scotia, Natal, or any of the Australian Colonies, 13s.

The remittance should be made by Post-office order. Back numbers cannot be sent out of the United Kingdom by the ordinary newspaper post, but must be remitted for at the rate of 4d. each to cover extra postage.

Messrs. JAMES W. QUEEN and Co., of 924, Chestnut-street, Philadelphia, are authorised to receive subscriptions for the United States for the ENGLISH MECHANIC, at the rate of 3 dols. 25c. gold, or Thirteen Shillings per annum, post free. The copies will be forwarded direct by mail from the publishing office in London. All subscriptions will commence with the number first issued after the receipt of the subscription. If back numbers are required to complete volumes, they must be paid for at the rate of 4d. each copy, to cover extra postage.

Vols. IV., VII., XXVI., XXVIII., XXX., XXXII., XXXIII., XXXIV., XXXV., XXXVI., XXXVII., XXXVIII., XXXIX., and XL., bound in cloth, 7s. each. Post free, 7s. 9d.

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*FRIDAY, JULY* 31, 1885.

# HISTORICAL NOTES ON THE CASSEGRAIN.—II.

By DR. ROYSTON PIGOTT, F.R.S., M.A.

### The Great Southern Cassegrain.

THE following resolution of the Council of the British Association displays the earliest efforts towards the construction of this great instrument:

"That it is expedient to proceed without delay with the establishment, in the Southern Hemisphere, of a telescope not inferior in power to a 3ft. reflector; and the President of the British Association, with the assistance of the following gentlemen, viz.: The Earl of Rosse, Dr. Robinson, Lord Wrottesley, J. C. Adams, Esq., the Astronomer Royal, J. Nasmyth, Esq., W. Lassell, Esq., Sir D. Brewster, and E. J. Cooper, Esq. be requested to take such steps as they shall deem most desirable to carry out the preceding resolution." (This was read at the Council of the Royal Society, Nov. 22, 1852.) The name of John Phillips was subsequently added, as also Sir John Herschel, Sir John Lubbock, and the Dean of Ely.

Under these circumstances arose a voluminous and, as it were, an all-round correspondence. Mr. Grubb, of Dublin, was intrusted with the execution of a Cassegrain telescope of 32ft. focal length and 4ft. diameter of mirror. It arrived safely about Jan., 1869. Mr. Robert Ellery acknowledged the safe receipt of all the apparatus, and incidentally remarks: "The *specula* are still in thin coats of varnish, and their surfaces appear in good order." It appears the varnish was made of *shell-lac.* The letter was dated Jan. 4, 1869. On Aug. 13, 1869, he further states:

"I am not satisfied with the performance of this great instrument, and I do not think the mirrors are at all perfect in figure; I have not yet seen anything like good definition of a planet with the lowest power (220). Of course, we get plenty of light, even with the nebulæ, but no definition with bright objects."

To this damnatory opinion the Astronomer Royal for Ireland, who had designed and calculated all the details, laboriously replies to a member of the Council:

"Like you, I am much surprised . . . It is fortunate Mr. Grubb put it in his contract that the telescope should be tried by the committee before he sent it from Dublin . . . It fully divided $\gamma^2$ Andromedæ.

"Mr. Grubb's command of figure is so great, that I am certain there may be other causes for this than any fault of the maker, or of the committee who passed it."

Mr. Le Seur, who was in charge of the telescope "out," says that the specula, by the advice of Mr. Lassell, were coated over with shellac varnish.

The large speculum was originally attached to the tube in its varnished condition; on the first favourable occasion it was taken down and *unvarnished*—a process which proved more troublesome than had been anticipated. The lac was very refractory, and the difficulty of removal exaggerated by the extreme heat then prevalent. After a process of solution in alcohol, "mopping up" (*sic*) and washing with water frequently repeated, a large number of markings caused originally by the varnish brush were apparent, and the whole surface had a mealy appearance (!)[*]

In spite of all these *contretemps*, it is written by a principal observer, "I never once obtained with it what I should call *moderately good definition.* I tried it on Saturn many times, but could not get any detail whatever. The larger division on the ring was visible, but was never distinct. The mirror at first had a mealy yellow appearance after the lac had been removed, which was thought to be due to a little residual varnish.

Why, then, did this great telescope at first fail in Australia, to realise the sanguine expectations of the committee? The maker, and the committee's deputation to Dublin, were both satisfied. Hear Mr. Howard Grubb: "I cannot understand Mr. Le Seur that the method employed . . . could not be supposed to have any deleterious effects on the polish, after stating that it was impracticable to remove entirely the shellac coating, the surface being sticky in parts, and afterwards the speculum tarnished quickly. The process was radically bad, and the speculum was left in an unclean state. . . . After months of use at Dublin, the speculum exhibited no tarnish. . . There is abundant evidence to show that speculum (A) has become unfitted for present use, solely from injudicious treatment at Melbourne." Then the committee selected to proceed to Dublin, after due inspection of Mr. Howard Grubb's work, declared it to be a masterpiece of engineering, and they were strongly impressed by the great convenience to the observer of the arrangements of the hour and polar distance circles. Now for the optical power: The telescope was tested with powers of 220, 350, and 450 (all negatives. The committee (assembled at Dublin) found that the light even of large stars was collected into small, hard, and perfectly circular discs free from rays, and though some diffused light[*] surrounded them, it was exactly concentric with the central discs. The 5th and 6th stars of the Trapezium of Orion were not only plainly seen, but were very bright; $\zeta$ Orionis was well shown, and the companion of $\gamma$ Andromedæ was clearly divided with the powers of 350 and 450, and the different tints of the components were evident. Uranus was well seen, but was surrounded with such a multitude of very minute stars that without access to the tables of his satellites it was impossible to know whether any of them were seen.[†]

(*To be continued.*)

# THE INTERNATIONAL INVENTIONS EXHIBITION.—XIII.

### Photography.

THERE is probably no group in the whole International Exhibition which shows so much progress in the last twenty-five years as that devoted to photography—always excepting electricity, which for special reasons has latterly shown extraordinary development. In photography the improvements and advances of the last quarter of a century have been great and varied; but they represent the steady growth of an art which has persistently progressed since its discovery, rather than the leaps and bounds which electricity has recently made. Twenty-five years ago the wet-plate process was the only one known to those outside the circle of inventors and researchers; nowadays dry plates are everything, especially to the amateur, and processes have multiplied almost with the years since Dr. Maddox, in 1871, published an account of his method of suspending or emulsifying silver bromide in gelatine, and applying the preparation to the glass plate instead of collodion. That process, strange to say, remained for about two years in a dormant state, when, in 1873, Mr. Burgess sold gelatine emulsion, and in the following year Mr. Kennett published his method of obtaining the same result, and issued dry plates. Four years after that Mr. C. Bennett discovered that by keeping the gelatine containing the silver salts liquefied at a low temperature for several days an extraordinary sensitiveness to light was produced, and, as he gave the discovery to the world, progress in dry-plate work has been remarkable. We are not, however, just now interested in a history of the modern progress of photography; but the student will not fail to linger at the case containing the exhibits of the Photographic Society of Great Britain, for there are to be seen old pictures, the results produced by the earlier processes, old apparatus, and other objects which illustrate the progress made in the art. Amongst these is the view of Kew, taken by Nicéphore Nièpce in 1827, and the original letter sent by him to the Royal Society in the same year. Here, also, are Talbotypes of 1844, instantaneous views obtained from 1856-1865 by V. Blanchard with wet collodion; carbon prints twenty years old by J. W. Swan; Dr. Maddox's gelatino-bromide negatives of 1871, and Col. Stuart Wortley's early productions with uranium plates. The case also contains some of the earlier productions and apparatus of Woodbury, one of the pioneers of the printing processes which have played so important a part in the illustration of modern books. The collection of photographs exhibited at the different stands, whether shown to illustrate the merits of a process or the advantages of using this or that piece of apparatus or special preparation, will be inspected with pleasure by both the amateur and the professional, for, as we need scarcely say, they are almost all first rate, and a jury of experts would be required to point out in what particular the products of any one process are superior to those of others. Apparatus is shown in considerable variety, but there is little that is so novel as to call for special comment, though many ingenious appliances deserve the attention of photographers, both professionals and amateurs—the latter being a large and rapidly-increasing class, some of them quite capable of holding a position in the front ranks of the exponents of photographic art. Taking the stands in their numerical order, we will point out some of the exhibits which appear to be specially worth notice, though we cannot pretend to exhaust even the comparatively small Group XXIX. Mr. Warnerke, of Champion-hill, S.E., shows the productions of sundry processes based on newly-discovered properties of gelatine emulsions, and his negatives on gelatine tissues leave little to be desired, except it is some special paper or other substance which will enable us to dispense with glass, in which direction, as will be seen from an article elsewhere, he has been making progress. Morgan and Kidd, of Richmond, Surrey, exhibit beautiful specimens of their method of working the gelatino-bromide process for enlargements, as described at some length in No. 876, p. 417. Mr. A. A. Common, of Ealing, W., exhibits a series of astronomical photographs, including the celebrated one of the great nebula in Orion, which is shown enlarged three times, and also seven times, from the original taken with his great 3ft. silver-on-glass reflector and 37 minutes' exposure. He shows also a collection of untouched negatives of various celestial objects, and a fine photo of the moon enlarged nine times. The smaller photograph of the Orion nebula is a very fine production, and is decidedly superior to that obtained by the late Prof. H. Draper. The latter, however, had to allow an exposure of over 100 minutes, and the large stars were consequently much over-exposed. Mr. Common, too, has a larger instrument, and an aperture which will make itself felt. No finer collection of astro-photographs is to be seen, though MM. Henry, of Paris, will, no doubt, soon make a considerable advance in this branch of the art. Mr. A. L. Henderson, of King William-street, E.C., exhibits fine specimens of ceramic enamels, and his machine for coating plates with emulsion. That is not shown complete, owing to want of space, but sufficient is there to give a good idea of its construction and method of working; and Mr. Henderson also exhibits his emulsion filter, washer, &c., which will enable those interested to compare his devices with other exhibits having similar objects. Mr. W. Middlemiss, of Thornton-road, Bradford, has several ingenious devices in the shape of light portable folding cameras, having long focus, reversing back, double swing back, and all requisite movements; but in this

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[*] *Proceedings* Roy. Society.

[*] The cause of this diffused light was subsequently discovered and removed.

[†] On the 19th Feb., 1868, the committee assembled in Dublin had the advantage of Mr. Lassell's presence in the examination of Uranus with speculum (A). The very speculum afterwards so miserably deficient in Australia.

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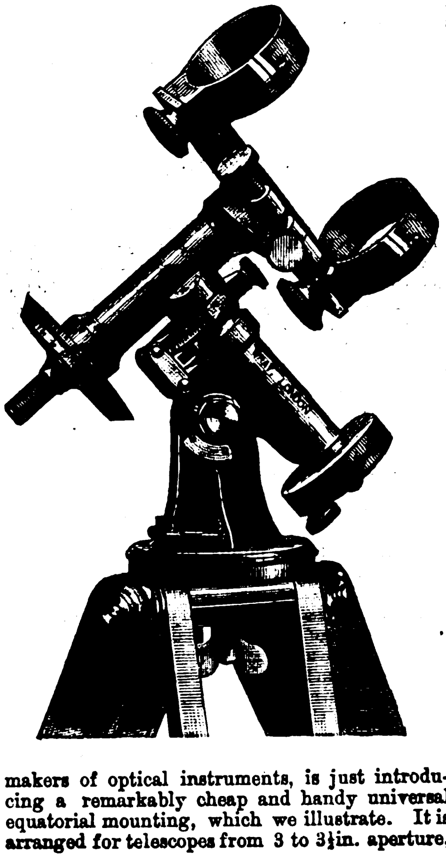
connection it may be as well to say that there is no lack of apparatus, and that it is impossible without diagrams to explain the differences between the various exhibits. It must be sufficient to state that such well-known makers as G. Hare, Calthorpe-street, W.C.; Rouch and Co., of the Strand; Swift and Son, Tottenham-court-road, W.; F. W. Hart, Kingsland-green, E, and some others, show a varied collection of cameras. Mr. Collins, Cochrane-street, N.W., amongst his photographic apparatus, exhibits a dark tent which complete weighs only 12lb. Sands and Hunter, of Cranbourn-street, W., besides cameras and shutters, exhibit a photographic gun for taking "snap shots" at moving objects (see p. 129, Vol. XL.), and a "beginner's set" of apparatus neatly arranged in a box, with a set of printing appliances similarly packed. Mr. W. Ouin, of Laurel Cottages, Tottenham, exhibits a simple drop shutter, which seems capable of withstanding much rough treatment. The model exhibited is made of mahogany, with the "drop" of ebonite, a pin with chain attachment being provided to hold the shutter up when focussing. If greater speed is required than can be obtained with the simple "drop," an elastic band can be easily fitted to pull the shutter down. Mr. Monsell, of Leeson Park, Dublin, exhibits a circular drop shutter of quadrantal shape, with a slide to regulate the amount of opening; and Messrs. Reynolds and Branson, of Leeds, show a flap shutter with a little counterpoise weight so that a slow, medium, or rapid movement can be obtained at pleasure. The London Stereoscopic Company, Cheapside, have a fine exhibit of photographs, many of them taken by amateurs, and they also display their apparatus specially adapted for amateurs. Messrs. Green and Fuidge, of Stratford-on-Avon, exhibit their patent actinometer, which is in the shape and about the size of a watch, with seven gradations of tint. The paper to be tested is placed in the instrument, and is acted upon through a perforated space in the dial. The tint produced in any observed time is thus readily compared with the seven permanent tints on the dial, and the exposure necessary for the given quality of paper and the character of the light is recorded in a note-book. The brightest light will only print the seven tints in one minute, and a light printing less than one tint in the same time is too weak for photographic work; so that the scale of seven comparison tints is capable of meeting all requirements. The actinometer is provided with a dark box, in which discs of sensitive paper can be kept ready for use. Mr. T. Furnell exhibits an adjustable instantaneous shutter attached to a camera, having the multiplex back, which we illustrated in No. 961, and is presumably, therefore, shown by Messrs. H. and E. J. Dale, of Ludgate-hill, E.C. Mr. B. J. Sayce, of Liverpool, exhibits a number of specimens made by the collodio-bromide process, in the perfecting of which he played so prominent a part. Mr. Samuels, of Hadley, Barnet, shows his improvements in cameras, by means of which double swing backs and sliding fronts are dispensed with. These consist of a taper bellows camera, with the lens-front supported by an adjustable staging of brass. There is no baseboard, and the tapered bellows enables any practical position to be obtained. Woodbury, Treadaway, and Co., of Great Saffron-hill, E.C., exhibit the Woodbury stannotype process, which we described on p. 511, No. 880. It consists in pressing a sheet of tinfoil into intimate contact with a gelatine printing surface, prepared by the well-known process, and using the tin face as the recipient of ink. Presses and plates are exhibited. Close by, the Woodbury Permanent Photographic Printing Company, of Ealing, W., exhibit the original Woodbury-type and carbon printing processes, with specimens of plates and presses; and at the adjoining stand the Platinotype Company give practical demonstrations of their process at stated hours. Some of the work exhibited is very fine, and, as our readers know, the process is simple and rapid, while the pictures produced are absolutely permanent, for they are composed of metallic platinum, a substance which, so far as is known, is perfectly unalterable. The Paget Prize Plate Company exhibit pictures produced by their gelatino-bromide plates, including those remarkable views of yachts in motion, by G. West and Son, of Gosport, which created some excitement when first shown. Mr. M. Auty, of Newcastle-on-Tyne, also exhibits two photos of lightning flashes, taken with these plates. Mr. J. W. Swan, Bromley, Kent, exhibits specimens of carbon printing, or autotype, with models and examples; illustrations of photo-mezzotint, "also known as Woodbury-type," photogravure, photo block-printing, the collodio-citro-chloride process, and gelatino-bromide process. Mr. Arnold Spiller, Canonbury, N., shows the products of sundry experiments with gelatino-chloride of silver transparencies, developed with hydroxylamine and various alkalies. At Mr. Hart's stand, mentioned above, a machine for using the magnesium light is shown, accompanied by a portrait of the late G. W. Simpson, the first taken by the magnesium light at a public meeting (1864). Marion and Co., of Soho-square, have a fine collection of apparatus, but make a specialty of their "sets for amateurs," which are sold at prices as low as 30s. for a real working apparatus. Their miniature camera in metal, about the size of one's thumb, which gives sharp little pictures 1¼in. square, is more than a curiosity, for the pictures obtained by it can be enlarged to cabinet size in a few minutes by the use of their Alpha paper. A fine specimen of Marion's blue process, so useful in the reproduction of working drawings, is sure to attract attention. Mr. Bernstein, of Finborough-road, S.W., exhibits specimens of photopeinture, a new method of reproducing oil paintings to the original or any size, which should be compared with the exhibits of what is called Anglo-French Photo-nature and Heliochromy, No. 2,725, hung on the N. wall of the East Central Gallery, in a line with the music room. No name or address is appended to this exhibit, though it is stated that they are photographs coloured without touching-up. There are many other pictures in the photographic group which deserve high praise, notably those exhibited by Mr. J. P. Mayall, Park-lane Studio, W., including the enlargements from his series of "artists at home"; but we have not space to do more than mention the fact, although we must direct attention to Mr. Foxlee's exhibit, in which he shows, by a series of examples, what he terms the "continuating" action of light in carbon prints, proving that the action is dependent upon moisture in the tissue, and is accelerated by heat.

## WRAY'S NEW UNIVERSAL EQUATORIAL MOUNTING.

MR. W. WRAY, of North-hill, Highgate, whose name is familiar to all readers as that of one of our most reliable and intelligent makers of optical instruments, is just introducing a remarkably cheap and handy universal equatorial mounting, which we illustrate. It is arranged for telescopes from 3 to 3½in. aperture, adjustable to different latitudes from 0 to 70°. The declination circle is 4½in. diameter divided on brass, with vernier reading to 2 minutes of arc, adjustable hour circle 3½in. diameter, divided on brass, with two sets of divisions and verniers reading to 30 seconds of time. Tangent screw motion in right ascension and slow motion in declination; levels and all necessary means of adjustment; brass clasps for holding telescope and strong oak tripod stand with stretcher. The equatorial mounting, packed in pine case complete, as shown, is sold for £18 10s.



## ASTRONOMICAL NOTES FOR AUGUST, 1885.

### The Sun.

| Day of Month. | Souths. | At Greenwich Mean Noon. | | |
|---|---|---|---|---|
| | | Right Ascension. | Declination North. | Sidereal Time. |
| | h. m. s. p.m. | h. m. s. | ° ′ ″ | h. m. s. |
| 1 | 0 6 2·27 ,, | 8 47 4 | 17 55 46 | 8 41 1·9 |
| 6 | 0 5 36·12 ,, | 9 6 21 | 16 36 4 | 9 0 44·71 |
| 11 | 0 4 55·65 ,, | 9 25 23 | 15 9 39 | 9 20 27·49 |
| 16 | 0 4 1·04 ,, | 9 44 11 | 13 37 11 | 9 40 10·26 |
| 21 | 0 2 53·20 ,, | 10 2 46 | 11 59 19 | 9 59 53·02 |
| 26 | 0 1 33·67 ,, | 10 21 9 | 10 16 44 | 10 19 35·79 |
| 31 | 0 0 4·56 ,, | 10 39 23 | 8 30 3 | 10 39 18·55 |

The method of finding the Sidereal Time at Local Mean Noon at any other Station will be found on p. 355 of Vol. XL.

The signs of renewed great Solar Activity, which became so notable a month or two ago, have by no means subsided, and the student should lose no opportunity of examining the Sun's disc.

### The Moon

Enters her Last Quarter at 9h. 55·3m. in the evening of August 3rd, and is New 14 minutes after Noon on the 10th. She will enter her First Quarter at 1h. 46·8m. p.m. on the 17th, and be Full at 5h. 25·2m. in the afternoon of the 25th.

| Day of Month. | Moon's Age at Noon. | Souths. |
|---|---|---|
| | Days. | h. m. |
| 1 | 20·3 | 3 42·6 a.m. |
| 6 | 25·3 | 7 59·2 ,, |
| 11 | 1·0 | 0 57·4 p.m. |
| 16 | 6·0 | 5 10·0 ,, |
| 21 | 11·0 | 9 7·6 ,, |
| 26 | 16.0 | 12 56·1 ,, |
| 31 | 21·0 | 4 4·6 a.m. |

The Moon will be in conjunction with Saturn at 2 p.m. on the 7th; and with Mars an hour later; with Jupiter at 2 a.m. on the 12th; with Mercury afterwards at 9 a.m.; and with Venus at Noon—all on the same day.

### Mercury

Is an Evening Star during the entire month, attaining his greatest elongation east of the Sun (27° 21′) at 3 a.m. on the 6th. About this time he may be seen after sunset over the W. by N. part of the horizon. His angular diameter increases from 7″ on August 1st to 10·6″ by the 31st, and by the middle of the month his crescentic figure is very apparent in the telescope.

| Day of Month. | Right Ascension. | Declination North. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 10 31·1 | 8 31·3 | 1 49·8 p.m. |
| 6 | 10 49·3 | 5 43·1 | 1 48·3 ,, |
| 11 | 11 2·8 | 3 18·7 | 1 42·1 ,, |
| 16 | 11 10·6 | 1 31·8 | 1 30·1 ,, |
| 21 | 11 11·2 | 0 41·0 | 1 11·1 ,, |
| 26 | 11 3·6 | 1 6·4 | 0 43·9 ,, |
| 31 | 10 49·3 | 2 55·9 | 0 10·0 ,, |

Hence it will be seen that Mercury describes a somewhat pendulum-like path in Leo, starting from a point to the south east of ρ in that con-

**Occultations of (and a near approach to) Fixed Stars by the Moon.**

| Day of Month. | Name of Star. | Mag. | Disappearance. | Moon's Limb. | Angle from N. Point. | Angle from Vertex. | Reappearance. | Moon's Limb. | Angle from N. Point. | Angle from Vertex. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | h. m. | | ° | ° | h. m. | | ° | ° |
| 6 | B.A.C. 1526. | 6 | 3 32 a.m. | Bright | 169 | 129 | 3 56 a.m. | Dark | 214 | 174 |
| 20 | B.A.C. 6287. | 6 | 11 39 p.m. | Dark | 137 | 165 | 12 35 p.m. | Bright | 238 | 272 |
| 20 | B.A.C. 6292. | 6 | 12 8 ,, | Dark | 84 | 115 | ‡1 15 a.m. | Bright | 291 | 328 |
| 21 | ρ¹ Sagittarii | 4 | 12 35 ,, | Dark | 128 | 157 | *1 39 ,, | Bright | 256 | 291 |
| 26 | 67 Aquarii | 6 | 5 9 a.m. | Bright | 114 | 151 | ‡6 9 ,, | Dark | 286 | 325 |
| 27 | B.A.C. 8365 | 6½ | †8 48 p.m. | N.N.W. | 199 | 162 | | | | |

* Star setting. ‡ Stars have set. † A near approach.

stellation. He will be twice in conjunction with Jupiter during the month: first at 9 p.m. on the 4th, and again at 11 a.m. on the 27th. He will further be in conjunction with Venus at 5 p.m. on the 8th.

### Venus

Is an Evening Star too, and may be caught after sunset glittering above the horizon to the north of west at the beginning of August, and to the south of it towards the end of the month. In the telescope she presents the appearance of a small bright gibbous disc, increasing in diameter from 11″ on the 1st to 12·2″ by the end of the month.

| Day of Month. | Right Ascension. | Declination | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 10 23·1 | 11 41·3 N. | 1 41·8 p.m. |
| 6 | 10 46·0 | 9 21·5 ,, | 1 45·0 ,, |
| 11 | 11 8·6 | 6 55·7 ,, | 1 47·8 ,, |
| 16 | 11 30·8 | 4 25·4 ,, | 1 50·3 ,, |
| 21 | 11 52·9 | 1 52·0 ,, | 1 52·7 ,, |
| 26 | 12 14·8 | 0 43·0 S. | 1 54·9 ,, |
| 31 | 12 36·7 | 3 18·1 ,, | 1 57·0 ,, |

The path indicated by the above ephemeris commences at a point north-west of ρ Leonis, extends through the remaining more easterly part of that constellation, and terminates between 2° to 3° to the south of γ Virginis. Venus will be in conjunction with Jupiter at 7 a.m. on the 6th; with Mercury (as stated above) at 5 p.m. on the 8th; and with Uranus at 2 p.m. on the 24th.

### The Night Sky

Is, for the purposes of the observer, a perfect blank,

### Mars, Jupiter, Saturn, Uranus, and Neptune

being all so placed as to be inacessible for observation with the telescope.

### Shooting Stars.

On the nights from the 9th to the 11th inclusive, watch should be kept for that most familiar of all showers of Shooting Stars—the "Torches" of Classical Thessaly, the "St. Lawrence's Tears," of the old Irish Catholics, and the Perseids travelling in the orbit of Comet II. 1862, of the modern meteoric astronomer. These August Meteors are notable for the trails they leave in the sky.

### Greenwich Mean Time of Southing of Nine of the Principal Fixed Stars on the Night of August 1st, 1885.

| Star. | Souths. h. | m. | s. | |
|---|---|---|---|---|
| α Ophiuchi | 8 | 47 | 9·76 | p.m. |
| γ Draconis | 9 | 11 | 26·03 | ,, |
| Vega | 9 | 50 | 26·47 | ,, |
| ζ Aquilæ | 10 | 17 | 26·95 | ,, |
| Altair | 11 | 2 | 22·66 | ,, |
| α² Capricorni | 11 | 28 | 48·55 | ,, |
| α Cygni | 11 | 54 | 34·77 | ,, |
| α Cephei | 12 | 32 | 48·89 | ,, |
| β Aquarii | 12 | 42 | 26·20 | ,, |

The method of finding the Greenwich Mean Time of Southing of either of the Stars in the above list for any other night in August, as also that of determining the local instant of its Transit at any other Station, will be found on p. 356 of Vol. XL.

## CUSWORTH'S PANORAMIC TRIPOD.

AN ingenious method of mounting a camera on a tripod has been recently brought out by Mr. C. Cusworth, of Ellington-street, N., who will shortly exhibit it on his stand at the Inventions. Tourists and those amateur photographers who desire to obtain panoramic views and quick shots at moving objects will readily appreciate the advantage of an arrangement which enables them to direct the lens in any direction without shifting the legs of the tripod. Mr. Cusworth's improved tripod consists of a wooden triangle, of any usual pattern, carrying a slightly raised disc, to which the camera is affixed by a thumb-screw. By means of a rack and pinion this disc can be rotated in either direction, so as to take in any portion of the field; the horizon may, in fact, be "swept" without disturbing the legs of the tripod. The arrangement will be appreciated at all times, but in cases where it is desired to take moving objects it will be especially valuable, as a portion of a turn of the milled head screw will at once bring an object into the field which has had time to escape from the grasp of the lens in the interval between focussing and inserting the dark slide. In many cases, too, it is not always possible to find a variety of suitable resting-places for the tripod legs; with Mr. Cusworth's arrangement, once they are firmly adjusted, the camera itself can be shifted to take in any portion of the view. As the screw which attaches the camera to the tripod is carried with the former, there is no risk of leaving it behind and finding it missing when it is most required.

## LUMINOUS PAINT.

AS several processes for the manufacture of luminous paint have been patented within recent years, both in this country and America, the following particulars may be useful to those who are looking for something better than the preparations now in the market. A phosphorescent mixture, or luminous paint, is an old discovery, but the means of applying it as a permanent paint were discovered by W. H. Balmain. Balmain's invention was patented in England in 1877, and in the United States in 1882. The invention consists in a luminous paint, the body of which is a phosphorescent compound, or is composed in part of such a compound, and the vehicle of which is such as is used as the vehicle in ordinary paint compounds—viz., one which becomes dry by evaporation or oxidation. The object or article to which such paint or varnish or wash is applied is itself rendered visible in the darkest place, and, more or less, capable of imparting light to other objects, so as to render them visible also. The phosphorescent substance found most suitable for the purpose is a compound obtained by simply heating together a mixture of lime and sulphur, or carbonate of lime and sulphur, or some of the various substances containing in themselves both lime and sulphur—such, for example, as alabaster, gypsum, and the like—with carbon or other agent to remove a portion of the oxygen contained in them, or by heating lime or carbonate of lime in a gas or vapour containing sulphur. The vehicle to be used for the luminous paint must be one which will dry by evaporation or oxidation, in order that the paint may not become soft or fluid by heat or be liable to be easily rubbed off by accident or use from the articles to which it has been applied. It may be any of the vehicles commonly used in oil-painting or any of those commonly used in what is known as "distemper" painting or whitewashing, according to the place or purpose in or for which the paint is to be used.

It is found that the best results are obtained by mixing the phosphorescent substance with a colourless varnish made with mastic or other resinous body and turpentine or spirit, making the paint as thick as convenient to apply with a brush, and with as much turpentine or spirit as can be added without impairing the required thickness. Good results may, however, be obtained with drying oils, spirit varnishes, gums, pastes, sizes, and gelatine solutions of every description, the choice being varied to meet the object in view or the nature of the article in hand. The mode of applying the paint, varnish, or wash will also depend upon the circumstances of the case. For example, it may be applied by a brush, as in ordinary painting, or by dipping or steeping the article in the paint, varnish, or wash; or a block or type may be used to advantage, as in calico-printing and the like. For outdoor work, or wherever the surface illuminated is exposed to the vicissitudes of weather or to injury from mechanical contingencies, it is desirable to cover it with glass, or, if the article will admit of it, to glaze it over with a flux, as in enamelling, or as in ordinary pottery, and this may be accomplished without injury to the effect, even when the flux or glaze requires a red heat for fusion.

In order to produce and maintain the phosphorescent light, full sunshine is not necessary, but, on the contrary, is undesirable. The illumination is best started by leaving the article or surface exposed for a short time to ordinary daylight or even artificial light, which need not be strong in order to make the illumination continue for many hours, even twenty hours, without the necessity of renewed exposure.

A. Krause, of Buffalo, N.Y., obtained a patent for improvement in phosphorescent substance dated December 30th, 1879. The patentee says: This invention relates to a substance which, by exposure to direct or indirect sunlight, or to artificial light, is so affected or brought into such a peculiar condition that it will emit rays of light or become luminous in the dark. It is a well-known fact that various bodies and compositions of matter, more especially compositions containing sulphur in combination with earthy salts, possess the property of emitting rays of light in the dark after having been exposed to sunlight. All of these bodies and compositions of matter are, however, not well adapted for practical purposes, because the light emitted by them is either too feeble to be of any practicable utility, or because the luminous condition is not of sufficient duration, or because the substances are decomposed by exposure to the atmosphere. Among the materials which have been employed with the best results for producing these luminous compositions are seashells, especially oyster shells. I have found by practical experiments that only the inner surface of these shells is of considerable value in the production of luminous compositions, while the body of the shell, although substantially of the same chemical composition, does not, to any appreciable extent, aid in producing the desired result. It follows from this observation that the smallest shells, which contain the largest surface as compared with their cubic contents, will be best adapted for this purpose. I have found that chalk, which is composed of the shells of microscopic animals, possesses the desired property in the highest degree; and my invention consists, therefore, of a luminous substance composed of such chalk, sulphur, and bismuth as will be hereinafter fully set forth.

In preparing my improved composition, I take cleaned or precipitated chalk, and subject it to the process of calcination in a suitable crucible over a clear coal or charcoal fire for three or four hours, or thereabouts. I then add to the calcined chalk about one-third of its weight of sulphur, and heat the mixture for from 45 to 90 minutes, or thereabouts. A small quantity of bismuth, in the proportion of about 1 per cent. or less of the mixture, is added together with the sulphur. The metal may be introduced in the metallic form in the shape of fillings, or in the form of a carbonate, sulphuret, sulphate, or sulphide or oxide, as may be most convenient. The substance produced in this manner possesses the property of emitting light in the dark in a very high degree. An exposure to light of a very short durtion, sometimes but for a moment, will cause the substance to become luminous and to remain in this luminous condition, under favourable circumstances, for upwards of twenty-four hours. The intensity of the light emitted by this composition after exposure is considerable, and largely greater than the light produced by any of the substances heretofore known. The substance may be ground with oil and used like ordinary paint; or it may be ground with any suitable varnish or be mixed in the manner of water colours; or it may be employed in any other suitable and well-known manner in which paints are employed.

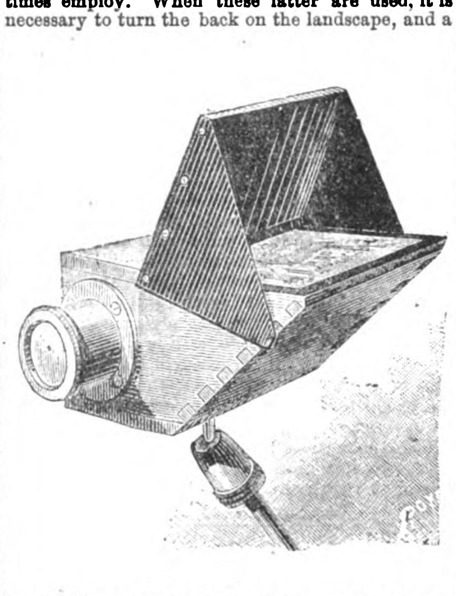
Merrill B. Sherwood, jun., of Buffalo, N.Y., obtained a patent for a phosphorescent composition, dated August 9, 1881. The author says: My invention relates to an improvement in phosphorescent illuminants. I have taken advantage of the peculiar property which obtains in many bodies of absorbing light during the day and emitting it during the night time. The object of my invention is the preparation by a prescribed formula of a composition embodying one of the well-known phosphorescent substances above referred to, which will be applicable to many practical uses. With this end in view my invention consists in a phosphorescent composition in which the chief illuminating element is monosulphide of calcium. The composition obtained by the formula may be used either in a powdered condition by dusting it over articles previously coated, in whole or in part, with an adhesive substance, or it may be intimately mixed with paints, inks, or varnishes, serving as vehicles for its application, and in this way be applied to bodies to render them luminous. The formula for obtaining the composition is as follows: To one hundred parts of unslaked lime (that obtained from calcined oyster shells producing the best results) add five parts of carbonate of magnesia and five parts of ground silex. Introduce these elements into a graphite or fireclay crucible containing forty parts of sulphur and twenty-five parts of charcoal, raise the whole mass nearly or quite to a white heat, remove from the fire, allow it to cool slowly, and, when it is cold or sufficiently lowered in temperature to be conveniently handled, remove it from the crucible and grind it. The method of reducing the composition will depend upon the mode of its use. If it is to be applied as a loose powder by the dusting process, it should be simply ground dry; but if it is to be mixed with paint or other similar substance, it should be ground with linseed or other suitable oil. In heating the elements aforesaid, certain chemical combinations will have to take place, and monosulphide of calcium, combined with carbonate of lime, magnesia, and silex, will be the result of such ignition. If, in the firing of the elements, as above set forth, all of the charcoal does not unite with the other elements, such uncombined portion should be removed from the fused mass before it is ground. If it is designed to mix the composition with paints, those composed of zinc-white and baryta should be chosen in preference to those composed of white lead and coloured by vegetable matter, as chemical action will take place between the composition and paint last mentioned, and its colour will be destroyed or changed by the gradual action of the sulphureted hydrogen produced. However, by the addition of a weak solution of gum in alcohol or other suitable sizing to the composition, it may be used with paints containing elements sensitive to sulphureted hydrogen without danger of decomposing them and destroying their colour.

In many and possibly in a majority of cases the illuminating composition applied as a dry powder will give the most satisfactory results, in view of the tendency to chemical action between the paint and composition when intimately mixed; in view of the fact that by the addition to paint of any colour of a sufficient quantity of the composition to render the product luminous, the original colour of the paint will be modified or destroyed; and also, in view of the fact that the illuminating composition is so greatly in excess of the paint, the proportions in which they are united being substantially ten parts of the former to one of the latter, it will be difficult to impart a particular colour to the product of the union without detracting from its luminosity. On the other hand, the union of dry powder with a body already painted by the simple force of adhesion does not establish a sufficiently intimate relation between it and the paint to cause chemical action, the application of a light coat of powder does not materially change the colour of the article to which it is applied; and, further, by the use of the powder in an uncombined state its greatest illuminating effects are obtained. Again, if the appearance in the daytime of the article which it is desired to have appear luminous at night is not material, it may be left unpainted and simply sized to retain the powder.

Orlando Thowless, of Newark, N.J., obtained a patent for a process of manufacturing phosphorescent substances, dated November 8, 1881. The inventor says: The object of my invention is to manufacture phosphorescent materials of intense luminosity at low cost and little loss of materials. I first take clam shells, and after cleaning place them in a solution composed of about one part of commercial nitric acid and three parts of water, in which the shells are allowed to remain about twenty minutes. The shells are then to be well rinsed in water, placed in a crucible, and heated to a red heat for about four hours. They are then removed and placed, while still red-hot, in a saturated solution of sea-salt, from which they are immediately removed and dried. After this treatment and exposure to light the shells will have a blood-red luminous appearance in the dark. The shells thus prepared are used with sulphur and the phosphide and sulphide of calcium to produce a phosphorescent composition, as follows:—One hundred parts, by weight, of the shells, prepared as above, are intimately mixed with twenty parts, by weight, of sulphur. This mixture is placed in a crucible, or retort, and heated to a white heat for four or five hours, when it is to be removed, and forty parts more of sulphur, one and one-half parts of calcium phosphide, and one-half part of chemically pure sulphide of calcium added. The mixture is then heated for about ninety minutes to an extreme white heat. When cold, and after exposure to light, this mixture will become luminous. Instead of these two ignitions, the same object may be in a measure accomplished by the addition of the full amount of sulphur with the phosphide and sulphide of calcium and raising it to a white heat but once. The calcium phosphide is prepared by igniting phosphorus in connection with newly-slaked lime made chemically pure by calcination. The condition of the shells when the sulphur is added is not material; but the heat renders them porous and without moisture, so that they will absorb the salt to as great an extent as possible. Where calcined shells are mixed with solid salt, the absorbing power of the shells is greatly diminished by the necessary exposure, and there will be a lack of uniformity in the saturation. On the contrary, by plunging the red-hot shells in the saline solution the greatest uniformity is attained.

## THE MONITOGRAPH.

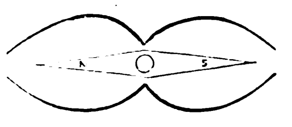
THE apparatus shown in the accompanying cut is a small improved camera obscura, which may be advantageously used as a substitute for the black convex mirrors that landscape painters sometimes employ. When these latter are used, it is necessary to turn the back on the landscape, and a reversed image is obtained. Again, as the glass is black, so as to prevent double refraction, the scale of tones is not accurate, and furnishes very disadvantageous data to the painter.



With the *monitograph*, which the artist may affix to the easel that supports his picture, we get a reduced image, but one that is very accurate in all its details. The apparatus is placed to the right of the artist, who thus has before his eyes the scene that he wishes to represent, while at the same time the reduced image is not reversed on the ground glass. The luminous intensity of the image is equal, and the tones are true to nature and may be reproduced upon the canvas. The apparatus is very light (weighing but 8oz.), and is therefore easily carried. It is mounted upon a rod that has a rotary motion, and that terminates beneath in a foot that may be fixed by screws to one of the legs of the easel. The image forms upon a sheet of ground glass, over which projects a black screen. This latter, which pivots upon on axis, shuts down upon the ground glass when the apparatus is prepared for carriage, and thus reduces the bulk of the whole and prevents the glass from being broken. The image obtained is very small, since it is formed upon a square surface whose sides scarcely exceed 2in.; but, as small as it is, it is very sharp and very luminous, and suffices to give the masses in general, and even the smallest details. The apparatus contains two total reflection prisms, one of which has its principal apex directed upward, and the other one its principal apex directed horizontally. The first reflects the image given by the lenses of the objective horizontally, and the second reflects it vertically to the ground glass. We have experimented with this apparatus, says *La Nature*, and found it to give good results. We noticed that there was no spherical aberration in it, and no refrangibility. We believe that it is capable of rendering genuine service to landscape painters and to staff officers who desire to obtain the general contour of a piece of ground. The apparatus is the invention of M. Marius Mallen, and is constructed by the well-known optician, M. F. L. Chevalier, of Paris.

## GAIFFE'S NEW MEDICAL GALVANOMETER.

IN this apparatus, which contains but one needle, and has no directing magnet, proportionability between the intensities and deflections is obtained by means of a special form given to the frame upon which the wire is wound. We give herewith a figure of the curve that Mr. Gaiffe has fixed upon after numerous experiments.



Upon examination it will be seen that the needle approaches the current in measure as the directing action of the earth increases; and experiment proves that the two actions counterbalance each other, and render the deflections very sensibly proportional to the intensities up to an angle of from 65 to 75 degrees. Another important fact has likewise been ascertained, and that is that, under such circumstances, the magnetic intensity of the needle may change without the indications ceasing to have the same exactness up to 65 degrees. As is well known, Mr. Desains has demonstrated that this occurs likewise in sinus or tangent galvanometers; but these have helices that are very large in proportion to the needle. In medical galvanometers the proportions are no longer the same, and the needle is always very near the directing helix. If this latter is square, or even elliptical, it is found that, beyond an angle of 15 degrees, there are differences of four or five degrees in the indications given with the same intensity of current by the same needle, according to the latter's intensity of magnetism. This inconvenience is quite grave, for it often happens that a needle changes magnetic intensity, either under the influence of too strong currents sent into the apparatus, or of other magnets in its vicinity, or as a consequence of the bad quality of the steel, &c. It was, therefore, urgently required that this should be remedied, and from this point of view the new mode of winding the wire is an important improvement introduced into medical galvanometers.—*La Lumière Electrique.*

## COLOURED GLASS AND ARTIFICIAL GEMS.

THE metallic oxides when mixed with any of the glasses dissolve in them with ease at a melting heat, and always change the colour more or less, sometimes producing very beautiful compounds, which, when well prepared, have a lustre and richness of colour strongly resembling the natural gems, though in an inferior degree. The business of making these coloured glasses and artificial gems is carried on to a very great extent in the manufacture of a variety of articles, and, though some of the management remains a secret in the hands of the artists, a good deal of valuable matter has been made public by the labours of Neri, Kunckel, Margraaf, Fontanieu, and many other practical chemists. It is very easy for any person at all used to chemical experiments to repeat most of these in the small way, with sufficient success to satisfy himself of the leading facts, though for the purpose of manufacture more care in the choice and preparation of the materials and a greater length of time in the melting part is required than most experimenters choose to bestow. It may be premised too that the art of making coloured enamels is essentially the same as that of coloured glasses, the chief difference being that in the former case the ground or vitreous substance that receives the colour is an opaque enamel glass, and in the latter a clear transparent glass. The colouring power of the metallic oxides is also in many instances much affected by the degree of heat to which they are exposed, and to the other ingredients with which they are mixed, and hence arise a good many precautions and niceties of management, many of which are only known to the practical artist. There seems good reason to suppose that much of this difference depends on the degree of oxygenation in which the colouring oxide is left after the action of fire, or of the other ingredients. The phenomena that occur in the use of manganese will hereafter be described, and something familiar happens in using the oxides of iron and silver. Sometimes a metallic oxide may be so nearly reduced to the reguline state as not to be perfectly soluble in the glass, but only suspended in it. This happens occasionally with the oxide of copper, which, when perfectly oxidised, gives a fine bluish-green, but when nearly in the metallic state produces a brown-red and not perfectly transparent glass. There is also a mutual action of the oxides upon each other, so that the glasses in which oxide of lead enters will not receive a red colour by iron, an effect which is produced with the merely alkaline glasses. Much remains to be done on this very curious and entertaining subject of the colouring power of metallic oxides, and it is only by a well-conducted scientific series of experiments that the perplexing intricacy of many of the receipts of the articles on this subject can be reduced to certain rules.

In making coloured glasses to resemble artificial gems, the glass which is to receive the colour (which is often called crystal) ought to unite the qualities of great purity, lustre, and hardness, together with a sufficient fusibility to melt at a moderate heat those oxides that are in danger of being decomposed by a high temperature. A vast variety of receipts have been given for such a glass, and it appears that several sorts are actually in use according to the price and object of the manufactured article. The glasses that possess the greatest lustre, and are at the same time easily fusible, are unquestionably those in which the oxide of lead enters very largely, and it appears that many of them are little else than oxide of lead vitrified with a much smaller proportion of silex than is used even in flint glass, or any other species. To these borax is an important addition, and often arsenic and other fluxes are added. But it unfortunately happens that the lead glasses are at the same time the softest, and scratch with the greatest ease. Hence it is the perfection of this art to find a compound, or manage any of the known compounds, in such a manner as to unite both lustre and hardness; in the former, the natural gems (the diamond excepted) may be very nearly equalled, but not in the latter.

Many of the oldest artists have had the idea that a harder glass would be obtained by making rock crystal the silicious basis than sand, flint, or any other stone of this genus. But this seems totally unfounded, for when once dissolved in a flux of any kind, the hardness of rock crystal is irrevocably lost, as it is not an inherent property of this particular species any otherwise than as depending upon its natural aggregation, which of course is destroyed. Perhaps it may be somewhat purer than the finest sand, or than powdered gun-flints, since these (the latter, at least, certainly) contain a very minute portion of iron, which possibly, though not very probably, may a little affect the very finest colours. It is rendered friable by being heated red hot and quenched in water the same way that gun-flints are. It should then be ground in a hard stone mortar, or in a mill, and not in any metallic mortar.

A few of these glasses may be here given from the directions of M. Fontanieu:—

No. 1. Mix 20 parts of litharge, 12 of silex, 4 of nitre, 4 of borax, and 2 of white arsenic, frit them in a crucible and afterwards melt, then pour the whole into water, separate any revived lead that may be found, and melt again.

No. 2. Mix 20 parts of cerusse, 8 of silex, 4 of carbonate of potash, and 2 of borax. When melted, pour into water, and re-melt in a clean crucible.

No. 3. Mix 16 parts of minium, 8 of rock crystal in powder, 4 of nitre, and 4 of carbonate of potash; melt and re-melt as before.

No. 4. Treat as above, 24 parts of borax, 8 parts of rock crystal, and 8 parts of carbonate of potash.

No. 5. Make a quantity of liquor of flints by fritting together 3 parts of alkali with 1 of rock crystal, which dissolve in water, and saturate with dilute nitric acid. Edulcorate and dry the silex, which precipitates, and which is then in a very fine impalpable powder. Then melt in a crucible with 1½ its weight of very fine cerusse, and pour the glass into water. Then break it down and melt it with one-twelfth its weight of borax, and pour into water as before. Lastly, melt this latter product with one-twelfth of nitre, and the result will be a very fine hard glass of extreme lustre.

Of the above glasses, No. 1, says the *Pottery and Glassware Reporter*, will be extremely soft and fusible, on account of the large proportion of flux, and it requires a very good crucible to withstand the corroding effect for a number of hours. The crucibles are found to stand better if they are first lined with any common glass without lead, for which purpose a little of the glass, No. 4, may be moistened with the water, rubbed over the inside of the crucible, slowly and thoroughly dried, and heated red hot before the mixture is added, which will give it a uniform glazing. Silex requires to make a perfect and sufficiently workable glass from 1½ to twice its weight of oxide of lead; and a glass of this kind with a smaller quantity of oxide of lead and a little other flux will be very hard and brilliant, and will imitate the diamond when properly set more that most other compositions.

The length of time required for fusion of the coloured glasses appears to be for the hard glasses or pastes at least twenty-four hours, but the softer mixtures are thoroughly complete in a few hours. In the glass, No. 4, the silex is first directed to be reduced to the state of the greatest purity, and the most impalpable powder, by previous fusion with an excess of alkali, and precipitation by an excess of acid. It is seldom, however, that such extreme nicety of preparation can be required, and probably finely powdered flints would answer as well, or even fine sand. The process of pouring the melted glass into water and remelting is used to mix the ingredients thoroughly, and is found by experience to have its use.

### Turquoise Blue Glass.

The *Sprechsaal* remarks that the manufacture of blue glass and glass fluxes by means of oxide of copper was known to the Egyptians in the oldest times, and was connected with the glazing of earthenware, &c. Specimens of this class of work are to be found in numerous museums, &c., the blue being, in most cases, turquoise blue, and the glaze is free from cracks, mostly in consequence of the body to which it was applied being of a suitable character. These glazes are not transparent, but slightly opaque. Among the discoveries of ancient Rhodian ceramic ware there are specimens of this glaze in conjunction with other colours.

It would seem that the art of making blue glass with the oxide of copper was never totally lost. Merett, Neri, and Kunckel give recipes for blue alabaster glasses from copper ash. According to the analysis of Borgstede, such a blue alabaster glass would be compared as follows:—

| | |
|---|---|
| Silicic acid | 82·95 |
| Alumina and oxide of iron | ·27 |
| Lime | ·08 |
| Potash | 16·08 |
| Oxide of copper | ·56 |
| | 99·84 |

This analysis would correspond with the following smelting composition:—

| | |
|---|---|
| Washed white quartz sand | 100· |
| Double purified potash | 29· |
| Black oxide of copper | 0 560 |

Chemically regarded, this substance is only silicate of potassium, which is super-saturated with silicic acid, and is coloured blue with some oxy-silicate of copper. This alabaster glass cannot be considered a real glass, for boiling in water would change it to a kind of soluble glass. Its external appearance is that of real glass, in which the separation of superfluous silicic acid (during cooling, after it had been previously completely dissolved in melting silicate of potassium) had brought about an opacity resembling that of alabaster.

Starting from the supposition that lead glasses are coloured green with oxide of copper, it is asserted that the potassium which (in some recipes) is introduced into the glass composition in the form of potash and saltpetre produces the blue colour. Silicate of potassium (for instance, potash and quartz sand melted together) will not make a real glass, but only a soluble glass, which is dissolved by boiling in water.

Besides silicate of potassium, silicate of sodium (made from soda) has the property of giving, with oxide of copper, blue or turquoise blue glass. It should not, however, be introduced under the quantitative conditions as silicate of potassium, as its chemical equivalent is smaller, and thus a composition with silicate is differently prepared from one with saltpetre. To render turquoise glass harder and more resisting, a further quantity of lime or silicate of lime must be added. Baryta can be used instead of lime, but it renders the glass more easily fusible. It is recommended to introduce baryta in the form of witherite (carbonate of baryta), which is relatively pure. The presence of iron in small quantities is no disadvantage. The action of magnesia is supposed to be the same as that of lime, but its small chemical equivalent should always be taken into consideration. The form of the oxide of copper (whether oxide of copper, copper ash, or carbonate of copper) is immaterial for the preparation of turquoise blue; it being understood that the various substances are free from impurity, and are employed in the right quantities. It is further remarked that with the increase of oxide of copper the intensity of the azure colouring in fluxes rich in alkali varies up to a certain low limit of percentage of the copper oxide. On the other hand, green again enters into the blue beyond this limit, and increases in proportion to the augmentation of the colouring substance.

## THE TRANSMUTATION OF ELEMENTS.

IN modern times it has always been held as one of the fundamental principles of chemistry that those bodies commonly called elements are unchangeable, and absolutely separate kinds of matter. The old alchemists, on the contrary, believed it quite possible to change one metal into another; and the greater part of their labours was devoted to finding some way of transmuting mercury into gold. Several, indeed, claimed that they had discovered the secret; but, like the inventor of the Keely motor, some little "adjustment" always remained to be perfected, which required a little of the precious metal obtained in the old-fashioned way of digging from the ground. Queen Elizabeth, when shown a piece of silver said to have been made from a piece of a brass warming pan, expressed her great interest in the discovery, but hinted that any one who could produce the precious metal so easily could have no possible need of aid from the royal treasury.

Were the old alchemists altogether in the wrong? or is there still some ground for the belief that the substances we call elements are really modifications of one primitive form of matter? It is not improbable that some of the elements are really compound bodies, and that by more thorough methods of analysis we may be able to discover their component parts. Take the element iron, for example. It forms two distinct series of chemical compounds—the ferrous and ferric, which differ from each other in their chemical reactions; and if they could not both be reduced to the same metallic iron we should be justified in considering them as compounds of two different elements. Many other metals show this same peculiarity. The allotropic forms of some elements have a bearing on this question. The diamond and charcoal are both forms of the same element, carbon. Both, when burned, form carbonic dioxide; but in every other respect they are totally distinct. Oxygen in the state of ozone is an entirely different body from the ordinary oxygen gas, but the chemist can find nothing but oxygen in either. If ozone and oxygen are only different forms of the same element, is it not possible that oxygen and chlorine, for instance, may be found to have a common origin? And if it could be shown that oxygen and chlorine could be changed into each other, why not mercury and gold, as the alchemists believed?

The recently discovered "periodic law" of the elements must not be forgotten in this connection. It is found that when the elements are arranged in the order of their atomic weights they form regular groups, closely related to each other in their chemical and physical characteristics. There are gaps in this series which will probably be filled by elements yet to be discovered. One such gap has already been filled by the element gallium, the properties of which were quite accurately predicted before its discovery, from the position of the vacant space of the series.

All these facts certainly show a connection of some kind between the elements; but what it is we do not yet know, and we must wait patiently for the results of future investigations. It must be remembered that as yet we have no actual proof whatever of the possibility of changing one element into another, or even of referring them all to one primary form of matter. We may treat iron or oxygen in any way we please, but as yet nothing but iron or oxygen has been produced from them; carbon is still nothing but carbon, whether in the form of coal, graphite, or diamond; and, although our more recent discoveries in chemistry and physics hint to us that perhaps the ideas of the mediæval scientists were not quite so absurd as they would have been considered fifty years ago, yet for the present we must retain the generally accepted ideas in regard to the individuality of the so-called elementary bodies.

There is a rich field in this direction for the scientific investigator. The tendency in all schools of chemistry at present seems to be towards the study of organic compounds, to the neglect of the equally important inorganic bodies. While the study of organic chemistry has certainly led to the most brilliant results, yet we can but feel that the field for discovery in inorganic chemistry is still as wide as in the days of Davy and Faraday, and will yield equally rich returns to the careful and patient investigator.—*Popular Science News.*

## A NEW STANDARD CELL.[*]

SINCE October last I have made some experiments on the zinc-alkali-copper oxide cell, with a view to determine the practicability of some modification of it. The fact that copper and iron, and perhaps some other metals, dissolve in potassium (or sodium) hydrate when used as cathodes suggested to me the possibility that the formation of the alkaline cuprate might occur at a definite and practically convenient difference of potential between the electrodes immersed in the alkaline bath. As a matter of fact, I find that a cell mounted with amalgamated zinc, potassic hydrate, and metallic copper gives, when charged until a blue colour appears, a deflection of 170 divisions on the scale of a Thomson galvanometer; the Daniell, mounted with saturated zinc sulphate and copper sulphate, giving 156 divisions. The zinc-alkali-copper cell is joined by a double key to charging cells and to the galvanometer, a resistance of over 9,000 ohms. being included in the circuit of the latter. The proper shunt is, of course, employed. This deflection of 170 divisions seems to be invariable, and the cell experimented upon promises to be a desirable practical standard of electromotive force. Its excellence appears to consist in the fact that the cuprate produced breaks up before it diffuses to the amalgamated zinc, depositing oxide of copper, which settles. The zinc is suspended about an inch above the copper—which is a spiral ribbon, exposing about two square feet of surface—and the resistance is less than an ohm. I have used a 10 per cent. solution of "depurated" potassic hydrate. After some trials it is found that the shifting of the cell from the charging source to the galvanometer circuit may be done leisurely, as the electromotive force does not seem to begin to fall off for some minutes. Further testing of the effect of changes of temperature, strength of solution, &c., is in progress. Thus far the temperature of the cell has been allowed to vary very little, not enough to affect the readings. I offer this preliminary note as of possible interest to your readers. This type of cell would be admirably adapted to furnish any desired multiple of its electromotive force.

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# ON THE COLOUR-CORRECTION OF ACHROMATIC TELESCOPES.

A Reply to Prof. Chas. S. Hastings, by Wm. Harkness.*

In the December number of this journal, pages 434 and 435, the distinguished Associate Professor of Physics of the Johns Hopkins University has criticised my theory of the colour-correction of achromatic telescopes in language which I quote here to avoid the possibility of misrepresenting it, merely adding numbers to the clauses for convenience of reference:—

"These results are directly opposed to those of a recent writer in this journal (Prof. Harkness, in the Sept. number, pp. 191-193); but his conclusions arise from erroneous calculations. (I.) Not only does his interpretation of his equation (12) imply the manifest absurdity that in a system of infinitely thin lenses in contact, its properties are determined by the order of the lenses, but the interpretation is impossible. True, $A_2$ should have an opposite sign to $A_1 + A_3$; but that asserts nothing as to likeness of the latter symbols in sign. (II.) Thus, $n$ in equation (16) may be negative, and, consequently, his subsequent reasoning is fallacious, for in that case $n$ does not have to be infinite to cause equation (27) to vanish. (III.) I may add that the origin of the confusion is in making the ratio $D \div E$ in equation (9) constant; it may be, and, of course, should be, indeterminate.

"(IV.) Prof. Harkness has made another mistake, founded upon inadequate experiment, which has so important a bearing on the theory of the double objective that it should not be allowed to pass uncorrected. His statement (p. 191) concerning the condition for colour-correction is substantially correct, though, in my opinion, it is not self-evident, but requires proof. This proof I shall supply in a forthcoming number of the *American Journal of Mathematics*. (V.) His experiment, however (p. 193), directly contravenes this principle, for he finds that the focal plane does not correspond to the minimum focal distance, but to something greater. (VI.) The source of error is the introduction of a variable element in the system—viz., the eye, which would adjust itself differently in observing the star and its spectrum. Had the writer used eyepieces of successively higher power, thus lessening progressively the power of accommodation of the system with his prism he would have seen his points $\gamma_m$ and $\gamma_n$ approach until they sensibly coincided; or better still, had he formed his spectrum by a grating (such as perforated cardboard) before the objective, instead of by a prism between the ocular and eye, he could not have been misled, since the uncoloured image would serve to control the eye."

"(VII.) Finally, the fourth conclusion (p. 196) is strictly true, though we are not to conclude, as would seem from the text, that the detriment due to secondary spectrum depends either solely upon the aperture, or varies conversely as the focal length. . . ."

Let us examine this criticism in detail, referring to its clauses, and to the equations of my original paper, by their respective numbers.

Clause I. virtually asserts that three quantities can be arranged in two classes otherwise than by putting one in one class, and two in the other. To prove this, we remark that equation (12) may be written

$$O = A_1 (b_1 + 2c_1 \gamma_0^2) + A_2 (b_2 + 2c_2 \gamma_0^2) + A_3 (b_3 + 2c_3 y_0^2) \ldots. (36)$$

For all glasses of which I have any knowledge, $b$ is positive and very much larger than $c$. This latter quantity is sometimes negative; but when this happens it is exceedingly small. $\gamma$ cannot be otherwise than positive. From these conditions it results that the quantities $(b + 2c \gamma_0^2)$ are invariably positive, and therefore the sign of each term in (36) depends solely upon the sign of its A. But in order that (36) may be true, one of its terms must have a different sign from the other two; and just because the properties of a system of infinitely thin lenses in contact are independent of the order of the lenses; the choice of this term is arbitrary. Taking advantage of this circumstance to follow the usual practice of opticians, I made the middle lens different from the other two, and wrote

$$-A_2 (b_2 + 2 c_2 \gamma_0^2) = A_1 (b_1 + 2 c_1 \gamma_0^2) + A_3 (b_3 + 2 c_3 \gamma_0^2) \ldots\ldots\ldots (37)$$

But Clause I. declares, "True, $A_2$ should have an opposite sign to $A_1 + A_3$; but that asserts nothing as to likeness of the latter symbols in sign." A statement which is manifestly untrue, unless it can be shown that three quantities can be arranged in two classes otherwise than by putting one in one class and two in the other.

Clause II. asserts that $n$, in equation (16), may be negative. This is absurd, because $n = A_3 \div A_1$, and it has just been shown that the signs of $A_1$ and $A_3$ are always similar.

Clause III. declares that $D \div E$ should be indeterminate; and that all my alleged errors arise from making it constant. Referring to equations (6) we see that—

$$\begin{aligned} D &= A_1 b_1 + A_2 b_2 + A_3 b_3 \\ E &= A_1 c_1 + A_2 c_2 + A_3 c_3 \end{aligned} \quad \ldots\ldots\ldots\ldots (6)$$

The A's depend only upon the curves of the lenses, while the $b$'s and $c$'s depend only upon the physical properties of the glasses employed. In designing an objective D and E are both so far arbitrary that any glasses and any curves may be chosen; but when the objective is completed, I certainly do hold that its curves and the physical properties of the pieces of glass composing it are constant. If I am right in this, it follows that both D and E, and also their ratio, are constant; Clause III. to the contrary, notwithstanding.

Clause IV. admits the accuracy of my statement that an objective is properly corrected for any given purpose when its minimum focal distance corresponds to rays of the wave-length which is most efficient for that purpose, but says the statement requires proof, and is not self-evident. With the law of dispersion assumed in equation (2), the focal curve can have but one tangent parallel to the axis of abscissas; and I did not suppose it necessary to tell the readers of this Journal that the parts of such a curve nearest the tangent line are those adjacent to the point of tangency. That consideration proves my proposition, and it is so elementary that I thought it self-evident. If more than two lenses and a dispersion formula involving more than two powers of the wave-length are assumed, I venture to say that the condition for coleur-correction stated above cannot be proved. It may be true in special cases; but in general the focal curve will have such a form as to give more than one minimum focal distance.

Clause V. involves the assumption that the focal plane must be tangent to the focal curve at the point where the latter makes its nearest approach to the objective. No reason is assigned for this, and I do not believe any exists.

Clause VI. virtually asserts that the focal distance of an objective is a function of the power of its ocular. For all astronomical instruments carrying filar micrometers, the first business of the observer is to place the wires accurately in the focus of the objective. This once done they are not again disturbed, unless to make some radical change in the instrument. A dozen eyepieces may be used in the course of a single evening; but no matter what their power, when they are focussed upon the wires they are always found to be focussed upon the objective. Hence the focal plane always coincides with the wires. But the plane of the wires is fixed, and the focal curve, as I have defined it, is also fixed. Consequently the points of intersection of the focal plane with the focal curve are fixed, and the universal experience of astronomers demonstrates that the positions of the points $\gamma m$ and $\gamma n$ do not vary with the form of the ocular.

As Clause VII. affirms the correctness of my fourth conclusion, it is only necessary to express my thanks for such an endorsement; but I cannot refrain from adding that since this clause rests upon equations condemned by my critic, there may be people wicked enough to inquire how these erroneous equations finally led to a correct result.

In this connection it is desirable to state that some months ago I investigated the relations existing in achromatic objectives between aperture, focal length, and secondary spectrum. As the admissible limits of the latter of these elements is arbitrary, it is not possible to fix absolutely the relations between the other two; but I believe the focal distance should rarely be less than that given by the formula—

$$F = (9{\cdot}04\, a^2 + 1296)^{\frac{1}{2}} - 36 \ldots\ldots\ldots\ldots\ldots\ldots (38)$$

in which F is the focal distance, in feet; and $a$ the clear aperture in inches. For small apertures the foci given by this expression are inconveniently short; while for large apertures they considerably exceed those in general use.

Now consider a system of infinitely thin lenses in contact, and let us inquire how many lenses are needed in the system to bring the greatest possible number of light rays of different degrees of refrangibility to a common focus with any given law of dispersion.

For this purpose we revert to equation (5), which may be written—

$$f^{-1} = (\mu_1 - 1) A + (\mu_2 - 1) A_2 + (\mu_3 - 1) A_3 + \&c. \ldots\ldots\ldots (39)$$

the number of terms being unlimited. For the dispersion formula we write—

$$\mu = \phi (\lambda)$$

The form of $\phi (\lambda)$ is regarded as unknown; but there will be no loss of generality if it is developed in a series arranged according to the powers of $\lambda$. We therefore have—

$$\mu = a + b \lambda^m + c \lambda^n + e \lambda^p + \&c. \ldots\ldots (41.)$$

in which $a$, $b$, $c$, &c., are constants, and the number of terms may be taken as great as is desired. Also, let us put—

$$\begin{aligned} C &= A_1 (a_1 - 1) + A_2 (a_2 - 1) + A_3 (a_3 - 1) + \&c. \\ D &= A_1\, b_1 + A_2\, b_2 + A_3\, b_3 + \&c. \\ E &= A_1\, c_1 + A_2\, c_2 + A_3\, c_3 + \&c. \\ F &= A_1\, e_1 + A_2\, e_2 + A_3\, e_3 + \&c. \end{aligned} \quad \ldots\ldots\ldots\ldots (42).$$

The number of these equations and the number of terms in the right-hand member of each of them being the same as the number of terms in the right-hand member of (41). Then by a simple transformation (39) becomes—

$$f^{-1} = C + D \lambda^m + E \lambda^n + F \lambda^p + \&c. \ldots (43.)$$

This is the equation of the focal curve; $\lambda$ being the abscissa and $f$ the ordinate. Its first derivative is—

$$\frac{d f}{d \lambda} = - f^2 (m D \lambda^{m-1} + n E \gamma^{n-1} + p F \lambda^{p-1} + \&c. \ldots\ldots (44.)$$

which, as is well known, expresses for every point of the curve the tangent of the angle made by the tangent line with the axis of abscissas. The number of rays of different degrees of refrangibility, which can be brought to a common focus will evidently be the same as the number of times the focal plane intersects the focal curve. But the focal plane is necessarily parallel to the axis of abscissas; and, therefore, the greatest possible number of intersections of the curve with the plane can only exceed by one the number of tangents which can be drawn parallel to the axis of abscissas. To find these tangents we equate (44) to zero, and obtain—

$$o = m D + n E \lambda^{n-m} + p P \lambda^{p-m} +, \&c. \ldots. (45)$$

As $\lambda$ can never be either zero, imaginary, or negative, we have to consider only the real positive roots of this equation, each of which corresponds to a tangent. To make the number of roots as great as possible, the quantities D, E, F, &c., must be independent of each other, which will be the case when the right-hand member of the equations (42) contains as many A's as there are powers of $\lambda$ in (41). Hence it is evident that the number of real positive roots in (45) will be one less than the number of powers of $\lambda$ in (41) and we conclude that—

In any system of infinitely thin lenses in contact, the number of lenses required to bring the greatest possible number of light rays of different degrees of refrangibility to a common focus is the same as the number of different powers of $\lambda$ involved in the dispersion formula employed.

The method used in deducing this result was adopted because it exhibits clearly the geometrical relations of the problem. The result itself is evident from a mere inspection of equation (43), which cannot possess more real positive roots that it has independent co-efficients—D, E, F, &c.

The colour-correction of an objective depends only upon the form of its focal curve; which form is as much under control as the nature of the case admits when the co-efficients, D, E, F, &c., of equation (43) are independent of each other. This, taken in connection with what precedes, demonstrates that—

In an objective consisting of a system of infinitely thin lenses in contact, the colour-correction cannot be improved by increasing the number of lenses beyond the number of different powers of $\lambda$ involved in the dispersion formula employed.

This result confirms the conclusion of my former paper, in which I used a dispersion formula involving but two powers of the wave-length, and consequently found but two lenses necessary in an achromatic objective. It also throws a curious light upon the general theory of achromaticity. If the law of dispersion had been such as could be expressed by a function involving but a single power of the wave-length, there would have been no irrationality of spectra, the mean dispersive powers might have been just what they now are, and yet, Newton would have been right in saying that achromatic telescopes were an impossibility. Conversely, the greater the number of powers of the wave-lengths involved in the dispersion function, the greater the number of rays of different degrees of refrangibility which can be brought to a common focus; and this, irrespective of any irrationality which may exist in the spectra. With rational spectra, and a law of dispersion involving at least two different powers of the wave-length, a pair of lenses would suffice for the construction of a perfectly achromatic objective. In strictness, these statements apply only to objectives consisting of infinitely thin lenses in contact. Possibly they may require modification when the thicknesses and distances apart of the lenses are considered.

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* From the *American Journal of Science*, Vol. XIX. No 110, February, 1880. See also Eng. Mechanic, present volume, page 447.

The textbooks teach that the condition of achromatism for two thin lenses in contact is

$$o = p_2 f_1 + p_1 f_2 \;\ldots\ldots\ldots\ldots\ldots \quad (46).$$

in which $f_1$ and $f_2$ are the foci, and $p_1$ and $p_2$ the dispersive powers of the lenses. They further teach that it is sufficiently accurate to put—

$$p = \frac{\delta \mu}{\mu - 1} \ldots\ldots\ldots\ldots (47)$$

in which $\delta \mu$ is the difference and $\mu$ the mean of the refractive indices for the rays D and F. For a law of dispersion involving at least two different powers of the wave-length, these equations will hold; but for a law involving only a single power of the wave-length they may be satisfied, and yet the system of lenses will not be achromatic. Instead of embodying, these equations are actually independent of the essential conditions of achromatism, which is that at least two rays of widely different wave-length must be brought to a common focus.

I have not had leisure to examine my critic's figures, nor does it seem worth while to do so. My equation (2) represents refractive indices with an accuracy of about four and a half places of decimals, while most of the authorities upon which he relies only give these quantities to five places of decimals. If this difference of five units in the fifth place of decimals can originate such changes in the focal curve as he supposes, it is evident that trustworthy conclusions can only be reached by using very accurate dispersion formulæ. Cauchy's formulæ, as written in equation (2), has hitherto been most used; but when compared with the best observations, the residuals, although small, show some constancy of sign. It has recently been claimed[*] that Briot's formula, which is

$$\mu = a + b\,\lambda^{-2} + c\,\lambda^{-4} + k\,\lambda^{2} \ldots\ldots\ldots (48)$$

represents the best observations throughout the whole space from the extreme ultra red to the extreme ultra violet within the limits of accidental error. If such is the case, a triple objective may be better than a double one; but my critic's figures certainly do not suffice to prove this. They are founded upon a formula whose independent variable is not the wave-length of the light, but the refractive index of a standard piece of glass; and his Table II., page 432, shows that, when compared with observation, this formula yields residuals exhibiting as much constancy of sign, and almost the same magnitude as those given by my equation (2). The use of any independent variable other than the wave-length is likely to produce erroneous results, and certainly does not tend to elucidate the subject.

Having seen that a dispersion formula involving only three powers of the wave-length suffices to represent the best observations, and remembering that this circumstance limits the number of lenses which can be employed with advantage in an objective to not more than three; we are now in a position to appreciate the absurdity of my critic's assertion, page 429, when inquiring if it is possible to eradicate the secondary spectrum by increasing the number of lenses in an objective, he says; "Theoretically, since a new disposable constant for colour change is introduced with each lens in the system, the answer is evidently affirmative; . . ."

For an objective consisting of more than two lenses and a law of dispersion involving more than two powers of the wave-length, the condition given in my former paper for the best colour-correction is no longer applicable. The problem then becomes very complex, but I am inclined to think that it is satisfactorily solved by attributing to each element of the focal curve a mass proportional to its efficiency, for the purpose of which the correction is required, and varying the curve until its moment of inertia about its intersection with the focal plane becomes a minimum. It is also probable that this condition will suffice to determine the relative merits of double and triple objectives; the focal curve with the smallest moment being the best.

Finally, it only remains to reiterate that the conclusions of my former paper are certainly correct to the degree of accuracy involved in my fundamental equations; that is, for a system of infinitely thin lenses in contact, and for the law of dispersion embodied in equation (2). For a different law of dispersion, or if the thicknesses and distances apart of the lenses are considered, these conclusions may require modification.

Washington, Dec. 29, 1879.

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[*] By M. MOUTON, in the *Comptes Rendus*, 1879, Vol. LXXXVIII. p. 1190.

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# THE NEW DOUBLE-COATED SENSITIVE PAPER.[*]

By LEON WARNERKE.

THE more photography becomes popular, so the more is felt the necessity of some good substitute for glass upon which to take a negative. It will be superfluous to assert that glass, being bulky, heavy, and brittle, is a very inconvenient material for outdoor work. A few more or less successful expedients have been proposed and tried for this purpose since collodion made glass the almost exclusive material for negatives. The question of a substitute for glass has received, however, more development since the introduction of the dry-plate process, and especially after that of collodion emulsion. I myself have been the originator of one of the systems, in which a collodion film, prepared on paper, was used as a temporary support. The introduction of gelatine emulsion for general use, with its great sensitiveneess and different physical properties of the vehicle employed, naturally necessitated a different method; and such was provided, either in the shape of a gelatine film pure and simple, or in the shape of a film temporarily attached to the paper, to be stripped off after development when dry, or in the shape of paper covered with emulsion, the image being developed and treated with hot water, as in my patent process. But the gelatine process has made the practice of photography very popular, and added a great contingent of new adepts. These use ready prepared glass plates, and get their pictures by a very simple process of development and subsequent fixing, and they naturally object to the smallest addition to the number of operations involved in the process of obtaining a negative on any substitute for glass. For such persons ordinary plain paper, covered with sensitive gelatine emulsion, answers the purpose, the number of the operations being the same as when glass plates are used. However, prints from such negatives show the grain of the paper, and the printing is very long.

My new sensitive negative paper, which I have patented, is designed to obviate these imperfections, and to render the quality of the print even superior to one obtained from a glass negative. I take the paper and cover it with gelatine emulsion on both sides. When exposing such double-coated paper in the camera, in the first instance, light will act on the front surface next to the lens, then, penetrating the paper, it will act also on the back surface. When this exposed sheet is immersed in the developer, two negatives, one on each side of the paper, will be produced.

But now let us suppose that the paper itself had some spots, both opaque and transparent; these will have no influence on the front image, but the back image will be influenced by the spots, and in the exact ratio of its opacity. In other words, all the imperfections of the paper will be corrected by the back image, rendering the composite negative perfectly smooth, no matter how coarse or imperfect was the texture of the paper employed.

I now pass round for examination a negative produced on this paper bearing some printed matter. The back image had corresponding transparent characters, and very distinct impression of the texture of the paper; but upon looking through the negative all appeared smooth, and such was also the print. Now it will be intelligible that a print from such a negative composed of the two will be also superior as regard roundness and pluck. If the paper used for the purpose be the ordinary photographic paper, Rive or Saxe, the objection to the slow printing remains in full force; but I use instead paper rendered so transparent by a special preparation, that a print from the negative I send round for examination did not occupy more time to print than one from a glass negative of the same density. This special paper offers other advantages. It does not curl when dipped into water, and even after very protracted washing it remains exceptionally strong, bearing an enormous amount of handling without cracking. It appears as if it was not affected by water at all; in fact, if you examine this wetted negative you will observe that to the touch it does not seem at all like paper, but rather like oilcloth or leather.

Now as to the details of using it: In single sheets it can be used in ordinary carriers, provided they are fitted with rebates instead of wire corners. Any rigid plate put behind will press it close to the rebates, holding it perfectly flat. One thing must be taken into consideration. At the back must be a dead black surface (velvet), otherwise, the paper being transparent, reflections from any light object behind will affect the back sensitive surface. However, the most legitimate use of the paper is in the roller slide. The new improved form I will now explain on this model (here Mr. Warnerke showed and explained the new form of his roller slide). The development of this paper is precisely like that of ordinary glass plates, preferably with ferrous oxalate, in order to avoid any pyrogallol stain. After fixing and washing it is advisable to pass the negative through an alum bath, to which has been added a few drops of sulphuric acid. Hydrochloric acid must not be used. This will bleach the paper if it has become discoloured with the iron oxide after long development. The finished negative can be dried on glass previously rubbed with talc, or simply by suspending it; but in this last case it will not be very flat when dry, and it is necessary to damp it again very slightly and to put it between sheets of blotting paper, and submit it to pressure between the pages of a book. After a very short pressing it will come out quite smooth, and will remain so, if kept dry.

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[*] A paper read before the Photographic Society of Great Britain.

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# USEFUL AND SCIENTIFIC NOTES.

**High Chimneys.**—The highest chimney in England is said to be that erected in 1839 at Mr. Muspratt's chemical works at Newton. It measures 397ft. 4in. During the same year an immense chimney was completed for the cotton factory of Messrs. Dixon, in Shaddongate, near Carlisle. It is one of the highest buildings in England, being 305ft. from the ground, of octangular form, of brick, with stone angles. The erection was carried on from the inside, stages being erected as the work proceeded, and the workmen and materials being taken up in boxes by a crab worked by four men. The largest structure of this kind in the world is the colossal chimney completed in 1861, by Mr. Duncan M'Farlane, C.E., architect, of Glasgow, for Messrs. Townsend's Chemical Works, Crawford-street, Port Dundas, Glasgow. This great chimney is indeed the loftiest building in the world, excepting the Great Pyramid of Gizeh, the spire of Strasburg Cathedral, and that of St. Stephen's, Vienna. It is circular in plan, and the following are the exact dimensions: Total height from foundation, 468ft.; height above ground, 454ft.; outside diameter at level of foundation, 50ft.; at level of ground, 32ft.; outside diameter at top, 14ft.; thickness at level of ground, seven bricks; thickness at top, 1½ brick. Before the erection of this chimney, that of Messrs. Tennant, Glasgow, was considered the highest known.

**Shrinking in Woollen Goods.**—A German technical journal states that woollen fabrics treated according to the following simple method will be found to be proof against shrinking, and will also retain their colour unchanged. The fabrics are first soaked for several hours in a warm, moderately concentrated solution of soda, to which about half a tumbler of ammonia water has been added, more or less, according to the quantity of material treated. At this stage the fabrics are washed out, after the addition of some water that is warm, then rinsed in fresh water. The same result may be reached by adding a tumbler of ammonia water to a small tub of water, soaking the stuffs for half an hour in this, and finally rinsing them in pure water.

**Spelling of Proper Names.**—The Council of the Royal Geographical Society have issued rules for the spelling of names of places, which are identical with those adopted for the Admiralty charts. The orthography of names in countries using Roman letters will not be affected; all others, only excepting a few familiar names, are to be spelt phonetically, as pronounced on the spot. The vowels are to be sounded as in Italian, the consonants as in English, *ch* being at all times soft and *g* hard, whilst *kh* and *gh* express gutturals. The rules fail to give letters to express the sound of the French *u*, *eu*, or *è*, or of the German *ae*, or *ä*, nor is any attempt made to distinguish between the sound of *ng* in *finger* and *singer*, on the ground that these sounds are rarely employed in the same locality. To this we demur. There may be objections to the introduction of the diacritical signs of Lepsius's standard alphabet, but the desired distinction might be attained either by the introduction of an apostrophe, as in *fin'ger* and *sing'er*, or by writing *fingger* and *singer*. The doubling of the consonants in order to shorten the sound of the preceding vowel is objectionable. The use of the ordinary accents is altogether preferable. Upon the whole, however, the recommendations of the Council are most acceptable, and we trust they will be acted upon not only in the case of maps and geographical works, but also in the case of pronouncing dictionaries.—*Academy.*

**Brockelbank's Weather Shield.**—In Group VI. at the International Inventions Exhibition, Mr. H. Brockelbank exhibits a weather shield and window for Hansom cabs, which deserves notice. This shield is a second roof, and slides forward to form a hood; then it can be lowered partly or completely, making a screen from rain, cold wind, &c., or a closed window. In closing or opening there is no interference with the passenger's head, and the shield can be operated with facility by either the passenger or the driver. An automatic arrangement opens the window, if the horse should fall while it is shut, thus avoiding risk of injury from broken glass.

# SCIENTIFIC SOCIETIES.

## LIVERPOOL ASTRONOMICAL SOCIETY.

THE fourth annual general meeting was held on Saturday, the 25th July; Mr. R. C. Johnson, F.R.A.S. (a vice-president), occupied the chair. The secretary read the minutes of the last annual meeting and a report on the affairs of the society. Since the last annual meeting 87 members and five associates had been elected. There had been one withdrawal, and the society had to deplore the death of the Rev. T. W. Webb, who had been one of its most valued members. There were now 258 members against 166 of last year and 49 of the year before. The fourth session was opened by a paper from Mr. Howard Grubb, F.R.S., F.R.A.S., on "The Adjustment of Equatorial Telescopes." Meetings had been held on the second Monday in each month during the session, at which 98 papers on astronomical subjects had been read and discussed, and the Society had published eight parts of its *Journal* and two numbers of *Transactions*, containing altogether 160 pages of printed matter, illustrated by 42 woodcuts and lithographs. Donations of 186 books and pamphlets had been received, and the publications of the Society had, in turn, been sent to the various astronomical observatories. The total income of the society for the last session had been £72 16s. 6d., and the expenditure £75 4s. 6d. Of the latter sum £69 had been spent in the printing and postage of their publications; the purely local expenses had been restricted to £1 for the rent of apartments. There was also an outstanding account of £23 for printing.

Mr. Isaac Roberts, F.R A.S., F.G.S., said this would leave a deficit of more than £25. He thought the amount for printing was larger than they were warranted in incurring from their present income, and he did not think it would be wise to forestall the income of the approaching session to provide for the deficit. He would suggest in future, either that they should decrease the amount of their literature or that the subscription should be increased, as there could be no doubt they were at present giving more for the money than they could afford to do. The Secretary said this question had been raised before, when it was decided that to increase the subscription would be to take the Society out of reach of the very class it was intended to encourage. As to the supposed deficit, he thought it would turn out rather a profitable investment when the assets were taken into consideration, for though they could not well be placed on the credit side of the balance sheet, he had no doubt that when they came to be realised there would be a considerable balance in their favour. The demand for the Society's publications had hitherto been very great, and even increased prices had been offered for numbers which were out of print. Last session such an emergency had been provided for by printing a larger supply, which had, of course, increased their expenses without in the mean time bringing in any return. The work of the Society had been very extended, and it had been thought preferable to increase their sphere of usefulness rather than to lay up a reserve fund; though, even looked upon as a commercial speculation, he would have every confidence in their success.

Mr. W. S. Franks, F.R.A.S., noticed with regret that Mr. Espin was obliged to remove from Liverpool, and would therefore be unable to undertake the duties of special observer. The fact, however, that he had purchased one of Calver's 17in. reflectors looked hopeful, and, whether special or not, he was sure Mr. Espin would continue one of their most valuable observers. (Applause.) The president and officers for the ensuing year were then balloted for and declared elected as follows:—President: Isaac Roberts, F.R.A.S., F.G.S. Vice-presidents: Rev. T. E. Espin, B.A., F.R.A.S.; W. H. St. Q Gage, F.R.A.S.; R. C. Johnson, F.R.A.S.; Rev. S. J. Perry, F.R.S., F.R.A.S. Special Observer: W. H. St. Q. Gage. Treasurer: G. C. Beecham. Secretary: J. W. Appleton, F.R A.S. Editor of the Society's Publications: W. H. Davies, F.R.A.S. Council: Joseph Baxendell, F.R.S., F.R A.S.; Miss E. Brown; W. F. Denning, F.R.A.S.; W. H. Davies, jun.; Thomas Gwyn Elger, F.R.A.S.; W. S. Franks, F.R.A.S.; J. E. Gore, F.R.A.S., M.R.I.A.; Rev. J. H. Honeyburne, M.A., F.R.A.S.; George Knott, LL B., F.R.A.S.; R. S. Newall, F.R.A.S.; W. H. Sharp, H. Thomas. Messrs. G. R. Farncombe, B.A., F. W. Longbottom, J. Scaife, and W. H. Wesley (R.A.S.) were elected members of the Society.

**Red Staining for Wood.**—The wood is plunged first in a solution of 1oz. of curd soap in 35 fluid ounces of water, or else is rubbed with the solution; then magenta is applied in a state of sufficient dilution to bring out the tone required. All aniline colours behave very well on wood.

# SCIENTIFIC NEWS.

THE comet discovered by Mr. Barnard on July 7 has been observed at Kiel, Arcetri, Vienna, Strasburg, Rome, and Palermo. Dr. Holetschek, of Vienna, computes that the perihelion passage will be the 25th of September, when the comet will have so far increased its distance as to become too faint almost to observe. Its present distance is about 150 million miles; but the comet is not of much interest. Prof. Millosevich, of Rome, says that it has a nucleus of about 11m. in the preceding part of the nebulosity. According to Mr. Chandler's calculation the perihelion passage was in May, but it seems probable that it will not occur until September.

Tuttle's comet should be looked for next month in the north-east, in the early hours a.m., though it is not expected until September.

Small planet 248, discovered by Dr. J. Palisa, of Vienna, has been named Lameia.

The Astronomische Gesellschaft meets at Geneva on August 19, Prof. Auwers presiding. Dr. B. A. Gould has presented the society with the stereotype plates of the catalogue formed from the Cordoba zones, and they will be preserved at Leipsic.

The fourteenth meeting of the French Association for the Advancement of Science will take place on August 12, at Grenoble, under the presidency of M. Verneuil, member of the Academy of Medicine. The public lectures will be on "The New Gallery of Palæontology in the Paris Museum," by M. Cotteau, and on "The Victualling of France," by M. Rochard. Numerous excursions will take place in the Alps as far as Chambery.

Mr. G. H. Darwin is making progress with the biography of his father. The volume, it is stated, will contain an interesting account of Darwin's method of research, and for the first time the public will have presented to them a true picture of the great naturalist's home and daily life. It is anticipated that the book will be issued before the year is out.

Mr. Alexander Watt is finishing a practical treatise on the electro-deposition of metals, including the electrolytic refining of copper and other metals and treatment of ores. The work will shortly be published by Messrs. Crosby Lockwood and Co.

The half-yearly meeting of the Scottish Meteorological Society was held on Monday in Edinburgh, Mr. J. Murray in the chair. Mr. Buchan submitted the report of the council, which stated that the cost of maintaining the observatory on Ben Nevis had been £335 above the amount of subscriptions received, and that £800 would be required to carry it on during the next twelvemonth. A temporary branch of the marine station had been established at Millport, on the Clyde, and much good work had already been done there. It was hoped that it might soon be possible to establish a permanent station on the Clyde. Dr. Sanderson gave in the financial report, from which it appeared that the memberships now number 689, and that the income for the year ending June 30th last amounted to £456, of which £417 was received in subscriptions. A sum of £5,154 had been expended in connection with the Ben Nevis Observatory, of which £2,020 was for building the observatory, and £1,798 for making the road to the top of the hill. The income of the marine station at Granton amounted to £998, and there was now a balance at its credit of £641. Professor Ewing, Dundee, gave an account of a scheme for the observation of earthquakes which it is proposed to carry out on Ben Nevis. He said that to find the earth in perfect stillness was extremely rare, and he supposed that what was meant to be investigated was every description of earth movements.

The Marine Biological Association is to receive Government aid on condition that its work is carried on in full concert with the Scotch Fishery Board. Our fisheries have been too long neglected, and it is satisfactory to find that at last the Government are aware of their national importance.

A useful course of lectures was concluded last week at the Birmingham and Midland Institute, when Mr. C. T. Millis, of the Technical College, Finsbury, delivered the last of the series on "Pattern-cutting for Sheet-metal Workers." Mr. Millis commenced his course by showing that pattern-cutting or, more strictly speaking, the development of surfaces, was the laying out of the surfaces of solids in a plane, and then dividing the articles for which patterns were required by sheet-metal workers into three classes, the first articles having equal slant or taper, such as coffeepots; the second articles having unequal slant or taper, as baths, hoppers, canister tops, &c.; and the third bent or twisted surfaces, such as vases, aquarium stands, moulding, &c. He then proceeded to explain the application of solid geometry to the setting out of the foregoing patterns, and the general principles underlying the same, methods for setting out patterns in a round, oval, and oblong, and for other articles of equal and unequal taper, such as elbows, T-elbows, elbows formed by tapering pieces of pipe, &c. Copies of supplementary notes, containing definitions for geometrical problems, useful to sheet-metal workers, were prepared by Mr. Millis and distributed to those attending the lectures—from 150 to 200 working men, the tickets of admission being distributed by the representatives of the societies of tin-plate workers, braziers, ironworkers, and similar bodies. It is proposed to bring before the Birmingham Trades Council a proposition to establish a class during the next session of the institute to carry on the work.

Bull's patent process of steel manufacture by means of water-gas—converting ore into steel without first making pig—is being tried at Trimsaran, Kidwelly. The following description of the process is published:—The gas producers are similar to the Strong and Lowe, or the *quasi* recuperative type. The coal is forced by a hot blast of air into partial combustion, the resultant heat of which is collected into separate recuperators. An interval follows, during which the air is turned off, steam is forced in a reverse direction through the recuperators, and becoming highly superheated, is decomposed or transformed into a powerful reducing gas. This is led through conduits to the tuyères of the blast furnace. It is expected from the careful arrangement of the crucible of the blast furnace, which is of the cupola form, that a bath of pure iron can be maintained in a fluid condition. When the metal is tapped it will be carried by ladle, and run into a Siemens open-hearth steel furnace.

At a recent meeting of the Master Car Builders' Association of the United States, the question of automatic couplers for goods waggons came up for discussion. Notwithstanding the Massachussetts law and the Boston trials, the difficulty of introducing a uniform automatic coupler is so great that only slow progress is being made. The Legislature of New York State has passed a law which declares that after July 1, 1886, couplers on new freight cars must be capable of being worked automatically. The subject was referred to the Executive Committee, to make a public trial, to employ experts, and to request the co-operation of the railroad companies.

Dr. Ramos, of Bristol, says that refrigeration of the lobe of the ear will stop hiccough. The refrigeration need be nothing more than the application of cold water.

Dr. G. W. Jacoby, of New York, read a paper recently before the American Neurological Society, in which he stated that hypodermic injections of a one per cent. aqueous solution of osmic acid had been found an effective remedy in the treatment of peripheral neuralgia, especially in the case of sciatica.

At the meeting of the San Francisco Microscopical Society, on June 24th, Mr. W. Norris presented a set of nineteen slides, being the first instalment of a series, which is intended to be a complete collection of all known Californian diatoms. Dr. J. H. Stallard read a paper on "Pathogenic Bacilli," in the course of which he stated that Koch's views as regards the cholera bacillus will soon be, in all probability, established beyond reasonable doubt.

Mr. A. Lyman, of New York, has invented a new cartridge, which consists in packing the shell with meal powder, and leaving a longitudinal hole quite through. It is contended that by this arrangement the ignition begins within the walls of the perforation, and gradually extends, the charge burning with augmenting rapidity, and the gas pressure rising steadily, so that the full effect is expended upon the projectile. From a smooth bore $\frac{6}{16}$in. calibre, 4ft.

long, a projectile 9in. long, weighing 3½oz., has been driven into a target composed of nine plates of ¼in. boiler iron, with a powder charge of less than an ounce. The inventor thinks that a 3in. gun and 40lb. of powder will send a projectile through a solid iron plate 3ft. thick.

According to Herr Stutzer, writing in the *Zeitschrift der Physiologische Chemie*, all vegetables contain three groups of nitrogenous substances—one soluble in water, represented by asparagine; the second, comprising albumen, dissolved by the hydrochloric acid pepsin of the stomach, and chemically distinguished from amides by forming insoluble compounds with copper hydroxide in neutral solutions; the third, composed of all those nitrogenous substances which are not soluble in water or in acid pepsin. The last group was the one examined. Commercial cocoanut cake used as fodder by farmers was treated with pepsin and pancreatic extracts, and it was found that the latter in an alkaline solution had somewhat less action on proteids than acid pepsin. The author's observations lead him to believe that soda alone is quite as powerful a solvent of nitrogenous principles as when combined with pancreatic ferment.

We learn that Mr. Clement L. Wragge, F.R.G.S., late of Ben Nevis Observatory, in consequence of recent correspondence, intends to visit Brisbane shortly. His mission is to confer with Major-General Scratchley, K.C.M.G., and the Queensland Government on matters relating to meteorological work in Northern Queensland and New Guinea. He hopes to establish a station at Port Moresby. An assistant will carry on the work of his Torrens Observatory, near Adelaide, aided by self-recording and electrically-registering instruments, and the result will henceforth be sent direct to the Royal Meteorological Society and the Government Meteorological Office, London, with both of which the Torrens Observatory is connected. Mr. Wragge is also arranging for the continuance of his observatory on Mount Lofty, South Australia.

**Artificial White Light with Metallic Magnesium.**—Magnesium added to a pyrotechnic mixture brightens the brilliancy of its flame amazingly. The powdered metal, as manufactured by the electrolytic process, can be well used for that purpose. Two and a half per cent. magnesium added gives the red strontium light a wonderful brightness, while with the barium light its green colour is rendered perfectly white, resembling the electric light. Such mixtures might serve well for photographic purposes; if with properly constructed apparatus and chimneys, the troublesome smoke and the evolution of injurious gases may be got rid of. The manufacturers of magnesium by electrolysis recommend for white light, one part shellac to be fused together with six parts of barium nitrate, the mass to be reduced to a fine powder, and thoroughly mixed with two and a half per cent. magnesium. For red lights the same amount of magnesium with one part of shellac and five parts of strontium nitrate answers well. When being used the mixture is spread upon a piece of sheet iron and ignited, or it is placed loosely in tubes of very thin sheet zinc of about two c.m. diameter. As the combustion proceeds the zinc is consumed with the pyrotechnic resistance.

**To Colour Brass Steel-Grey or Black.**—Add one part of hyposulphate of soda and two parts of sulphate of copper to 100 parts of water. Cleanse thoroughly the object to be coloured, place it in the mixture and heat it. A darker tint is procured by adding more hyposulphate of soda, while a larger quantity of sulphate of copper will produce a bluish or steel-grey colour.

M. de Tromelin has attacked the hypothesis that clouds are composed of vesicles or hollow spheres of condensed vapour. He supposes that every solid body, whatever may be its diameter, retains around it by adhesion a special atmosphere of the gas in which it is plunged; that the thickness of this atmosphere is nearly independent of the volume of the solid body; that the attraction which retains it is within the domain of the molecular forces, and is manifested only within very short distances. In this way he accounts for the difficulty of completely removing the air from a tube which is to be filled with liquid. In the case of a vesicle surrounded by its atmosphere, the thermal absorption of the water is much greater than that of the surrounding diathermanous air. The atmosphere of the vesicle is consequently expanded, and the particle with its atmosphere floats by displacing an equal volume of the circumambient air. The dust particles which are observed in the sun's rays are supposed to be sustained in the same way.

# LETTERS TO THE EDITOR.

*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

*All Cheques and Post-office Orders to be made payable to* J. Passmore Edwards.

*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original."
*Montaigne's Essays.*

## THE PRIME MERIDIAN FROM A FRENCH POINT OF VIEW—ANOTHER PRICK OR TWO FOR THE SUN-SPOT BUBBLE—TERRESTRIAL TELESCOPES—THE POWERS THAT (CAN'T) BE—TARDY "NOTICES" OF PHENOMENA—EQUATORIAL MOTION FROM AN ALTAZIMUTH ONE—SPECTROSCOPE.

[24537.]—I have been highly amused by the perusal of the report of a lecture by Dr. Janssen on "The Universal Prime Meridian," delivered before the Paris Geographical Society. As an example of Spread-cock-yism (if I may adapt a familiar American expression) it is perfect. The learned Doctor is most irate that so overwhelming a majority of the delegates to the Washington Conference should have selected Greenwich as the initial point for all terrestrial longitudes. Richelieu settled the Meridian, and it seems a kind of horrifying piece of impertinence to Dr. Janssen that anyone should dare to upset what was decreed by the notorious Cardinal, in joy at whose death bonfires blazed all over Paris. Il va sans dire that France has effected practically everything that has been done in geography and hydrography, whence the ingratitude as well as the folly of the selection made by the Congress becomes apparent at once. One infinitesimal crumb of comfort the French delegate does seem to have picked up at Washington—General Strachey announced that England has begged to join the Metric Convention. Just so, England (or the tailors of Tooley-street who claim to speak for her) may join the Convention; but if General Strachey does not die until the most unscientific French system, founded on an erroneous measure of a local Meridian, is used in English commerce—well, Methuselah will be a baby to him!

Humbug dies hard, and I do not, therefore, apologise for once more reverting to the subject of sunspots and the weather. All readers of the English Mechanic must know how blatantly it has been asserted that the years of maximum Solar disturbance are those of the greatest rainfall, and *vice-versâ*, such assertion having been made in this country as a reason or excuse for demanding that someone should be installed in a "Solar Physical Observatory," at a large salary, in order that, by watching sunspots, he might predict the weather. In letter 24196 (p. 211), I made extracts from the Report of the Committee on Water Supply presented to the Meteorological Society, and since then I have been reading the "Report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich, Read., 1885, June 6th," in which I find Mr. Christie stating on p. 10 that "it would seem that the maximum both of sunspots and faculæ occurred about the end of 1883 or beginning of 1884"; and on p. 14, "The rainfall in 1884 was 18·0in., being about 7 inches below the average of the last 40 years." The same condition of things is recorded in the Meteorological Observations made at Stonyhurst, where the rainfall last year was 5·47in. below the average of the previous 37 years—and so from all parts of the kingdom. Recently, too, I have come across a very interesting work entitled "Observations Upon the Topography and Climate of Crowborough Hill, Sussex," by C. Leeson Prince, M.R.C.S., F.R.A.S., &c., which contains, amid a quantity of other information, elaborate details of Sussex Rainfall for 46 consecutive years. Taking the pains to compare this with Wolf's Tables of Sunspot Maxima and Minima, I find that not the smallest discoverable connection exists (or has existed for 46 years, at any rate) between the spotted area of the sun and the amount of rainfall. Now, this is a question of *fact*, and not of the very least of opinion, which is open to investigation by everybody who can read and write; and in the teeth of it, it is impossible not to question either the bona fides or the absolute sanity of any person or persons persisting in attempting to blow the pricked bladder up again.

Might I be allowed to suggest that the reproduction in these columns of the article by Professor Holden (to which Mr. Sadler refers in the concluding paragraph of letter 24474, p. 428) would be of interest and advantage to a great many of your readers who cannot obtain access to the publication in which it originally appeared.

Premising that Kitchiner was far from being the most careful writer who ever lived, I rather fancy that the solution of Mr. Mee's difficulty (letter 24477, p. 428), or part of it, will be found in the fact of the untrustworthiness of the estimation of the powers of eyepieces made by the opticians who construct—or sell—them. A few (a very few) of the highest class will measure such powers accurately, and furnish the purchaser with the true amount of amplification; but when one gets to high powers and the run of telescope sellers, the tendency to exaggerate seems irresistible. Besides, while, of course, a power of 2,000 on a 7in. reflector would show a bright star as an amorphous smudge of light, no observer could legitimately say that he had *seen* the star with any such a power. Finally, note what Kitchiner himself says in various parts of his book "On Telescopes," as to the use—or rather, utter uselessness—of high magnifying powers (p. 74).

Letter 24504 (p. 451) suggests to me to say that on the morning of July 22nd I received the June number of the R.A.S. *Monthly Notices* containing Dr. Hind's predicted details of the occultation of Aldebaran, which had happened 13 days previously! Of the value of this to those Fellows of the Society who happen to be practical observers it would be needless to insist. Happily in the English Mechanic we have a journal read practically by every owner of a telescope in the United Kingdom. If we were left to the tender mercies of Burlington House for the announcement of such phenomena as a daylight occultation, I am a little afraid that many a one would go unobserved and unrecorded.

The task set by "Montmartre" in letter 24508 (p. 452) is beyond my capacity, inasmuch as the quantities of altitude and azimuth and hour angle and N.P.D. do not vary equably, which they must do if an equatorial motion could be obtained by a single movement. *A fortiori* this would apply to an arrangement for following the moon with her very irregular motion. For example, she souths to-morrow morning 45 minutes later than she did this; on the morning of August 7 one hour later than on that of the 6th; on the morning of Sept. 1 52 minutes later than she did on that of August 31, and so on.

It is quite worth the while of "E. B. F." (query 57100, p. 463) to attach a 5-prism spectroscope to any astronomical telescope of an aperture exceeding 3in. With it he would see the C, $D_3$, and F lines bright in the spectra of the solar prominences. He had better buy Browning's "How to Work with the Spectroscope," for a reply to his succeeding query (57101).

**A Fellow of the Royal Astronomical Society.**

## ASTRONOMICAL.

[24538.]—I have no wish to appear to dispute with so eminent an astronomer as Mr. Franks (letter 24505), so, if you will allow me, I will only ask him to think over and compare his own dicta as to 100 to the inch and the explanations I offered. The "reductio ad absurdum" is founded on his statements, not on mine.

May I be allowed to ask him if all vision is not identically the same, whether of stars, planets, or the page of "E. M." on which this appears? Every image is made up of points, and the light from any point passing through any aperture results in a disc and diffraction rings. In practice only bright points make sufficient impression on the retina to produce rings, and in the case of surfaces the discs and rings overlap and become continuous. This is optical theory. Perhaps Mr. Franks denies it.

But he tells us "the intrinsic brightness of either a bright star or faint *comes* depends upon aperture and nothing else." Will he kindly consider this again? The total amount of light from a star depends upon the aperture; but when we raise a disc and spread that light over a perceptible area, we certainly, in my judgment, reduce the intrinsic brightness. We see the faint *comes* as well under such circumstances, because the same quantity of light reaches the retina, but the image is less bright. I am afraid this is a "reductio" again.

If Mr. Franks still differs, I can only ask him to try it practically, premising that if his aperture will not stand 100 to the inch and give clean discs, it is necessary, in order to try fairly, to reduce aperture to some size that will do so. If he does not find star images decrease in intrinsic brilliancy as they increase in size with powers above 50 to the inch, I will admit I fell into the ditch he speaks of.

I have read "Newcomb" with attention, but I certainly gain by using high powers on close objects; and I think a perusal of Mr. Sadler's letter

(24352) shows great observers have been of opinions very similar, and have found the same practical results. Messrs. Franks, Gaudibert, and some others appear to possess exceptional sight, which enables them to see close doubles and elongations with low powers. I have no such ability.

In letter 24478, *re* 70 Oph., does ang. lat. 40° mean P A 40°? Because if it does, I must, with all due deference, ask Mr. Franks to measure again.

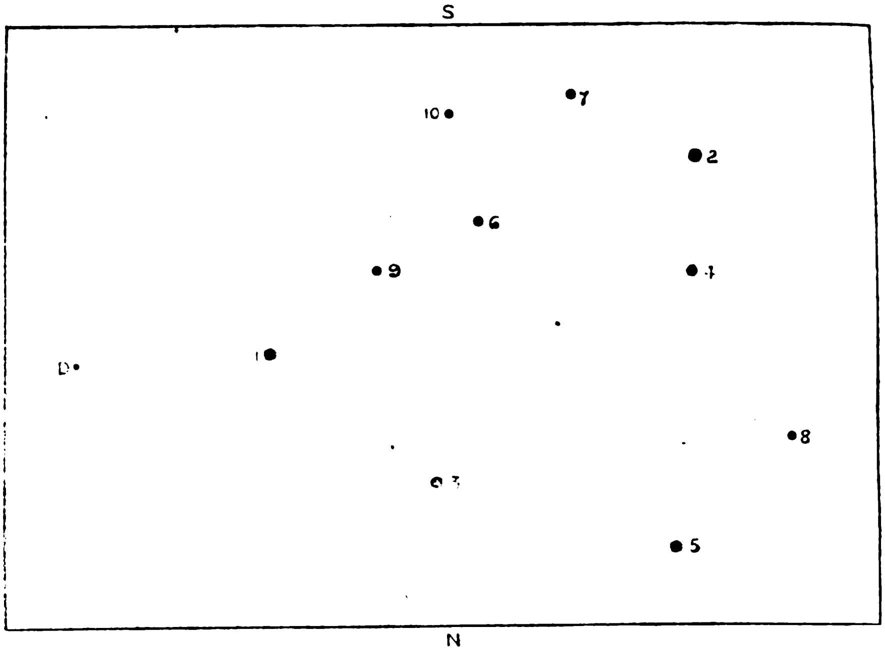
I believe the *comes* to 101 Cassiopeiæ is seldom seen. It may interest some to know that on July 8th I saw it north and a little preceding. The best est. of position is that it is in a direct line for the preceding star of the 10·3″ pair.

What is present distance of close pair of Σ 2481?

Webb mentions two faint *comes* to 6468 B A C. This should be three, as there is another at same distance as the two.

Mr. Tarrant furnished me with sketch of 53 Ophiuchi, and I have seen all his stars; but I am sure there are more within the space he includes, although the thick London air will not allow me to see them well enough to fix their positions. He shows one, a little *p.* a line from C to D. There is another star between this and C.

**E. Holmes.**



## THE RED STAR BIRM. 464.

[24539.]—THERE is an error of about half a minute in the R.A. of Birm. 464 in Schj.'s first catalogue of red stars (*Ast. Nach.* 1591), which Mr. Birmingham has followed in his Red Star Catalogue, and in his reference to this star in the *Monthly Notices* for June 1874. Schj.'s place in his second catalogue is correct. I have only been able to find two indubitable meridian observations of it, after searching more than 100 catalogues; for the supposed determinations in the Dunsink Observations iv. cannot belong to this star. It was also observed once in a 20ft. sweep by Sir J. Herschel. The following are all the results known to me, reduced to 1880·0:

| | h. m. s. | |
|---|---|---|
| $H_2$ | xviii. 43 48·47 | − 8° 2′ 26 4″ |
| Santini | 49 49 | 33·5 |
| Lamont | 49·20 | 39·1 |
| [Dunsink | 24·73 | 24 6] |

$H_2$'s observation is given in his list of red stars on page 449 of the "Results of Astronomical Observations made at the Cape of Good Hope." It was made in a sweep in the last half of the year 1827. Santini's observation is found in the zones at the end of his little-known work, the "Descrizione del Circolo Meridiano dell' I.R. Osser. di Padova"; the observation was made in July 1844, and is the mean of two determinations. The three observations on which Lamont's result is founded were made in September 1860, August 1861, and September 1863. They are given in the "Annalen der König Sternwarte bei München (Supplement-Band ix.)" The Dunsink place is the mean of two determinations (one being allowed only ⅓ weight) by Dr. Dreyer in 1879 and 1880. I have marked this "D" in the diagram. The magnitude is given as 9·5 on July 29th, 1880, the best observation; but Burnham called Birm. 464 7 0 mag. on July 24th, and 6·8 mag. on July 31st, 1880. The object observed at Dunsink is evidently some other star near. It is curious that, though Birm. 464 appears as the brightest star of the triangle on the maps of Inghirami and Capocci, its place was not determined by the former, though he observed Nos. 2, 4, and 5 (the numbers are those given by Mr. Gemmill in letter 24480, page 429). Its absence from Bessel may be accounted for either on the supposition that the star was so faint at the time the zone was observed at Königsberg as to escape Bessel, or, which I think more probable, that the star being a bright one, Bessel preferred to observe the fainter star No. 5 near it, leaving the bright one for other observers. There is possibly a third explanation. Birm. 464 has a very faint *comes* at 14·3″, forming the pair β 969, and No. 6 appears to be β 970; while No. 9 is apparently *h* 868, given in Sir John's third catalogue without mags., pos., or distance, as "a beautiful little double star in the field with a most remarkably red star 9 mag." It is from this observation that the star is included in the list of red ones in the Cape observations. It would seem at first sight as if Birm. 464 had a considerable p.m. in decl. from a comparison of the observations of $H_2$, Santini, and Lamont; but $H_2$'s observation is not of course delicate enough to determine this, and Santini's is in error, as there is a similar discrepancy between his observations of No. 5 and Lamont's, while Bessel's place of No. 5 agrees exactly with the latter's, as does Santini's No. 2. In the diagram I have inserted Nos. 1, 2, 3, 4, 5 from Lamont, 6 from Burnham, 9 from Herschel, 7, 8, and 10, from Inghirami's map ("Mappa Uranographica," also in the Berlin star maps). This map was made in 1827 and 1828, and Capocci's about the same time. Inghirami used a 4in. Fraunhofer, and annular micrometer, Capocci probably a 3⅓in. I regret that owing to its south declination I am not able to examine the group. The following are the mags. of Birm. 464, not included in his Red Star Catalogue (with the exception of Herschel's), with the dates—

Herschel. 1827·7 9 mag., "most remarkably red."
Inghirami. 1827-1828 8 mag. Estimated from map.
Capocci. 1828 ± 8 mag. Estimated from map.
Santini. 1844·52 7 mag. Colour not noted.
Lamont. 1860·73; 1861·63; 1863·74. 6½ mag. Colour not noted.
Burnham. 1880·53, ·54, ·56, 7·0 mag.; 1880·58 6 8 mag.
Gore. 1884·71 8 mag.
Gemmill. 1884·63 8 mag. "Magnificent ruby."

I do not think that, all things considered, there is much evidence of variation. The mags. assigned to red stars by different observers vary considerably. For instance, Mr. Webb made the magnitude of this very star 9·5 on Sept. 22nd, and Mr. Birmingham 7·5 on Sept. 23rd, 1873.

The following are the magnitudes assigned to the other stars in the group, including those which I have estimated from the maps of Inghirami and Capocci.

| No. | Ll. | Bessel. | Ing. | Capocci. | Santini. | Lamont. | Burnham. |
|---|---|---|---|---|---|---|---|
| 2 | 8½ | | 8½ | 8 | 8 | 7 | |
| 3 | | | 9 | 8½ | | 8 | |
| 4 | 8 | | 8 | 8 | | 7½ | |
| 5 | | 8½ | 8½ | 8 | 8½ | 7 | |
| 6 | | | 9 | 9 | | | 8 3 |
| 7 | | | 9 | 9 | | | |
| 8 | | | 9 | 9 | | | |
| 9 | | | | | | | |
| 10 | | | 9½ | | | | |

July 24th. **H. Sadler.**

P.S.—Burton's mag. (7·5) of Birm. 607 does not appear in the Dublin observations.

## THE DAYLIGHT OCCULTATION OF ALDEBARAN.

[24540.]—REFERRING to Mr. Pearson's remarks on the above subject which appeared in your issue of the 24th inst., I would beg to inform that gentleman that the times of immersion and emersion were taken at Rousdon by a sidereal chronometer which has been rated by star transits taken at my observatory with an instrument in excellent adjustment, and I have, therefore, no doubt whatever that my time is correct within the decimal of a second, and is quite independent of the position of Lyme Regis.

As Mr. Pearson is doubtless aware, there is considerable difficulty in deciding upon the exact instant of emersion in the circumstances under which the occultation of Aldebaran took place (the full blaze of sunlight), and, therefore, a small error may possibly occur in the time noted; but with the immersion the case is entirely different, and the time of that phenomenon is accurately given, in proof of which I may mention that the longitude deduced from it agrees exactly with the position of Rousdon Observatory, derived from a recent measurement taken by the Ordnance Survey Department.

I am unacquainted with Mr. Pearson's partially graphic method, beyond casually glancing at some examples of it given in the ENGLISH MECHANIC. It, however, appears to be a modification of the well-known graphic method of Mr. Penrose.

While thanking Mr. Pearson for his kind advice, I prefer to trust to the results of actual observation, and time derived from transits, rather than to his method which, at the best, can only give approximate results. **C. E. Peek, M.A. F.R.A.S.**

Rousdon Observatory, July 27th.

## THE DOUBLE STAR Σ. 1959—ERRATUM.

[24541.]—I AM glad that Mr. Gaudibert (letter 24503, p. 451) has succeeded in identifying his pair. I mentioned Σ. 1959 because the angle and distance seemed similar to those of Mr. Gaudibert's pair, though as Σ. 1959 was included in β.'s first series of Chicago measures (which I thought Mr. Gaudibert possessed), and the magnitudes were so very different, I hardly thought it possible that the two could be identical; still, I was surprised that so bright and easy a pair, as Mr. Gaudibert's seemed to be from his description, should have escaped notice so long. Σ. 1959 is either W. B. (2) XV. 668 or 670; but I do not know which of the two it is, as it is not in *Pos. Med.* β. identifies it with 668, and Stone with 670. The places for 1885·0, brought up from Weisse's Bessel, are—

W. B. (2) XV. 668. XVh. 30m. 9·1s. + 35° 9′ 8 9″
670. XVh. 30m. 16·1s. + 35° 6′ 27·9″

Bessel calls both 9 magnitude; Arg. rates 668 at 9·1 mag., and 670 at 9·0. Σ. calls A of his 1959 9 mag. in 1829, and 8·5 in 1831 and 1833. It has very seldom been measured, though De. observed it five times between 1863 and 1872, calling the larger star 9·5 mag. in Σ.'s scale on all five occasions, B ranging from 10·0 to 11·0 mag., or 10·4 mag. as a mean. De. calls it very difficult on three nights, from its faintness and comparative closeness. Howe rated A 9 0 and B 10 0 mag. on the one evening on which it was measured at Cincinnati. The difference between these estimates and Mr. Gaudibert's is astonishing. The following are the principal measures:—

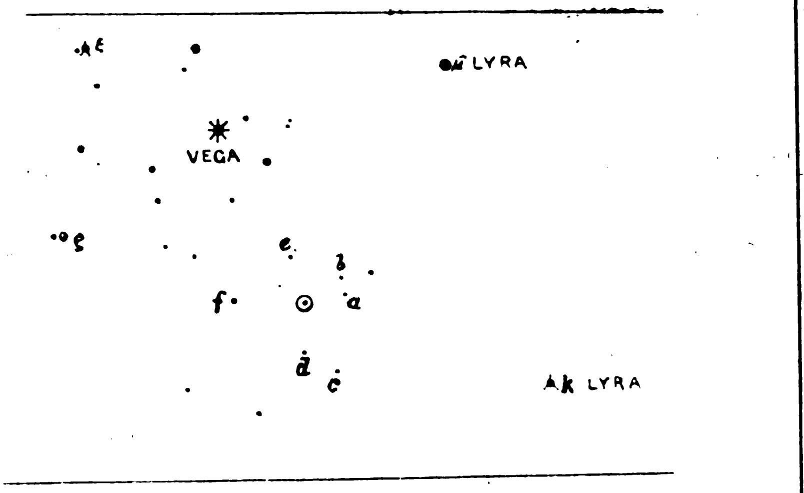
| | | | | | Mags. |
|---|---|---|---|---|---|
| Σ. | 241°·07 : | 1″·713 : | 1831·58. | 3 nights. | 8·7, 10·3 |
| De. | 240·86 : | 2·002 : | 1868·27. | 5 nights. | 9·5, 10·4 |
| β. | 242·3 : | 2·08 : | 1878·41. | 1 night. | not given |
| C. O. | 240·1 : | 1·80 : | 1879·30. | 1 night. | 9·0, 10·0 |

The pair is evidently unchanged. As 8·5 Σ. is about equal to 9·1 mag. Arg., the agreement of the various estimations of magnitude is satisfactory; but this makes it the more remarkable that Mr. Gaudibert should ever have called A a 6th magnitude star. I should be glad if he would look again at this object, and determine which of the two stars in Weisse's Bessel Σ. 1959 is. His circles, by the way, must be considerably out of adjustment. It is curious that the place of Bode 26 Coronæ should have agreed so exactly with Mr. Gaudibert's first place for his pair.

In letter 24532, page 456, *for* 13·9in. Henry Bros. *read* 14·9in. Henry Bros. **H. Sadler.**

## B. 448 VEGA.

[24542.]—IN reply to Mr. Gemmill's request (letter 24480), I send the accompanying little map of the vicinity of B 448 copied from Harding's Atlas, which will, I hope, help him (rough though it is) to find Birmingham's star. The position of the red star (which is not given by Harding or Lalande), marked by a small circle, I have laid down carefully from Birmingham's position reduced to the epoch of Harding's Atlas (1800). I



have lettered the small stars in its immediate vicinity, and they are as follows :—

*a* = Lalande 34324 (8½m.)
*b* = „ 34335 (8)
*c* = „ 34342 (8)
*d* = „ 34421 (8)
*e* = „ 34412 (7½)
*f* = „ 34570 (·)

There is no magnitude assigned to *f* in Lalande's catalogue; but the star was estimated 7½m. by Hencke (*Mon. Not. R.A.S.*, 1859, *p.* 341).

With reference to B. 607, my only authority for Burton's 7·5m. is the note in the "Red Star Catalogue." Burton's estimate certainly seems very small. If B. 607 is really variable, the limits of variation would, I think, be included between 4m. and 6m.

With reference to the obsevrations of "H. D." (letter 24479), I may say that the distant *comes* to Vega *is* a suspected variable, and is No. 556 of my Catalogue. **J. E. Gore.**

July 18.

## TWO BRILLIANT METEORS—BARNARD'S NEW COMET.

[24543.]—While engaged in comet-seeking with the 9in. reflector on the evening of July 6th, about eleven o'clock, I was startled by an almost blinding flash of light in the telescope. Quickly removing my eye from the instrument and looking upwards, I beheld a magnificent meteor moving rapidly from a point south-east of the zenith towards the north-west. It disappeared at an altitude of about 40°. Before disappearing it burst into four or five balls of varied colours, those in the rear being a vivid green merging into purplish, the foremost and largest ball being an intense crimson. No report was heard, although listened for some time. No visible train. I learned the next day that it had been seen in other places, one of them forty miles west of this observatory.

Again, on the morning of July 8th, while resting my eyes momentarily from the telescope, I saw another very fine meteor moving across the northern heavens from east to west below Polaris. This one left a very bright train visible to the naked eye two or three minutes, and in the telescope which was turned upon it (as is my custom often) it could be seen for a much longer interval twirling and curling into most fantastic forms.

The new comet discovered July 7th by our good and industrious fellow-worker, E. E. Barnard, of the Vanderbilt University, Nashville, was readily picked up by me on the evening of July 10th, in approximate R.A. 17 hours, 15 minutes; declination south 6° 30′. It is faint, and has a peculiar flashing appearance in different parts of the coma. It has a good-size nucleus decidedly on one side, and that, naturally, towards the sun. Last night I saw indications of a very short brush-like tail. The comet was easily found with the 9in. Newtonian, and was seen afterwards with the aperture reduced to 4in. **William R. Brooks.**

Red House Observatory, Phelps, N.Y., July 13.

## THE GIME ACCUMULATOR.

[24544.]—Have any of your readers had any experience with the Gimé accumulator, which is thus described in a French paper:—The new accumulator of M. Gimé is composed of cylindrical tubes of lead, placed vertically in the following position:
o o
o in an oaken chest, lightly coated with gutta-
o o
percha, and forming a series of lines analogous to and in much the same manner as the plates of other accumulators. All the tubes of the same line communicate with each other, the alternate lines being joined to the negative and positive poles of the battery. The tubes are filled with sulphate of lead, which the inventor has found to be preferable to red lead, and perforated with vertical apertures, which permit the liquid to enter and rise to the top. The combination of elements does not differ essentially from that found in the ordinary type of accumulator. But the construction of the battery is unique, and possesses this advantage: the leaden cylinders, when in use, can be far more readily removed than the plates of other accumulators. From the information given by M. Gimé of the work of an element of 100 kilogrammes—the only type yet constructed—the formation of the element lasts 120 hours. It returns in the discharge 85 per cent. of the energy absorbed during the charge. Its practical capacity is 3,700 kilogrammètres per kilogramme of lead, and its electromotive force at the discharge is more than three volts—sometimes as high as 3·5 volts. We give these figures as they have been given to us, and without vouching for their accuracy. The last assertion, above all—viz., as to the E.M.F.—is especially doubtful, and should assuredly be taken *cum grano salis*. For the chemical action produced by the element, Gimé would seem to be almost identical with that observed in the Platé secondary battery, as well as in the Faure-Sellon-Volckmar type, and, so far as we can see, there is nothing in the construction or working of the Gimé battery that explains how such an E.M.F. as that claimed by the inventor could be generated. Nevertheless, the new apparatus shows great ingenuity in its construction, for it is simple, and permits of the easy and expeditious removal of the positive leads, which, if the battery possesses the economical qualities attributed to it by its inventor, will serve to make it particularly valuable in industrial employment.

As I wish to construct a large accumulator battery for experimental purposes, I should be glad to have the criticisms of your readers, Mr. Sprague and others, on this form. **G. M. B.**

## 100 TO THE INCH APERTURE.

[24545.]—I have been a devotee to telescopic pursuits all my life, and have derived no small amount of information from the pages of the "E. M." I would not trouble you now, but some of the remarks of our friend and mentor, Mr. W. S. Franks upon the 100 to the inch question seem to need further explanation.

He says (letter 24505) that he must maintain "that the atmosphere does enter into this question," the question being whether the atmosphere can set optical theories at defiance, and so prove that a 26in. telescope could not bear 1,300 on planets. Is there any reason why, given a sufficiently steady night, a 26in. should not bear 1,300 as well as a 12in. will bear 600. If there is not, then the question is not a question of comparative powers different-sized instruments will bear, but of the limit our atmosphere practically imposes on the highest powers possible on any telescope. Atmospheric disturbance may limit the highest power possible to one that can be well enough used on a 10in. instrument; but this is not setting optical theories at defiance.

If a 26in. on sufficiently steady air will not stand as high a power as a smaller instrument proportionately, can Mr. Franks give us any reason for its failure, supposing it to be perfect in figure? And I cannot follow him as to brightness of star images. If, as he says, it is dependent upon nothing else but aperture, then I suppose he means that the intrinsic brilliancy is the same whether I use 100 or 600 on my 6½in. mirror. Now I raise a disc with 300, and with 600 the disc is twice as large in diameter, and four times the area. To me this larger disc is apparently much less intrinsically brilliant; but Mr. Franks, if I follow him correctly, asserts that it is of the same brilliancy as the smaller image. Will he explain how the same total quantity of light can be spread over four times the area and remain as brilliant intrinsically as before. There is something in optical theory as expounded by astronomers, which differs much from the theory of light as expounded by Tyndall and Prof. Abbé, for they teach us that diffraction phenomena take place under all circumstances of vision, and irrespective of brightness of objects, while Mr. Franks tells us that the vision of bright points is altogether a different thing to the vision of surfaces less bright. I have always thought the softening of outline with high powers was entirely due to the enlargement of points into discs, and this on planets, moon, stars, or anything else. **W. P. Dodge.**

## AN ADJUSTABLE OBJECT-GLASS FOR TELESCOPE—I.

[24546.]—Having been so fortunate as to obtain the advice and assistance of your able and skilled correspondent "Prismatique" in carrying out a plan which I submitted to him for making an o.g., now the instrument has been received from him, I propose to send some account of it.

The two glasses which form an o.g. are in most cases placed in contact, and when this is the case any errors which may arise in the correction of the spherical aberration can only be remedied by a fresh grinding of one or more of the surfaces; but if instead of having them in contact we place them at a small distance apart, all such error may be eliminated simply by varying the distance between the lenses, and this will certainly be a gain, for many fresh adjustments of distance may be made in the time which would be required for fresh grinding and polishing.. The calculations for spherical aberration should be made so that when the lenses are in contact there should be a slight over-correction of sph. ab., and when this is the case we may always obtain a proper correction by removing them to a suitable distance. Whenever there is over-correction, the lenses have to be further separated, and when there is under-correction they must be brought closer together. And this is equally true for the colour correction also; in fact, the increase of distance manifestly reduces the correcting power of the flint lens in both cases; for, suppose the distance to be increased till it becomes equal to the focal length of the first lens, the spherical aberration of the flint becomes 0, so that for the pair it is reduced to that of the first lens only. Also for the colour aberration, when a ray passes through the optical centre its deviation is 0. And hence the nearer the rays pass to the optical centre, the less becomes the deviation produced. Hence, in both cases, if there is a slight over-correction when the lenses are in contact, either the one or the other aberration may be corrected to any degree of accuracy simply by increasing the distance, and without having to grind lenses afresh. It must be borne in mind, however, that the same distance which gives the best correction for the one does not necessarily do so for the other; and so, perhaps, in practice we shall generally have to give and take—that is, make a slight sacrifice of the one for the benefit of the other, according to the judgment of the artist. It would seem, however, that a small change of distance which would produce a considerable effect upon spherical aberration produces one which would not be nearly so sensible upon that for colour; thus, C and F or C and G will be nearly as good for colour correction, the one as the other; but the difference of distance required for their corrections respectively will produce a much more sensible effect on spherical aberration.

In the belief, then, that the aberrations might be so well corrected, I ventured upon trying whether a larger aperture than usual might not be of advantage, and the telescope was so made accordingly, though not altogether with the approval of "Prismatique." Its dimensions are: Focal length, about 44in.; aperture, 3½in.

"Prismatique" thinks, after making trial, that the arrangement of making curves, &c., is decidedly a good one; but that in some respects, which he has pointed out, a somewhat better one might be made. Anyhow, whatever may be the defects in the architect's design, it is evident that the artist has done his work exceedingly well, and the adjustment of distance, which he says is a much more difficult and delicate operation than might be expected, has certainly been made with consummate skill. And I believe that, in spite of any little defects which it may have, and which certainly seem to be capable of remedy in a future experiment, the instrument may fairly be described as being one of a high class.

I had hoped before this to have sent some account of its performance; but it is as yet unprovided with a finder, and therefore, as the eye which I use for observation is not in very good order, and having, moreover, come to an age when a person can no longer afford to pay attention to ailments which in times gone by he would have looked upon as trifles, the expenditure of eye-power in finding stars compels me to be somewhat sparing in its use.

**W. G. Penny.**

(*To be continued.*)

### MOTION FOR TELESCOPE.

[24547.]—I FEAR that "Montmartre," letter 24508, will not succeed in giving his telescope the proper motions to follow stars of different declinations from any one driving rod or handle; but he may do it much easier and cheaper by using the bladder clock—as I have applied two to my new stand for the 15in. Calver mirror,—and which I will endeavour to describe, so as for any one to apply them to telescopes on a similar stand. Having already described the stand and mounting on p. 189 of the present volume, I shall only add that the tube of the larger telescope is 9ft. long, and 18in. square, and with the mirror, &c., weighs 300lb. The tube for mounting it is the largest gas-tubing I could obtain, being 4in. internal diameter, with the smaller size turning in it. The arms also for directing and regulating the motion of the telescope are longer and stouter, as are also those for carrying the telescope. In other respects it is similar.

Now for the driving of the telescope: The bladder clock I have described before, but will do so again. A square box, 9in. inside and 14in. high, has in it a square of wood that will slide easily up and down, and having a rod fixed in it going through the top of the box, like the piston-rod of the steam-engine. Under this square piston are placed two football indiarubber bladders of the largest size, one on the other, and crossed in the box so that their orifices are in different corners of the box; in these are inserted metal tubes of short length, to connect them by short lengths of indiarubber tubes to a forked metal tube—one bladder to each fork, and the other end of the fork to a long rubber tube to reach to the eyepiece of the telescope. The metal tubes allow the rubber tube to be tightly bound on them, and make an airtight joint. The bladders are crossed on each other, as they rise more equally under the piston when blown into. Openings are made in the corners of the box to allow the tubes to rise with the bladder. These two bladders will give the piston 9in. rise: more bladders may be added if necessary. I find these sufficient.

Two boxes of this description are fixed to the stand—one to the arm for altitude, and the other to the arm for azimuth; this last to an extension of the fast and loose arm behind the post, and they both move with the telescope. On the top of the piston two bricks are placed to keep the piston on the bladders and drive the telescope.

On the top of the piston rod a piece of wood carrying a pulley is so placed as for the pulley to be over the centre of the piston rod.

Motion in azimuth is given to the telescope by the box thus: In the description on page 189 the directions and fixing of the strings are given, but I had better repeat them here. First, a string from the end of the longest crosspiece or sleeve in which the crosspiece turns runs through a pulley on the end of the arm and thence to a second pulley under the arm and near the post, and thence to a weight which pulls the telescope after the star. To control this a second string from the other end of the cross sleeve runs through other pulleys and thence to the gimlet near the eyepiece.

Now, this string is not fixed to the sleeve, but runs through a pulley fixed to the sleeve, and thence to a second pulley on the end of the arm, and thence to the driving-clock. It runs through a pulley on the top of the box of the driving-clock, thence through the pulley on the top of the piston-rod, and is fixed to the top of the box on the other side of the piston-rod.

Now, when the bladders are inflated the piston-rod is 9in. above the top of the box, with the string over the top of it, and this check-string of the azimuth movement is allowed to move just as the air is let out of the bladder, and the piston falls, the telescope following the star as the air is let out of the bladder. The other box for the alt. motion is fixed to the other arm in front of the post and near the far end.

The string for directing the telescope in alt. is not fixed to the end of the tube, but runs through a pulley fixed to the tube, and thence returns to the arm, and by a loop in the string hung on the arm.

When the telescope is to be driven by the clock, if the star is east of the meridian and rising, a string carrying a hook runs from the top of the box, and thence through the pulley on the top of the piston-rod, thence through a second pulley on the top of the box, and thence through a third pulley on the end of the arm when it is hooked in the loop which previously hung on the arm. Thus the descent of the piston will allow the telescope to rise. If the star is falling, a second string fixed to the top of the piston-rod hooks into a second loop in the string from the tube and pulls the telescope down as the piston falls.

The two tubes from the bladder are brought to the telescope near the eyepiece, where the cock of each may be easily regulated to keep a star in the field of view.

Of course, the telescope is equally under control by the gimlet and strings, the clock attachment not interfering with that.

If "Montmartre" will make his stand like this and allow his telescope to be lifted by the heavier counterpoise, and try the gimlet and string plan, instead of the wheel and brasswork, I am certain he will be so satisfied with it as to always use it in future.

I have now had many years' experience of it, and would in no case return to screw motions or rack and pinion.

Also by having his cross piece long on one side and only just protruding from the tee piece on the top of the spindle on the other, he will have his other tube and counterpoise quite out of his way, and require but slight weight to balance his telescope and other tube. His telescope will require no ladder cradle to fix it to the tube; but with two or more rings fixed to the tube, and larger than his telescope, he may wedge his telescope into them with long strips of wood, so that it shall lie as safely as in a box made for it.

Each ring should be made of two flat pieces of iron, so bent as for one end to half-clasp the tube, and the other to form half the ring to hold the telescope. With three bolts and nuts through it, the telescope will be firmly and safely held in any position he pleases.

When used as a day telescope the position will be nearly horizontal, and the greater length of the eyepiece will be no inconvenience.

**Philip Vallance.**

### THE KING'S CROSS ACCIDENT—THE PENISTONE DISASTER.

[24548.]—MUCH obliged to "Midland," p. 457, and of course I do not wish to say anything or to have anything said until after the inquiry; but perhaps "Midland" can help me to solve what has always been a puzzle to me, and that is why "inquiries," as they are called, are always so long delayed? From what I know I have not the least hesitation in expressing the opinion that inquiries into the cause of so-called accidents are delayed in order to bring the evidence into a "suitable" state! They may not be purposely delayed in all cases, I admit; but I confess to a suspicion that there is never any anxiety to strike the iron while it is hot, and have an explanation before time has been obtained to "balance" the accounts of the individuals concerned and "clear the company." I shall probably be told that it is an unjustifiable suspicion; but I am old traveller on suburban lines near London, and have kept my eyes open as well as I could, and I want to know how it is that stationmasters and their subordinates never know anything about accidents beyond the fact that there is a breakdown, and that would-be passengers must do the best they can. Understand me, please: I do not blame the underlings, for they are obeying orders, doubtless; but whose orders are they, and what has a railway company to fear unless it has done something wrong? This policy of mystery will surely recoil on the heads of those who inaugurated it, and the directors or head officials of railway companies will find that honesty is as usual the best policy. For "honesty" in this connection of course read "straightforwardness." Accidents on railways ought to be curiosities, provided you understand the word, for such an affair as that at King's-cross is no more an "accident" than I am Haroun-al-Raschid—I wish I was, for I would make some of the highly-paid "directors" who know literally nothing of the actual working of railways "sit up." At present the majority of them are merely financial speculators, who care little about the arrangements so long as a dividend is declared. It must be so, or the brake question would have been settled long ago. That leads us to the case arising out of the Penistone disaster. Can anyone—does anyone—doubt that if the jury in that case had been in the slightest degree acquainted with railway working they would have brought in a verdict for the defendants? They have practically decided that it is impossible to discover a flaw—an incipient flaw—in a crank axle, and that a good brake, such as the Westinghouse, would not have prevented, or, at least, mitigated the effects of that awful affair. I know very well that experts say they cannot discover these incipient flaws; but permit me to ask whether they have ever tried anything but the ordinary "inspection" of the shops? Have they tested the axles by Prof. Hughes's method, or the simple process of sounding them when slung? If they have, I shall be glad to read a description of their method; but I do not anticipate that I shall be so far gratified, for the whole system is rotten, and there is no "progress" in railway matters beyond the new dimensions which the locomotive superintendent gives to his engines, which are not a bit better than those designed by his precursors. So, in the matter of brakes, you cannot find a jury (12) of disinterested engineers or mechanicians who have any doubt about which is the best brake, and yet you will find directors, who rely upon the statements of the officials, sanctioning the use of appliances which add one more item to the long list of death-traps for drivers. The driver of an express train has always seemed to me to be a bit of a hero—he has, at least, the stuff of which heroes are made, and, perhaps, in the same conditions, would shine as much as those who obtain peerages and pensions. He certainly carries his life in his hand, and to his calm eye and ready hand many passengers unknowingly owe their lives. It is impossible, of course; but, side by side with the "accidents" we read of, what a tale might be told of the disasters just avoided, of the smashes averted, by the cool courage of the engine-driver—the biped in smuts and grease, who is, nevertheless, a "man," every inch of him.

**Nun. Dor.**

### COMPOUND LOCOMOTIVES.

[24549.]—I WONDER that those of your correspondents who were so eloquent recently over the alleged iniquities of the new Mid. 19in. cylinder engines—engines which are, or will be, amongst the finest in the kingdom—had nothing to say about the North-Western compounds. These, as you are well aware, were designed chiefly with the view of reducing fuel consumption. There are two classes of compounds, the small or "Experiment" class, working with 150lb. pressure, and the big or "Dreadnought" class, working with 175lb., and weighing over 40 tons. Both classes, however, really work at pressures considerably higher than the nominal figures, which is to be borne in mind in considering the results yielded.

One fact in reference to the compounds admits of no contradiction—they are unable to attain the highest speeds. Up to about 50 miles an hour they are well enough, but back pressure in the big cylinder, stiffness of working, or some other cause prevents the proper running of the engine when this rate is exceeded. However great the emergency, a compound cannot exceed its normal pace downhill, and thus it happens that if by any mischance time is lost uphill, the train has to come in late, for time cannot be made up downhill. With some of the fastest trains it is all but impossible for the compounds—small ones at any rate—to keep time. No compound yet has ever kept time with the 10.10 between Bletchley and Rugby, or is likely to. I much doubt if they could manage the 12 noon, Euston to Rugby. The facts relating to the speed power of the compounds are more than even sophistry can distort; and whilst, therefore, the number which have been built is cause of astonishment, it is merely another instance of the pertinacity of engineers.

Next to time lost in running comes time wasted in starting. Sometimes compounds have not merely delayed, but have absolutely refused to start at all until assisted by another engine. With heavy trains half a minute to a minute is often lost on starts, especially if the gradient is unfavourable. Of course, other engines do so too sometimes, but not to the extent the compounds do.

It is not easy to get at the coal consumption, but inquiries tend to show that drivers receive no more coal premiums than formerly, if as much. I am induced to believe that no coal really is saved, a view which is supported by the trial on the South-Western. If report is correct, the number of failures with compounds is abnormally high and general repairs expensive. The oil required for lubricating purposes is also very considerable.

There may be amongst your numerous readers someone who will do battle for the compounds, and give us the other side of the case. On the North-Western I have searched in vain for an official or servant who will say a good word for the new engines. Many a time have I been met with the reply, "We must not say anything about them." Everyone dislikes the compounds, though it would not do to express it. Hence the reticence of drivers. But when a driver has a good engine, did anyone ever find him unwilling to expatiate on its merits?

July 26. **Kappa.**

### COUNTERBORE AND FACING BAR.

[24550.]—THE following sketch and illustration of a counterbore and facing bar is contributed by Mr. A. B. Landis to the *American Machinist*. Thinking it would interest your readers I send it over to you. It is inexpensive, and is easily kept in working order, as the cutters will not require replacing for a long time, and when that is required they are cheaply made. In the sketch, Fig. 1 is an end view of the bar; Fig. 2, a side view, edgewise of cutters; and Fig. 3, a side view, showing the flat side of cutters. A is the pin or guide, which is solid with the bar. B B are the cutters, which are inserted in slots on the side of the body, D, of the bar, running the extreme length to the taper shank, as shown. These cutters are plain pieces of flat steel fitted to the slot; the lower ends of these pieces form the cutting edges, and project sufficiently beyond the body D to give clearance to cut the body D is cut out with a milling cutter at G G, which gives room for the cuttings to remove freely. The cutting faces of the cutter radiate to the centre of the bar, making the best

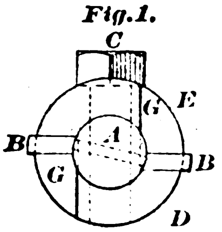


Fig. 1.

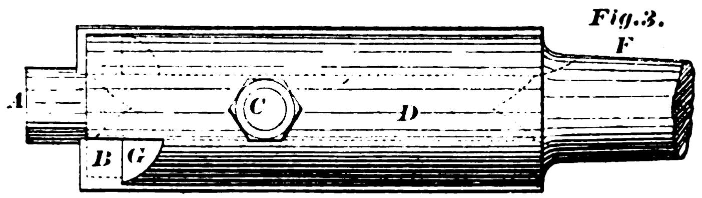


Fig. 3.

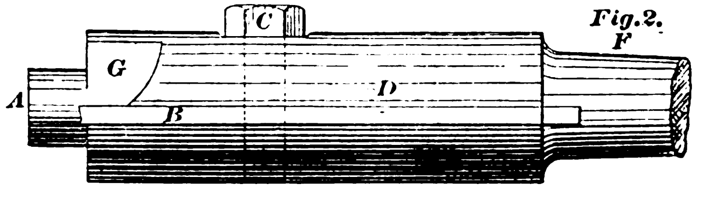


Fig. 2.

possible cutting edge. The body of the bar, D, has a slot, E, sawed through it from opposite sides (as will be seen by dotted lines on Fig. 3), so as to remove as much stock as possible, making the two sides yielding. A bolt, C, passes freely through one side, and is tapped or screwed into the other side. By drawing up this bolt tightly, the two sides of the body D are sprung, and rigidly clamp the two cutters. The cutters can be quickly removed, and sharpened and replaced, as will be seen, and are readily adjustable as to length, so as to make both cutters cut equally. In order to make practically no wear on the pin, A can be turned smaller, and screw-threaded or left plain, and a hardened sleeve either screwed or pressed on it, which can be removed when too much worn and another replaced; but by hardening the pin made as shown, the wear is practically no consideration. The writer made this style of a bar for use in the works where he is employed, and finds it to be great economy, as it is easily kept in order and the cutters will last a long time, as almost their entire length can be used up before needing replacing. Another good feature is that the cutters are solidly backed at the cutting edge, consequently it is almost impossible to break them. We use the bars for facing bosses around holes where bolts are used, requiring true surfaces, but they can also be used for counterboring holes.

Lowell, Mass. **G. F. H.**

## THE HISTORY OF THE TIDAL PROBLEM.

[24551.]—THE evident connection between the period of the tides and the phases of the moon led philosophers to attribute these phenomena to lunar influences long before the true theory was understood. The rise and fall of the tides of the ocean presented a spectacle too remarkable and too important to the social and commercial interests of mankind not to have attracted notice in the early period of the progress of knowledge; but the actual records which we find in ancient authors concerning the tides are exceedingly few and scanty. The reason of this seems to be that the principal seats of civilisation and learning were situated in regions remote from these great oceans and seas, where these phenomena are most developed. As many of your readers who are interested in the subject may not have access to the original sources from which the following sketch is derived, I have thought it desirable to place on record a concise epitome of the progressive results attained by early philosophers in their attempts at the solution of the problem.

The first historical observation of the tides which has come down to our times is probably that of the historian Herodotus, who in Book II. chap. 11, of his great work, speaking of a long but narrow bay, diverging from the Red Sea, in his description of the land of Egypt B.C. 445, says: "In this bay the tide regularly ebbs and flows." Pliny, Book II., chap. 97, as quoted by Lalande in the fourth volume of his "Astronomy," page 8, has the following very remarkable passage on the matter: "That the tides of the ocean ebb and flow is exceedingly wonderful: these are produced under various circumstances, but the cause is in the sun and moon," and he proceeds to describe their course and order very accurately. He died in A.D. 79.

In Lingard's "Antiquities of the Anglo-Saxon Church," chap. 10, we have a succinct account of the knowledge of the subject possessed by the Saxons. "From their insular situation," he observes, "the Saxons could not be ignorant of the interesting phenomena of the tides, and Bede seems to have suspected the existence of that cause, the discovery of which has immortalised the name of Newton." Bede lived A D. 700, and he connected the ebb and flow with the action of the moon, with whose motion they so accurately corresponded that he was tempted to believe that the waters were drawn towards that luminary by some invisible influence, and after a certain time were permitted to return to their former situation. In his work, "De Ratione Temporum," chap. 27, page 116, he says: "The tide is drawn forward as if by certain influences of the moon, and again it is poured back to its natural bounds, when the force alluded to ceases." He does not, however, venture to speculate on the nature of this attraction, but confines himself to the following enumeration of the particulars in which the motions of the moon and of the ocean appear to coincide. "As the moon daily recedes twelve degrees from the sun, so, on an average, the tides are daily retarded four points" (eight and forty minutes) "in their approach to the shore. Some days before the conjunction they seem to increase; and from the fifth to the twelfth, from the twentieth to the twenty-seventh day, they continually diminish. But the gradations of increase and decrease are not perfectly regular, and these anomalies may be ascribed, perhaps, to the impulse or resistance of the winds, more probably to the agency of some unknown power." The Anglo-Saxon, however, was able to correct an erroneous opinion of former philosophers. It had been pretended that in every part of the ocean the waters began to rise at the same moment; but daily observations authorised him to assert that "On the eastern coast of Britain the tide was propagated from the north to the south, and that it reached the mouth of the river Tyne before it washed the coast of the Deiri."

Descartes, after Selencus, as quoted by Plutarch, imagined that the moon, pressing on the surface of the waters immediately beneath it, forced those waters to rise along the distant coasts, attaining their maximum of elevation 90 degrees from the spot at which the moon was in the zenith.

The gravitation of the waters of the ocean towards the moon was clearly understood by Kepler, A D. 1608, although he failed to indicate the law of gravitation. In one of his dialogues he writes: "The sphere of attractive value which is in the moon extends as far as the earth, and entices up the waters, but as the moon flies rapidly across the zenith, and the waters cannot follow so quickly, a flow of the waters is occasioned in the torrid zone towards the westward." And again, in his "New Philosophy," "There are two primary causes of the motion of the seas—the moon and the diurnal revolution. The moon does not act on the seas by its rays or its light. How then? Certainly by the common effort of the bodies, and (to explain it by something similar) by their magnetic attraction. It should be known, in the first place, that the whole quantity of water is not contained in the sea and rivers, but that the mass of earth (I mean this globe) contains moisture and spirit much deeper even than the sea. The moon draws out this by sympathy, so that they burst forth on the arrival of the moon, in consequence of the attraction of that luminary," &c.

Galileo expresses his regret that so ingenious a philosopher as Kepler should give such an explanation as that, a portion of which has just been quoted. His Fourth Dialogue is a development of a treatise on this and other subjects, which was sent to the Archduke Leopold in A D. 1618. His theory was erroneous; but it required a further advance in the science of motion to point out its insufficiency. He attributed the tides to the rotation of the earth, combined with its revolution round the sun. From the earliest ages the problem had been regarded as most difficult, inasmuch that it had been designated "the grave of human curiosity"; so Galileo, having a theory of his own, clung to it with the utmost tenacity. His desire to excel others urged him on its prosecution. There is an unfounded legend that Aristotle drowned himself in despair of being able to invent a plausible explanation of the extraordinary tides in the Euripus. Pytheas, a contemporary of Aristotle, had observed that the full tides occur at full moon, and the ebbs at new moon. Posidonius, as quoted by Strabo, maintained the existence of three periods of the tide—daily, monthly, and annual, "in sympathy with the moon." The College of Jesuits at Coimbra had pointed out the true relation between the tides and the moon, and so had Antonio Dominis; but they failed to apprehend the fact that the same attraction was exerted on the earth as well as on the water, and thus the theory was left incomplete.

It was in A.D. 1640 that Horrox, whose youthful genius stands out so prominently in other scientific researches, announced to his friend Crabtree that he had undertaken the prosecution of a series of observations on the tides. His home was near the mouth of the river Ribble, where the range of the tides is sometimes 30ft. He stated that many interesting particulars had been revealed to him, and he appears to have been the first who undertook the prosecution of these investigations with a thoroughly definite object. His last letter to Crabtree was written only a month before his death, and it seems almost incredible that a youth of twenty-two could have exhibited in his researches such sagacity of thought and such fertility of invention. The obscurity of his position caused him to be neglected in his lifetime; but posterity claims him as one of the most remarkable philosophers that any age has produced.

**James Pearson, M.A., F.R.A.S.**

Fleetwood, July 27, 1885.

(*To be continued.*)

## WHAT IS "CREATION"?

[24552.]—I AM quite willing to accept "F.R.A.S.'s" explanation so far of the mode in which I have employed the word "creation." I have made use of it in much the same way as many people employ the term "electricity," or as he would employ the word, "gravitation"—that is, simply acknowledging it as a source of phenomena which we discern, but cannot ultimately explain.

"F.R.A.S." does not profess to account for the *first* appearance of abnormal forms, though he acknowledges their occurrence. Natural selection presumes their occurrence, but cannot explain it, and all that I have suggested is—and it may be taken only as a provisional theory—that the first appearance of such abnormals may be referred to Creation, no other explanation being forthcoming.

What I meant by "selective creation" is that some new variety having appeared, by means of creation, this new variety is not only liable to be propagated, but, in its immediate descendants, a tendency towards further variations in a similar direction is not unfrequently found, and these variations are explicable only by creation. The sum of these variations may, in many generations, appear as a more constant and distinct variety or species, but such a result is not what one could call a "sudden creation."

"F.R.A.S." will unhesitatingly ascribe to gravitation the phenomena he observes in the movements of celestial and terrestrial bodies, and, being ignorant of what gravitation is, he will do so in humility.

I see no reason why, with like humility, he should hesitate to ascribe to "creation" the phenomena otherwise inexplicable, which he observes in organic nature, even though the *modus operandi* be still more occult; or at least, why he should hesitate to declare, as a true scientist, the insufficiency of natural selection *per se* to account for organic nature as we find it. **H. B. F.**

## FLOWER-POTS.

[24553.]—CAN any of your scientific readers help to me to decide whether unglazed or glazed earthenware is most suitable for use as flower-pots? The common flower-pots become dirty and slimy, and actually, I think, play the part of refrigerators to the roots of the plants, except when they have become hot by exposure to the sun, for after watering, evaporation goes on at the whole exterior surface, with the subsequent lowering of temperature so well seen in connection with the ordinary water-cooler bottles. The shape of the modern flower-pot is convenient, but not particularly noted for its elegance of design; and the question now to be decided is whether something more shapely and economical in glazed earthenware cannot be designed. That the gardeners of China, as also those of that little "Eastern England," Japan, have long used glazed pottery of forms artistic and varied goes without the saying. Even that most primitive of all plant receptacles, a joint of bamboo stem, is glazed with silex outside by Nature herself, and there now seems an opening for our garden potters to emulate each other in the production of well-shaped crockeryware for the garden indoors. But apart from all considerations of shape, permit me to ask whether it would be inimical to plant life to have the ordinary pots glazed. In many cases—perhaps the majority—where the ornamental glazed pots or vases are used, the plant itself is in a porous-pot of common make which is placed within the "china." If any of your readers have had experience in growing plants in the ornamental coloured and glazed vases, will they kindly say if they have experienced any difficulty in cultivation which can be traced to the nature of the "pot."

**Conservator.**

## EXAMINATION OF MINERALS BEFORE THE BLOWPIPE.—III.

[24554.]—Box No. 11.—Greyish white, compact; amorphous fragments, but apparently having a rhombic or rhombo-prismatic crystalline structure: very hard (a penknife leaves steel on surface).

| | |
|---|---|
| I. Powder in B acid. (1.) Faint orange p.c. from bottom of bead at first; green p.c. afterwards unchanged. (2) Transp. and opaque-white mass, very slowly dissolving. | (1.) (2.) Alkaline aluminous silicate, with large prop. of silica and alumina: a very small prop. of soda. |
| II. Added CoO. (1.) Cobalt borate balls, very slowly dissolving to pink (not purple) suffusion. | (1.) Alkali, probably a small proportion of lithia (the potash suffusion is purple). |
| III. Added lime. (1.) Milky streaks at once; with more lime, bead opaque, milk white. | (1.) Large proportion of alumina, and probably, no lime in mineral (*a*). |
| IV. Fragment in E.P. (*b*). (1.) Fuses in part, but remainder dry, exfoliating. (2.) Blood-red, but momentary p.c. | (1.) Not much alkali. (2.) A small proportion of lithia. |

What mineral is this?

Box No. 12.—White, semi-transparent, vitreous, amorphous; hard (penknife causes very little powder, but yields no steel on surface).

| | |
|---|---|
| I. Powder in B acid. (1.) Transparent ice-like mass, *slowly* dissolving (2.) p.c. at bottom of bead for a moment blood-red; afterwards green p.c. unchanged. | (1.) Alkaline aluminous silicate, with little alkali, and much silica and alumina. (2.) Alkali lithia. |
| II. Added CoO. (1.) Very slight pink suffusion; but half the mass not yet dissolved (*c*). | (1.) Not much alkali. |
| III. Added CaO. (1.) Lime balls not decomposed, but surrounded with milky matter, so added mixture (*d*) of CaO + 3 times the mineral. (2.) Bead, milky and opaque; but not all over. | (1.) (2.) Considerable proportion of, but not *very* much alumina. A little soda. |
| IV. Fragment in E.P. (1.) Reddish orange at first; but (2) in strong H.P. (*e*) a pale rose tint. | (1.) (2.) Might be either strontia or lithia; but can't be strontia, which forms balls in B acid like lime. |

What is this Mineral?

Box No. 13. Grey transparent plates or scales, like talc or mica; very soft.

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|---|---|
| I. Powder (obtained by rubbing several plates together on a file, and then crushing between agates) in B acid. (1.) Blood red p.c. from bottom of bead. (2.) Scales (from not properly crushed powder), surrounded by dirty yellow suffusion, all dissolving to vitreous matter, like syrup dissolving in water. Bead, dirty yellow. | (1.) Lithia. (2.) Iron, dissolved by a considerable proportion of alkali, without which the scales would be quite insoluble. |
| II. Added CoO. (1.) All dissolved to pink bead. | (1.) Considerable alkali. |
| III. Added lime. (1.) No milkiness; but bead covered with black slaggy enamel, with (2) white metallic, dendritic crystal on surface. | (1.) Failure to detect alumina, which must be present, from the mineral not being properly crushed. (2.) Probably reduced cobalt. |
| IV. A large scale fused *per se* (1.) (black, magnetic) and powder boiled, &c., in B acid, but many scales still present which give off a vitreous solution. (2.) One or two white opaque balls. | (1.) Considerable proportion of iron. (2.) Trace of magnesia. |
| V. Added lime. (1.) Yellowish-white, opaque, enamel bead. | (1.) Large proportion of alumina with iron. |
| VI. Added CoO. (1.) Co borate balls dissolved to deep *purple* suffusion now, especially over the platinum wire. | (1.) Presence of considerable proportion of potash, in addition to the lithia. |
| VII. Vesiculated bead (*f*) breathed on vesicle, and remelted to a bead BB. (1.) Melts with an intense green light. | (1.) Presence of fluorine; shown here as hydrofluoric acid, to which it is converted by the moisture from the breath. |
| VIII. Original powder in P acid. (1.) Large transparent mass undissolved. | (1.) Large proportion of silica. |
| IX. Bead VIII. crushed and boiled with drop of water in glass bulb (!). (1.) Glass attacked and dulled in neck of bulb. | (1.) Presence of fluorine confirmed. |

This is a most troublesome mineral to handle, on account of the difficulty of properly crushing it. Fortunately, its scaly structure and reaction for lithia render its immediate identification quite easy.

Box No. 14.—White, semitransparent, amorphous, but with prismatic cleavage of fragments on their long axes, (*g*)—soft.

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|---|---|
| I. Powder in B acid. (1.) Considerable effervescence, and on raising the bead to white heat, great and continued effervescence without smell; the green p.c. remaining unchanged. (2.) White, opaque, fringed fragments; no solution going on. (3.) Bead semiopaque, with grey opaline matter. | (1.) This must be a sulphate of some base which retains its sulphuric acid with great tenacity—as barium (*h*). (2.) The reaction of cyanite (a silicate of alumina); but this mineral is soft. (3.) Much combined water. (*i*). |
| II. Powder made into paste with equal part of potash, and drop of water, fused into a ball on Al plate B.B.; ball crushed, boiled, and dried powder in B acid, B.B. (1.) A number of opaque white balls, evolving quantities of opaline matter, and bubbles amounting to effervescence. | (1.) Sulphate of barium, which is the only base evolving opaline matter in this way. Even the fusion with potash, &c., was unable wholly to separate the Ba and $SO_3$. |
| III. Fragment gives a pale green pyrochrome *per se* (1). | (1.) Barium. |

It was impossible to help finding out (and showing) what this mineral is.

Box No. 15.—Yellowish white, amorphous, compact, translucent, hornlike—soft.

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|---|---|
| I. Powder in B acid. (1.) Great effervescence without smell; green p.c. temporarily yellowed. (2.) Clear balls, giving off dense streaks of opaline matter, which soon coalesce into one large transparent ball, not quite round, showing its specific gravity to be higher than that of calcium borate. | (1.) Carbon dioxide, formerly called carbonic acid gas ($CO_2$, test for S on silver here, if doubtful of the fact). (2.) Barium. |

The dullest student can have no doubt of the nature, and therefore, the name, of this mineral.

Notes.—(*a*) Because, if there had been, with such a small proportion of alkali unable to dissolve them, milky streaks (of calcium borate decomposed by alumina) would have appeared in operation I. Still there may be a trace of lime here, to be detected by treating the fused and boiled powder in a phosphoboric acid bead, as before explained.

(*b*) E. P. for "Ellychnine pyrochrome (Greek *Elleuchnion* a wick), made by touching the side of the wick of a candle or wick lamp with the hot assay *while* the pyrocone is being produced. The whole blue pyrocone is then surrounded by a coloured "mantle" of flame of the peculiar colour communicated.

(*c*) It will be observed that I am not fully carrying out my own system. The bead containing the silicious mass should, no doubt, be treated B. B. until it is shown absolutely whether the mass is thus soluble or not; and the sharp practitioner will at once see here that by further treatment B. B. I would probably have obtained more lithium borate to act upon the cobalt afterwards; but I am pressed for time, and consider the above sufficient indication for the identification of a mineral.

(*d*) The mixture is made with a penknife from little heaps on an agate slab, and then ground well together by a superplaced agate.

(*e*) H. P. for hydrocarbonous pyrocone, signifies that the assay is to be held well within the point of the blue pyrocone.

(*f*) There is nothing to *induce* this operation here but the knowledge (obtained from the scaly structure and lithia reaction) that this mineral probably contains fluorine.

(*g*) Found by trying to slice them with a penknife.

(*h*) It is as well to state here that this important reaction (evolving sufficient effervescence to suspect sulphuric acid, the presence of which is confirmed by further intense treatment before the blowpipe and the ordinary test for S on silver) is afforded by no other mineral than barite (or "heavy spar"); fragments of gypsum, the likest to it, being after a time decomposed in B acid B.B. into balls of calcium borate and bubbles of $SO_3$.

(*i*) Barite is said in mineralogical works to contain little or no water; but in B acid B.B. all barium minerals, and even chemically pure baryta, evolve copiously this grey opaline matter, which I believe to represent combined water.

*Remarks.*—As this paper has already extended to the limits so kindly allowed me by the Editor, I shall reserve my remarks on this subject for the letters on "Pyrology," into which I have been seduced or forced by Mr. A. H. Allen, whose evident difficulties of comprehension they will, I hope, help to explain.

**W. A. Ross.**

## PYROLOGY.

[24555.]—The letter of Colonel Ross on "Pyrology" (24514, p. 453) illustrates in a striking manner his method of argument, and the difficulty under which chemists labour who may desire to learn from him the grounds for his views.

As one instance is as good as a hundred, I would call attention to the calcium borate question. Colonel Ross says that if he makes a bead of boric acid on a little loop at the end of a piece of platinum wire, adds quicklime, and again heats before the blowpipe, a ball or sphere will be formed in the clear bead, and may be isolated by treating the bead with hot water. The operation has always been performed by Col. Ross on small quantities of material, the weight of lime employed being, I believe, usually from 5 to 8 milligrammes, or, say, one-tenth of a grain. Col. Ross always finds the weight of the sphere or ball to be just four times that of the weight of the lime employed, so he assumes that it contains 25 per cent. of lime and 75 per cent. of boric acid. Chemists generally, including myself, object that this is not proved, and that a portion of the lime added may remain dissolved in the clear portion of the bead, the ball containing more than 75 per cent. of boric acid. We invite Col. Ross to prove the objection unfounded by looking for lime in the clear portion of the bead by known chemical methods, and by ascertaining by accepted methods the proportions of lime and boric acid actually present in the ball insoluble in water. But to render such experiments satisfactory and convincing to chemists, they must be conducted on reasonably large quantities of material, those hitherto used by Col. Ross being insufficient to establish the composition of his calcium borate balls with sufficient precision, seeing that mere errors of weighing would cause serious discrepancies with the amounts he uses. Col. Ross replies that a distiller might plead for the operation being performed on a bucketful of material, and a smelter would not be satisfied with less than a ton. As a matter of fact, distillers and smelters habitually employ much smaller quantities of material than buckets and tons for their assays; but if they had reason for holding the opinion that nothing less than these amounts would suffice for the purpose, they would be justified in considering the statements of Col. Ross "not proven," if he persisted in operating on quantities and by methods which they did not accept as adeqnate. But Col. Ross appeals to *chemists*, and yet does not think it worth while to use methods which would bring conviction to their minds. Instead of testing for lime in the clear portion of the bead by ordinary chemical methods, he says that no lime *can* be there because it would at once collect and form a ball, which is just what chemists want to have *proved*. It is the woman's argument—"it is, *because* it is." But let it be quite understood that, when chemists suspect lime to exist in the clear portion of the bead, they mean in a condition of *solution*, and not in the form of small balls visible under the microscope. It seems necessary to explain this, for Col. Ross twice quotes me as having argued that some of the lime was "dispersed about the bead." The quotation marks are his, and are liable to convey the impression to readers that I had previously used these words, whereas I have done nothing of the kind, and they are a serious perversion of my meaning.

I may say that there is a very grave reason for doubting the definite nature of any borate of calcium having the composition attributed by Col. Ross to his balls. The simplest formula for a borate of calcium containing 75 per cent. of $B_2O_3$ and 25 per cent. of CaO is—

$$Ca_5B_{24}O_{41}\text{; or, } 5CaO,\ 12B_2O_3.$$

This is, primâ facie, a very improbable constitution for a definite compound, and chemists will want rigid analytical proof of its accuracy before they accept it.

As I said in my last letter, chemists are only too glad to have useful additions made to their methods and tools; but they are sceptical of the value and reliability of processes which the author himself does not appear to consider it worth his while to investigate thoroughly. Personally, if all Colonel

Ross says of his calcium borate balls were proved to be true, I should not abandon the processes for determining lime which are at present in vogue, for, to be of any practical use, it would be necessary for the new process to allow of lime being determined to within 0·5 per cent. of the total amount, in presence of variable proportions of silica, phosphoric acid, oxide of iron, oxide of manganese, alumina, and magnesia. I do not think Col. Ross claims such a degree of accuracy, even when working on pure lime in an unmixed state; in fact, with such small quantities as he employs, such a degree of accuracy is beyond the indications of the balance. I fully appreciate the value of much of Col. Ross's work, and the industry with which he has worked at blowpipe analysis, with the result of devising a number of new methods and ingenious pieces of apparatus; but I think these methods and apparatus have their own proper use, and are as ill-adapted to replace the accepted wet methods of the chemist, as the latter are to replace the blowpipe-methods of the mineralogist, mining engineer, and "prospecter." The difference is a very clear one. When one has a mineral product which is unrecognisable by its physical characters, the work done by Col. Ross is a most valuable aid to its identification: but, when this desideratum is effected, and an accurate quantitative determination of the different constituents is required, wet methods must be resorted to, except in a limited number of very special cases.

**Alfred H. Allen.**

## DYNAMO MACHINERY.

[24556.]—I am obliged to your correspondent, in letter 24512, for his careful reply; but the matter is not quite satisfactory, and I should like to hear further.

There can be no objection to his calculations of the shunt dynamo, as they point to the method of obtaining the greatest efficiency at least cost by increasing the diameter of the iron cores without changing the weight of wire, which is generally adopted in practice. In regard to the experiment with the two sets of coils, they appear to be selected as type of a dynamo that is theoretically perfect.

Now, if these coils are moved to give the effect of a dynamo, in order to obtain the mechanical efficiency of 32 to 1, the large coils must have twice the speed of the smaller coils; if the speed is the same as the small coils, the efficiency is 16 to 1, and at half the speed 8 to 1. To put the case in algebraic form, if at the maximum velocity of induction $C$ is the current produced by a magnetic field, and the number of revolutions of a dynamo is constant per minute, then if the dynamo has double the dimensions, because the armature has twice the diameter, the increased speed of the centre of the wire coils in a Gramme, or the circumference in a drum armature, tends to change $C$ to $C^2$ for the electro-motive force is in proportion to the square of the speed. But by supposition, the maximum velocity of induction is already obtained, and the current cannot increase except by an increase of magnetism; this can only be produced by increased weight of iron or copper, and the theoretic efficiency of a perfect form of dynamo can therefore only be increased by weight, and for any special form is in proportion to the weight.

The increase of efficiency of a larger dynamo when the number of revolutions per minute is constant, is due to the greater speed of the circumference of the armature, which could be got as easily by an increased number of revolutions per minute; but there is a mechanical advantage in construction, which consists in the fact that the same distance may be kept between the field-magnet and armature cores, both in large and small machines; the advantage is, however, very small.

**J. Sutcliffe.**

## TRIPLE COMPOUND ENGINES.

[24557.]—Some years ago I took part in a discussion in your columns which had reference to compound versus single engines. I took what seemed to me the commonsense view, that owners of steam vessels would not have adopted the compound system unless they had good grounds for believing it to be economical. Since those days we have advanced apace, and now the compound has developed into triple expansion engines. At the last meeting of the Institution of Naval Architects, Mr. A. E. Seaton contributed a paper on the triple compound engines, and backed his opinions by some statements which, if not true, ought to be demolished by those who still stick to the simple engines. He said:—As I was quite convinced that economy was due to the system rather than to the higher pressure, it was decided not to increase the boiler pressure more than was necessary to suit the triple system. The other three ships were being fitted with engines having cylinders 25in. and 50in. diameter by 45in. stroke, and supplied with steam of 90lb. pressure from a double-ended boiler, 13ft. 9in. diameter by 15ft. long, having a total heating surface of 2,310ft. so that these engines have every qualification for being economical, so far as general proportions go, the stroke being an abnormally long one and the boiler of ample size. Experience has since shown that these engines are economical in coal, and the wear and tear exceptionally small.

The new engines for the fourth boat were made with considerably shorter stroke, and the cylinders proportioned so as to give equal power; they are 21in., 32in., and 56in. diameter by 36in. stroke, the high-pressure cylinder being supported on columns immediately over the medium cylinder, and in other respects these engines were made as near as possible like the others. Steam at 110lb. pressure is supplied from a double-ended boiler 12ft. 9in. diameter, and 15ft. long, having a total heating surface of 2,270 square feet, and identical in design with the boiler supplied for the other engines. The propellers were made exactly alike in all respects, and the ships being likewise precisely alike, a comparison of the performances of the one fitted with the triple engines could be made with as little grounds for differences of opinion as is possible. One of the ships fitted with the ordinary compound engines was named the *Kovno*, that with the triple compound engines the *Draco*. Their dimensions are as follows:—Length between perpendiculars, 270ft.; breadth, 34ft.; depth of hold, 18ft. 3in.; and of 1,700 tons gross register. They are ordinary cargo boats, built of steel, having a raised quarter-deck and long bridge amidships, but nothing about them otherwise requires comment.

After making a voyage or two to the Baltic, and finding that everything was working satisfactorily, the *Kovno* was loaded with 2,400 tons dead weight, and sailed in January, 1883, for Buenos Ayres; the *Draco* was loaded with 2,425 tons dead weight, and sailed March, 1883, for Bombay, the distance in both cases being about 6,400 miles. It was thought advisable, for purposes of comparison, that the ships should steam at as near as possible the same speed; and to attain this object, we considered the safest plan was to instruct the engineers as to the average amount of coal they were to burn per day, and experience with these ships on their Baltic voyages had fixed this at 12 tons in the case of the *Kovno* and 10 tons in the case of the *Draco*. During the voyage each ship seems to have had fair average weather, and equal care was taken in getting the best results possible. The average speed of the *Draco* was, however, 8·625 knots, or 207 miles per day, the engines making on the average 57·5 revolutions per minute, while the *Kovno* did only 8·1 knots, or 194 miles per day, the engines making 55·5 revolutions. The coal used was ordinary South Yorkshire, just as it comes from the pits for bunker purposes. The indicated horse-power in each case would average about 600. The total coal consumed was 326 tons in the *Draco* and 405 tons in the *Kovno*, or a saving of 19·5 per cent. over the ordinary compounds, with an increase of speed of 6·5 per cent.

In December, 1883, one of the others, the *Grodno*, sailed from Bombay, and attained an average of 8·5 knots, or 204 miles per day, the engines making 57 revolutions, with a coal consumption of 12·8 tons per day, or 469 tons on the voyage. The *Draco's* consumption is therefore 30·5 per cent. less than that of the *Grodno* on the round voyage, and 20·3 per cent. per day.

The success of the triple compound engine was in these instances more than had been anticipated, and induced Mr. Wilson to go a step further. The s.s. *Yeddo* had been refitted with boilers made for a working pressure of 90lb. per square inch, but owing to the size of the shafting the working pressure was limited to 70lb.; the average consumption of coal under these circumstances on two voyages was 17 tons per day. These boilers had a margin of safety beyond what was required by the rules when made, and as the Board of Trade rules had been modified in the mean while, it was found that they could with safety be worked at 100lb. per square inch. A third cylinder was now fitted on the top of the original low pressure, and the safety-valves loaded to the 100lb., and the ship was despatched to Cronstadt. After making two voyages under similar circumstances to the two previous ones, the average consumption was 13·5 tons per day only. In this case it was the same ship, same boilers, same engines, same propeller, and same men, the only difference being the addition of a third cylinder and the increase of pressure.

So far all the trials had been made with two crank engines; so it was now decided to construct another set of engines for 150lb. pressure, having a crank to each cylinder. These engines had cylinders 20½in., 33in., and 58in. diameter by 36in. stroke, and were fitted into the screw steamer *Rosario*, whose dimensions are 275ft. 3in. between perpendiculars, 34ft. 3in. beam, and 19ft. 2in. depth of hold, 1,862 tons gross, and the deadweight capacity 2,550 tons. In March last year she was loaded with 2,530 tons deadweight, and did the voyage to Bombay at an average speed of 8·6 knots on a consumption of 10·5 tons per day of South Yorkshire coal, and burnt on the voyage 347 tons. This result is superior to that of the *Draco* when the size of the ship is taken into account, but is not so much so as might have been anticipated from the increase of pressure and the rate of expansion, which was 14·4 in the *Rosario* and 12 in the *Draco*. Another set of engines was made from the patterns of those of the *Draco*, but with the high-pressure cylinder 20in. diameter, steam at 150lb. pressure being supplied from two single-ended boilers, having a total heating surface of 2,200 square feet. They are fitted in the s.s. *Finland*, a cargo boat 270ft. long, 35ft. beam, by 18ft. depth of hold, and 1,954 tons gross register. In January she was loaded with 2,500 tons dead weight, and sailed for Rangoon. The average speed attained was 8·42 knots per hour, or 202 miles per day, on a consumption of 10·3 tons of Welsh coal per day, the rate of expansion being 12. It should be mentioned that all these ships named are fitted and steered with steam steering gear, so that in comparing these results and those published of the engines made by an eminent engineer in the north of England, an allowance should be made, as in that ship there was no steam steering gear. I have chosen to make all these comparisons by reference to the ships' logs, and to give results such as a shipowner looks for rather than those which engineers prefer to use in forming a judgment on the merits of different engines. I do this for two reasons: first, because the commercial success of the triple compound engine depends on the saving it can effect in a long voyage; and secondly, because I had no reliable indicator diagrams from which the consumption per indicated horse-power could be calculated with any degree of accuracy.

I think these statements, which could be corroborated by the experience of others, support the position I took up some years ago, when I asserted that in spite of its complication and multiplication of parts, the compound marine-engine is more economical than the simple engine. There are still paper theorists who shut their eyes to plain facts, and maintain that with equal pressures the single engine competes favourably with the compound.

**J. B. C.**

## SHIP PROPELLING.

[24558.]—In this age of inventions and rapid development of various industries, it is no wonder that men of genius are ever racking their brains to devise a quicker, safer, and cheaper means of propelling vessels.

I have had the pleasure of an interview with a most respectable working man (an engine-man) who has devoted many years of study to this particular subject, and he is fully convinced that he has perfected a mechanical contrivance that will entirely obviate all resisting weight, or what is perhaps more correctly termed "back weight," and reduce "the slip" by 90 per cent.; also an increase of 500 per cent. of grapple over the most modern appliances, reduce the speed of the engines from 40 to 50 per cent. at the same time doubling the speed of the vessel with an accompanying reduction of 50 per cent. of fuel and 50 per cent. less weight in the engines and appliances; consequently, half the space will only be required for machinery, &c. More than that, the engines will not occupy the most valuable part of the vessel as by all other inventions, but will be situated aft. Most of the existing vessels could with very little expense be altered to suit this invention.

The mode of propelling is by a system of paddles so arranged that the engines cannot move them through a given space without moving the vessel through an equal space less 10 per cent.

There are various minor improvements and modifications that simplify it throughout; so that if it is really capable of performing what my friend asserts is a fact, then the distance between Liverpool and New York will be accomplished in little more than three days, and the greatest revolution in navigation will have been achieved that this 19th century has witnessed.

My object in writing to you is because I thought if a publication so widely patronised as yours would kindly insert my letter, it would be the means of bringing this matter under the notice of those interested in ship propelling, for the inventor living so far inland is removed from every one who is interested in the subject.

If anyone is desirous of obtaining fuller information I shall be pleased to give it them.

**W. Griffin.**

40, Oxford-street, Bilston, Staff., July 25th.

## SIR EDMUND BECKETT'S "CLOCKS AND WATCHES AND BELLS."

[24559.]—Allow me to point out the following errata in 7th edition of Sir E. Beckett's "Clocks and Watches, and Bells." P. 62, line 14, for "brass," read "glass." P. 199, line 91, for "J," "J," read "S," "S."

I am sorry to say that both Fig. 26, on p. 141, and accompanying description are incomplete, and that the apparatus, as figured and described, would fail to work as intended.

We find the four-year wheel (Y in Fig. 26) is moved on, *one pin* at a time, by the "click" on lever L M; and that L M is actuated by gravity, its end resting on the snail-shaped cam, fastened on the arbor of wheel M, and L M falling once a month, as wheel M takes that time to rotate. Therefore the wheel Y can, and does, turn on its arbor only one pin at a time, and that but once a month as often as the cam on M rotates.

Suppose it is now Feb. 26th in an ordinary year, and that the wheel Y has not been moved since the month came in, we also see that the tooth E on lever D C will fall against Y once in 24 hours, as the "one-day" wheel, D, revolves. The falling back of lever D C will occur soon after midnight, as the indices of calendar clocks usually move at this time when the new day begins.

At midnight, then, on Feb. 26th, the pin D pushes lever D C aside until the dial records "Feb. 27th," and the lever is free from the control of pin D; then spring at C throws over D C until its movement is stopped by tooth E on D C, banking against edge of Y, and the length of E is made just sufficient to permit click G to trip over and pick up one more pin on dial wheel M.

As midnight of 27th approaches D C begins its movement to the right again, and G takes its pin along, so that at midnight the index is advanced one step and registers "Feb. 28th." As before, in due time pin D sets lever D C free to fall back toward Y and D C falls. How far ought D C to fall this time? Must it pick up only one pin on M and register the 29th next? No; this is not leap year, and we have no Feb. 29 in it. Hence, the click G must trip over pins Nos. 29, 30, 31, and get hold of and bring forward pin No. 1, so that at midnight it may register March 1st.

To secure so deep a drop as this a notch is filed in the edge of Y, deep enough to let E fall four depths instead of one only; furthermore, it is plain that Y must have been moved so as to place this notch in position to catch E at some time before D C falls back soon after midnight of the 27th, and it is equally plain that Y had not moved when D C fell back 24 hours previous. In other words, the cam M must have moved and dropped off the lever L M during the 24 hours alluded to just now.

So far all is plain; but at midnight of the 28th click G advances, not now with one pin only, but with a mouthful of pins—*i.e.*, 29, 30, 31, and 1—and the index marks, as it should, March 1; and by gradual advance of pin D, the end of lever D C is at last free once more to drop, abutting, as before, against Y.

As the next date is March 2nd, the tooth E must drop this time only far enough to let G pick up one pin on dial wheel M; but the deep notch in the edge of Y is *still in position*, and the tooth E must go four depths instead of one, and register March 5 instead of March 2nd, and from this the dates would be all in confusion.

As the mechanism is now arranged, it is clearly impossible to remedy this, for there is no way to move wheel Y except the lever L M falling off cam M once a month, and, as said cam has already dropped the lever on the 27th Feb., we must wait till M revolves again.

Sir Edmund evidently forgot that, after providing means to move wheel Y into position, he must also find a way of removing the deep notch when its usefulness was gone. Of course, the same trouble would occur at the ends of all the short months, as well as on March 1st. Two movements are therefore necessary: one to put the notch *under* E as the short months close, and another to promptly *withdraw* said notch as soon as the tooth E is lifted out of it.

The "Ithaca Calendar Clock Co." do this by using a year wheel and a four-year wheel; but as I have not yet examined the interior of their clocks, I can give no idea of the plan employed. Sir E. Beckett will, no doubt, remedy the oversight now that his attention has been directed to it.

On page 145, note at bottom, Sir Edmund gives his views on the orthography of the expressive Americanism "buncombe," and insists that "bunkum" is the true way, the other being altered by someone who knew of "the noble house of Duncombe."

The absurdity of this explanation is very laughable when one reflects that of all who have occasion to spell this word in America, not *one* in *ten thousand* ever heard of "the noble family of Duncombe"!

If Sir Edmund possesses a good atlas of the United States, I wish he would look at the map of North Carolina, and he will there find, in the extreme western part of the State, and intersected by the Blue Ridge, the little county of Buncombe.

Its population has always been largely of the backwoods class, and somewhat illiterate, while proud.

Many years before the Rebellion this county was once represented in the State Legislature by a backwoodsman who had been appalled all the session by the new ways of life he had met with at the Capitol, and so had kept as "mum as a mouse." Finally, on the last day of the session, he paralysed the "Patres Conscripti" by bursting out into a long and flowery speech, evidently committed to memory and utterly mal-à-propos of the bill under consideration.

After adjournment the members anxiously asked the source of his sudden inspiration, and were informed that his county expected to hear from him in the papers, and therefore he had prepared his speech. "In fact," said he, "I care nothing for the bill under discussion, I am merely talking for Buncombe."

This is the origin of the phrase. It is not "bluster"; but when a man talks with no object in view but hearing his own voice, or making an impression on the "ignobile vulgus," it is "talking for Buncombe."

**Roi ne Puis, Souza Je suis.**

## WARPING AND CRACKING OF CASTINGS.

[24560.]—I note your article on the "Warping and Cracking of Castings," and the difficulty occasionally in getting the core removed in time to allow for shrinking. I beg to say that I got over this trouble by using "hard loam bricks" in some class of goods. When the castings were thin they were used one over the other the whole depth of the mould, and a strong pointed bar would cut a passage down in a minute or two; in thicker castings, they were built in, so that the bricks broke the joint. **W. S.**

## TWO EYES ARE BETTER THAN ONE.

[24561.]—Mr. Nelson, in his letter 24511, writes:—"A one-eyed man sees every whit as well as a man with two."

Mr. N. surely knows of the advantage of keeping both eyes open when using a telescope; if not, any sailor will show him. **W. R. Kennan.**

## IRON AS AN ELEMENT IN THE BATTERY.

[24562.]—What is the reason that iron is not used instead of zinc in the battery? I have read of some objections, but cannot they be overcome in some way? I was reading the other day some remarks made by the president of a society in Glasgow on this subject, and I should be glad if your readers would ventilate the matter for our benefit. These are the remarks which attracted my attention more particularly:—

Iron has been frequently used as the electro-negative element of a battery, especially when in the passive state, by contact with concentrated nitric acid. Probably the objection to its use as an electro-positive element has arisen from earlier experimenters finding local action uncontrollable, which in the case of zinc was easily obviated by amalgamation. I have recently made some experiments in this direction; in point of fact, constructing a sulphate of copper cell, in which the copper is used in contact with sulphate of copper, as is customary in Daniell's cell; but the zinc is replaced with iron used in contact with protosulphate of iron; and find that three of such cells connected in series decompose water, so that the electromotive force is probably what theory indicates, about two-thirds that of a Daniell cell: moreover, such a construction of battery gives what the chemist dearly loves—a chemical cycle easily worked, restoring the chemicals to their original state. The solution of sulphate of iron produced by the battery on evaporation and distillation yields sulphuric acid (or sulphurous acid) and peroxide of iron, the former ready to be combined again with the deposited copper, and the latter ready for the blast-furnace and reduction to metallic iron. I find a form of cell similar to the Sir Wm. Thomson or Medinger cell, with some practical alterations in detail, to suit best, which, requiring no porous cells, can be made of any dimensions. A saturated solution of sulphate of copper contains one-fifth of its weight of the salt, and it floats upon a saturated solution of sulphate of iron, which contains only about one-third of its weight of the salt, so that if the sulphate of iron is drawn off as a saturated solution, the copper plate requires to be at the top and the iron at the bottom of the cell.

If, however, saturated solution of sulphate of copper be put into a bell-jar, and metallic iron be placed in the upper part of the jar, the copper is replaced by iron, and we have a solution of sulphate of iron half-saturated floating upon a solution of sulphate of copper fully saturated. The line of demarcation between the two solutions remains quite distinct for weeks, and very little diffusion occurs; consequently a very manageable cell is made by a horizontal copper plate being put at the bottom of a cell containing a saturated solution of sulphate of copper, and one or more vertical iron plates being placed above in half-saturated solution of sulphate of iron. The solution of sulphate of iron is easily protected from the action of the atmosphere, and consequent decomposition, by means of a thin layer of mineral oil. If from time to time a solution of sulphate of copper is poured down a wide tube, reaching to the copper plate, the iron solution being simultaneously drawn off from a higher level, a constant battery is constituted, which involves no cost in working beyond that incidental to the removal and recovery of the products, and which throws no product into the market the sale of which would be doubtful.

More plate surface, however, requires to be used with iron than with zinc, but iron is only one-fourth the price of zinc. I have found that three iron cells only give two-thirds of the electrolytic action given by two zinc cells, so that in practice probably the iron plates require to be double the size of the zinc plates for equal currents of electricity; but even then the arrangement should approximate in economy to the cost of lighting by the dynamo. It is obvious, also, that torrents of electricity could be evolved from the iron used in precipitating copper by the wet process of Henderson and others, if tanks be arranged in a similar way.

What do our electricians and chemists think? Anything that would cheapen the battery current considerably would be of great value; but I suppose there is no hope of competing with a dynamo. **J. T. M.**

## GINGER ALE.

[24563.]—As this is the season when all sorts of beverages are welcomed by the thirsty, the following process of making ginger ale, given by a correspondent of the *Mineral Water Trade Review*, may be useful to some of your readers:—

Select a good sound unbleached ginger; Jamaica may be preferred, although I found a fair sample of Cochin yield a very good extract. The great aim is as far as possible to insure the freshness of the root, as ginger loses a considerable amount of its peculiar odour by long keeping, although its pungency remains almost unchanged. The extract is prepared by pounding 20oz. of the root into a coarse powder, which should be rendered uniform by passing it through a sieve of forty meshes to the inch; the granules thus obtained are mixed with a sufficient quantity of dilute spirit, composed of equal parts of alcohol at 60°, and distilled water, so as to form a paste, which is placed in a percolating apparatus, and left to macerate for 48 hours. Next pour on dilute spirit, so as to obtain 70oz. of tincture; press out the marc strongly, and finally add sufficient liquid to make up 80oz.

Of the tincture thus prepared, take 7oz., mix with 6 pints of water and sufficient kaolin (China clay), or thoroughly washed whiting may be used; filter through paper so as to obtain a perfectly bright filtrate, in which dissolve 6lb. of sugar without heat. This quantity will be found easily soluble in the above proportion of water.

This forms the first part of the process, which is completed by the addition of 140 drops of tincture of capsicum berries (obtained by macerating 8oz. of the bruised berries with 25oz. alcohol at 60°, and 25oz. distilled water, and proceed as in making the essence of ginger; the product should measure 50oz.); also 180 drops tincture of vanilla (made by macerating 1oz. vanilla pods, thoroughly bruised in a mortar, with 2oz. distilled water and 8oz. alcohol at 60° for eight days); also 6 drops essence of cloves (essential oil of cloves 1 part, alcohol at 60° 9 parts) with 30 drops essence of lemon, which quantity will be found perfectly soluble in the syrup, providing that the quality is good, and 2oz. of citric acid dissolved in 6oz. of water.

The syrup thus completed may be coloured by the addition of burnt sugar as required, and finally filtered with a little paper pulp in the usual way. One ounce and a half is the requisite quantity for each bottle. If it is deemed necessary to give an extra amount of foam more than exists naturally in the ginger, a most efficient heading may be obtained from the following formula:—Soap-wort root (*Saponaria officinalis*) in coarse powder, 4oz.; animal charcoal, 2oz. Macerate two days in a mixture of alcohol 60°, 4oz.; pure glycerine, 4oz.; distilled water, 8oz.; then percolate so as to obtain 11oz. of finished extract. Two drachms of this will be found sufficient for 1 gallon of syrup.

**T. T.**

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In the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, M. Carnot, in a report presented by him on behalf of the Committee of Chemical Arts, showed that the cause of the corrosion of sheet copper employed for the sheathing of ships is the presence of cuprous oxide, which, in contact with salt water, occasioned the formation of soluble salts, even when the air is excluded. In order to reduce more completely the oxygen compounds present in the copper, he introduces a small quantity of metallic manganese, which completely reduces the cuprous oxide remaining in the metal, and becomes converted into a manganese silicate, in contact with the sides and the sole of the furnace. If a few thousandths of manganese remain alloyed with the copper, they affect neither its malleability nor its resistance to the action of sea water. The manganese is introduced in the form of cupro-manganese, an alloy containing 75 per cent. of copper, and 25 of manganese.

# REPLIES TO QUERIES.

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[56440.]—**Warnerising.**—To "ALTO PETIT."—Many thanks for notice on p. 436 of query on the above subject. I should be obliged if you would favour me with the number and date of patent, or further particulars of process.—R. M.

[56676.]—**Free Reeds.**—I am sorry to be again necessitated to reply to "G. L. B.," p. 457, in connection with this query. That gentleman still fails to comprehend the exact requirements of the querist. May I again remind "G. L. B." that the querist requires to know how to tune reeds, but evidently does not know how to proceed? I now inform "G. L. B." (in reference to the various prices charged for reeds) that 18s. is a price charged for a set of reeds of medium quality, and that some dealers even charge 20s. and 25s. a set, so that, under these conditions, 18s. is not the highest price charged, and the reeds which you obtain for this amount could not, in consequence, be "the best." These prices, viz., 18s., 20s., and 25s., are those of local dealers in reeds, and are therefore much beyond the usual prices of sets of reeds from the makers. This answers "G. L. B.'s" inquiry on p. 457. For the benefit of the querist, and those interested, I submit a few practical remarks and hints on the subject of tuning reeds. 1st. Harmonium reeds are not "tuned" (in the true sense of the term) by the method suggested by "G. L. B." in a previous reply. The reeds are merely filed up roughly to pitch, and require to be carefully tuned when they (the reeds) are screwed on the soundboard or pan. 2nd. American organ reeds, in most instances, are voiced and tuned in a tuning apparatus which is used in the various factories in which American organs are made. These reeds, like those used in harmoniums, require a little refining in tone and tune, when they are placed in the instrument in which the reeds are intended to remain. 3rd. In 99 cases (if not more) out of every 100, when American organ reeds go out of tune, it is caused by the dust (which is continually being drawn into the instrument) adhering to the tips of the vibrators. This has the effect of flattening the reeds, and so causing them to sound out of tune. In this case it is only necessary to remove the vibrators, and carefully remove the dust from them. When replaced in their tubes, after this operation, they will be found to be in tune, unless the reeds are corroded through exposing the instrument to the damp. In the latter case the corrosion must be removed, and this will afterwards necessitate the tuning of the reeds. Each of the described operations should only be done by persons familiar with the construction and care of American organs. To those who are not acquainted with the method of tuning reeds, I may now inform them that when a reed gets out of tune it goes flat, and requires a slight scrape on the tip of the reed, which will, in most cases, bring it in tune again. The latter remark applies chiefly to harmonium reeds. If "G. L. B." considers it necessary to describe the "tuning bellows" used in reed-organ factories, I have no objection to kindly request him to do so, particularly as he evidently thinks that I am not acquainted with it, which idea, I may respectfully inform him, is utterly incorrect.—G. FRYER.

[56784.]—**Bicycle.**—The best way I find is to grind or file the face of both bearings, for I have them to do nearly every week, as I am in the trade, but I find that it always answers the purpose.—JOHN COOPER.

[56835.]—**Copy Drawings.**—If "W. R. A." will look on p. 242, and through the indices of his back volumes for references to articles on this matter, he will, after reading and making a few more trials, be able to put a more definite query. Full particulars of the ferro-prussiate process have been given, and I suspect it only requires a few more experiments for the querist to succeed.—E. G. M.

[56848.] — **Grinding Pearl Barley.** — The querist can compel the dust to go into his loft by means of a powerful exhaust fan; but exactly how that is to be arranged remains to be settled when further details are given.—ESSAR.

[56851.]—**Small Motor Castings.**—Would it not have been better for this querist to have returned one of the F.M.'s, and obtained a proper match? Mere difference in weight might not make much difficulty; but another pattern is awkward.—T. J. M.

[56853.]—**Writer's Cramp.**—I am afraid there is not much that is satisfactory that can be said to this querist. If he has been under a specialist who has failed, there is not much reason to suppose that any advice given in these columns could do him good. Alleged remarkable cures by the gentleman he names have been published in the *Lancet*, and he might communicate with Dr. A. de Watteville, of St. Mary's Hospital, Paddington, W., with advantage.—SCRIBO.

[56879.] — **Ferrotype Photograph.** — I am afraid this photo. is irremediably spoiled; but if it is of any special value, I would recommend querist to consult an expert photographer, who would no doubt put it right if possible.—T. M.

[56937.]—**Tons Measurement.**—Tons measurement is the tonnage of a vessel calculated according to her length, breadth, and depth. Tons burden is the amount of cargo she is capable of carrying, and is found by calculating every forty cubic feet of cargo space as one ton.—JAMES MCCASH GOVAN.

[56940.] — **Manufacture of Aluminium.**—Evidently A. H. Allen could not have read my answer to the above with much interest, or else he cannot know much about it, or he would not have contradicted the answer to the query on the subject. It distinctly says on page 418 that "In order to complete the process, and convert it into aluminium, the aluminium chloride is treated with sodium, in order to withdraw the metal. The operations are completed in a few days, &c., &c." The Webster process is a simple and successful one, for all the by-products are regained. The potash and sulphur are extracted, the iron thrown down as a fast and splendid blue, while the residual sulphuric acid is concentrated for use. But the chief advantage is its supersession as a dry and speedy process over the old and cumbrous method of precipitation, by which enormous quantities of substance had to be handled, and a bulky and gelatinous mass produced, requiring a great length of time to dry before being fit for use, and was even then contaminated by impurities. By the new way, the alum requires but twenty-four hours for conversion into the dry and pure alumina. Using three retorts of 2cwt. capacity for the anhydrous alum, the Aluminium Crown Metal Company, at their works near Birmingham, produce two tons weekly (1883) of the oxide at one-fourth the cost of the precipitation process. The alumina thus obtained is balled with charcoal and salt, made into chloride and reduced for metal, the aluminium obtained being perfectly pure, containing no iron, the least trace of which is fatal to its use for alloy. Bars of aluminium bronze (Webster's process) have not broken till a strain of 42 tons per square inch was applied.—P. E. W.

[56948.]—**Gas-producing Apparatus.**—Replying to (1) I would state that I can only give you an approximate size, because you have omitted to tell me whether the engine inspires its charge and fires on having completed, say, one-third of its outstroke; whether every outstroke it fires the entire cylinderful compressed, or whether it is of the Otto type? At any rate, the sizes I should give as approximate would be air-pump 6in. bore by 3in. stroke. The generator surrounding it may be square, if you like. In the absence of the data wanting above, I cannot give you anything like a reliable reply as to the extent of the minimum safe sum wanted in the generator. (2) I would not advise the air-pump being made square, because it does not need to be bored, and the flanges, if turned, are handier round than square, whilst the angles of a square would, in my opinion, be likely to cause damage very soon to the diaphragm. (3) Benzoline and gasoline are not the same thing, although derived from a similar source, and gasoline is certainly by far the best gas producer. (4) As the cost of the gas is relatively that of the gasoline, the cost per 1,000ft. I should put down at, say, 6s. A gentleman who uses this in quantities says his gas costs him but 5s. 3d. a 1,000ft. The strength of gasoline gas is in excess of coal gas, as shown by the indicator diagram; but apparently the expansion is not so well maintained. Should you desire, by advertising your address, I would draw the attention of the firm who now make this apparatus commercially to it, and have no doubt they would supply a set of castings very cheaply. You would find the pattern making for it somewhat troublesome. I made one for myself, and it was a lengthy job, owing to the core-boxes and parts needed to get the passage ways, &c.—INVICTA.

[56949.]—**Aluminium and Calcium.**—To MR. W. J. GREY.—I intend taking your advice respecting Al, and shall include Ca and Mg. I must differ from you respecting the properties of Ca. It is now six months since I made my last sample, and it remains unalterable. Four years since I made an alloy of Ca and Ni, and deposited a beautiful white metal. I also alloyed it with Cu, and produced a rich gold colour. The salts for plating with Ca are far more economical than Ni salts. The CaO can be so easily obtained at a trifling expense, that it appears to me to open a new field for enterprise—particularly as an alloy.—F. W. GERHARD.

[56950.]—**Lead Burning.**—In your issue of the 24th, Mr. P. J. Davies takes an unfair advantage of us. We received a memo. from him on the 17th inst. of more or less the same tenour of his communication to your journal. We answered him, saying we were unable to forward a machine, having a large shipping order to fulfil which took the whole of the machines we had in stock, but would make an appointment to meet him as soon as we had another ready. Would it not have been more fair to have waited a reply from us, instead of rushing into print so early with his reply (*sic*). How can he positively say, "I cannot speak in favour, &c.," especially when he has not tried? Would it not have been more English-like to have said: Not having as yet tried or tested Briggs and Co.'s lead-burning machine, I will withhold my opinion until I have done so? He speaks disparagingly of the specimens of lead burning at our exhibit. May we ask, Did he go with an unbiased opinion, or with (as we think) a jealous feeling? Will he inform us what is wrong, and what is faulty? Probably he has made a mistake, and what he takes to be wrong or faulty, a less practical man will prove to him is an improvement. In this age we live and learn, and we must say that one person has yet something to learn, though perhaps he will not admit it. We cannot expect a favourable or unbiased opinion from Mr. Davies if this is the way he takes an unfair and non-tested advantage of our machine. We do not pretend to say that the burning is done by a professional lead burner, but only wish to prove "that it will burn lead," and that the machine is handy to carry about, being always ready for use, and does not require preparation with acid or spelter.—BRIGGS AND CO., 58, Rokeby-street, Stratford, London, E.

[56956.]—**Ball Bearings.**—Charles Hosken is of the same way of thinking as the writer used to be. For several years he condemned these bearings and rode machines with parallel steel collars. About four years ago he bought a bicycle with ball-bearings to front wheel, and at once found out his error, and has since ridden machines with ball-bearings to both wheels and pedals also, and as long as he can get them does not intend to have any other. Besides being easier of propulsion, they almost dispense with the use of oil and its attendant mess. In the matter of road grit they are about on a par—it very soon destroys either if allowed to get in.—R. R. N.

[56956.]—**Ball Bearings.**—Would Mr. Hosken (p. 458) give me the name of one of those "first-rate riders" who are "opposed to ball bearings," and, referring to his remarks about "new-fangled ideas," can he tell me of any amateur, maker's amateur, or professional, who would engage in a race that he really wanted to win, except on a bicycle having ball bearings? This question was argued at some length many volumes back; but until we get a perfect bearing, in which the axle is always separated from the bearing by a film of oil, I imagine that those who want to win "pots" will always use balls.—ESSAR.

[56956.]—**Ball Bearings.**—I think that Mr. Chas. Hosken would be doing good service if he would let us know what bicycle bearings he would recommend, and why? It is easy to say "Have nothing more to do with ball bearings"; but to those who have always looked upon double ball bearings as the best one could have, it is not easy to do so unless we have reasons given why others should be preferred. Taking a bearing to mean the part through which the axle revolves, it is not easy to see how perfection is to be reached. It seems to me that there must be friction in three different directions, one vertically and the other two laterally—viz., one to keep the forks up against the wheel, and the other some contrivance to prevent the bearing itself from working outwards. I cannot see how anything better than balls can be contrived to answer these purposes as long as the balls are kept quite clean and well oiled. Cones would probably be very good if metal could be got sufficiently hard to resist all wear; but if once a groove begins to cut the bearing must be bad.—J. R. T.

[56969.] — **Hydraulic Ram.** — Our friend "W.A.S." misquotes my statement at page 458, as it was not my intention even to say that, nor did I say so. What was stated may be made more clear by explaining that: Supposing the valve to be open, and water flowing steadily and quietly out, the water would flow round and over the valve without closing it or lifting it to its face. But let the same water, under the same head, flow out with speed, at a given rate of speed, the water would, pressing on the under side with a power equal to the head and the speed, quickly close it; and, supposing that no recoil took place, would, the valve no longer being in partial equilibrium, still hold the valve to its face, and the ram would cease to work. But, as I have before stated, there is a recoil; the valve therefore falls, due to a superior pressure above it, and partly by gravity. We will assume it has fallen, and also assuming it was not loaded to represent the statement I made, the least speed of the outflowing water would close it again, long before the falling column had attained a speed sufficient to force water more than a very small height. Therefore, for a nominal lift, the conditions are very simple. It was for this reason that I made the statement I did, and my inference was intended to mean (and the querist states he knows the principle of the apparatus) that the valve must either be in itself, or, as made by a well-known maker, of such a weight that the flow of water has time to gain sufficient speed to acquire the necessary momentum required to force the water on the delivery. General Morin's work I know and have; but I do not by any means agree with him on all points. It is not reasonable to waste time and space on such a matter. I could point out several items. Still, on the whole, the book is both interesting and instructive.—INVICTA.

[56977.]—**Strength of Beams.**—"A. B." inquires the relative strengths of beams: 1st, a bar 4in. deep by 2in. wide; 2nd, a bar 3·8in. diam.; 3rd, a bar 3·5in. square. Answers have been given by "J. S. C." and "Dubliniensis." That given by the latter does not appear to be clear to the former (see p. 439), and I must confess neither of them is clear to me. I have always understood that the strength of beams varies inversely as the length, directly as the breadth, and directly as the square of the depth, or in a formula as $\frac{B\,D^2}{L}$. This rule is that given by Goodeve, Anderson, and several others, and if correct the strength of the first would be represented proportionally to the others by the number 32. In the second and third cases as $b = d$, the strengths would be 3·8 cubed or 54·87, and 3·5 cubed or 42·88 respectively. But by this formula it follows that a square and round bar of equal thickness would have the same strength, which is inconsistent, seeing that the areas are as 1 is to ·7854. I shall be much obliged to the two gentlemen referred to above, or other readers of the "E. M." if they will kindly explain the matter further for the benefit of the original inquirer, and of—F. A. R.

[56679.]—**Supported Beam.**—I beg to apologise to "J. S. C.," for contradicting his assertion that there is no strain at the centre of the beam. I did not take the statement in its strictly mathematical sense. Of course, the centre is a point, and has no magnitude. The strain upon the point is therefore infinitely small. In concluding, I must compliment "J. S. C." upon the power which he possesses, in common with Prof. Goodeve, of leading the readers of his writings into literary traps.—BACCHUS.

[56997.]—**Hydropathy.**—For nervous debility a strong brine made of Tidman's sea salt is very strengthening. The same water can be used more than once. It had better, perhaps, be slightly tepid, and the sponge merely dipped in the water and rubbed over the body, which is less exhausting than a large volume of water. I would strongly advise "Quixote" to leave off tea and coffee, both of which act injuriously on nerves and stomach, as I found, bringing on migraims and sleeplessness. Milk, boiled or cold, and diluted with water if preferred, is a nerve-strengthener, also Schweitzer's cocoatina, a small quantity of which is sufficient, as I find it digests better when weak.—C. M. Y.

[56997.]—**Hydropathy.**—"Quixote" may be unable to go to a hydropathic establishment, as advised last week in the two replies to his request. He says "he has nothing but a tub and sponge, and is probably wrong in his mode of procedure." In my plan not even a tub or a sponge is needed; nothing that is not already in the room, and yet I derive much refreshment and invigoration from my "hydropathy." All I do is to pour some water into the hand-basin, wet a corner of a towel, squeeze it a little so that it is wet, but does not run, and then wet-rub a division, and only a division, of the body. Then I at once dry-rub the part wetted with a dry and coarse towel until it is dry and comfortable—not wet, or damp, or chilly. I then do the same to the other divisions, and the process is complete, and I feel refreshed, enlivened, and strengthened, and that what I have done has done me good. I make three divisions—(1) chest and one arm; (2) a leg and the other arm; (3) the other leg and the back. It takes 8 to 10 minutes to do the whole job. Not much water is needed. There is really but little to remove from the skin unless one is engaged in dirty work, and the water I find is only clouded—like rinse water, in fact. There is no splashing or mess made, and nobody knows whether I do it or omit it. Now for a great secret, especially for the weakly and nervous. I do not *chill the feet*, or stand in any tub or pan, or on a cold floor or oilcloth: washing the feet or head is done at other times, and forms no part of my morning's ten minutes' "hydropathy." I am careful directly I take my warm feet out of bed to put on my socks and keep my feet warm, and my system admits of that, while most plans do not. "Quixote" should make that his key-note; secondly, by working in divisions, I prevent the evaporation and the chilling of the body incidental to the plan of wetting all over at once. If "Quixote" will avoid these two great evils, and "do" his head and feet somewhen else, I am satisfied that he will find great benefit obtainable without any "apparatus"—without even a tub or a sponge, and without any "establishment."—NO CHILL.

[57022.]—**Perchloride of Iron Battery.**—To "SIGMA."—This battery, which is called a new one, is like most of these new and patent batteries—very old. I tried it myself over thirty years ago, and it will be found mentioned and slightly explained on p. 159 of my "Electricity," 2nd edition. The source of the energy is the reduction of perchloride of iron to protochloride. The proposed gain is in the spontaneous regeneration of perchloride through the agency of atmospheric oxygen. The battery is, in fact, a Bunsen, in which the zinc is replaced by iron with greatly reduced force, and the nitric acid replaced by perchloride of iron, also with lessened force. It gives off no fumes, and that is its only merit; but it polarises very quickly, and its E.M.F. is low. "Ex-Garrison Gunner's" difficulty arises from his supposing that the actions are equal and opposite, the similar formation and reduction of chloride of iron, forgetting that these are two chlorides. The iron is not reduced and then oxidised by the air, but perchloride becomes protochloride, and then the air in presence of excess of hydrochloric acid, probably by a series of operations or else by direct action on the hydrogen of the acid in presence of photochloride of iron, re-forms perchloride. The energy of this oxygen is the source of the current.—SIGMA.

[57026.]—**Problem.**—To this problem, as stated, no definite solution can be given. The quantity of water required must depend on the relative amounts of the two whiskeys in the mixture; but these are not given, nor any data from which they could be deduced. If these relative proportions are known, the problem may be solved without the aid of algebra. Assuming that equal quantities of the two whiskeys are mixed, the value of that mixture would be $\frac{16 + 19}{2}$, or 17s. 6d. per gallon. If the mixture be now diluted with water until its price is reduced to 12s. per gallon, the proportion of water added will be equivalent to the difference between the two rates divided by 12— $\frac{5·5}{12}$ or $\frac{11}{24}$ of a gallon of water to each gallon of the mixed spirits. Applying these data to the 51 gallons stated to be the final result, a simple rule-of-three calculation shows that these 51 gallons consist of—

| Gals. | |
|---|---|
| $16\frac{1}{35}$ | of water, |
| $17\frac{17}{35}$ | whiskey at 16s., |
| $17\frac{17}{35}$ | do. 19s., |
| 51 | mixture at 12. |

—W. HARDIE, Joppa.

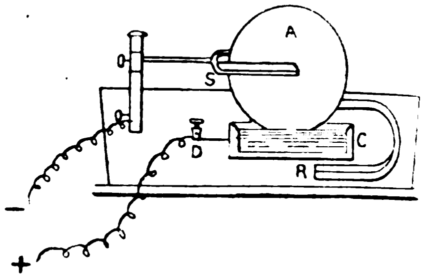
[57028.]—**Stamping in Relief.**—Many thanks to "Os" for his kind information, and would he (or others) kindly give the details of the process, whether by press or hammer? I have been put off over and over again till seven valuable weeks have been wasted before I could get hold of a few gross tickets, and to save such loss and annoyance in the future, I wish to know the most economical way in which I could get out my own tickets readily as wanted. I have the die, and am offered the "counterpart" for 3s. 6d. What are the counterparts composed of? And is this as cheap as I could make one for from the die? I suppose, whether struck up in a press or by hammer, something of the kind would be needed to sink the plate into the letters? What kind and strength of brass would be suitable, and what should be about the cost of press or other needed appliances? And would they do for stamping stationery in relief and colours? I suppose a separate die would be required? Can the tickets be stamped and cut out of the sheet at one operation or not? I noticed on some of the first tickets received some reddish fluid. What may it be, and for what purpose, and how is the lacquering or finishing done? A rough sketch of the most suitable appliances would greatly oblige.—A WOULD-BE STAMPER.

[57033.]—**Refining Gold.**—Dissolve alloy containing gold in a mixture of hydrochloric and nitric acids. The chlorine of the hydrogen chloride unites with the gold, forming gold trichloride ($AuCl_3$), which is soluble in water. To a solution of this add a small quantity of ferrous sulphate ($F_2SO_4$). A brown precipitate of very finely-divided gold is formed. Then filter, wash, and evaporate to dryness, leaving pure gold.—H. L. C.

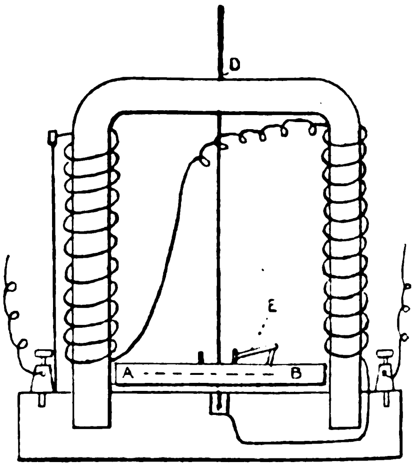
[57039.]—**Firing Mines.**—Get Dyer's book "On the Induction Coil." You will find in it various ways of firing mines.—THOS. H. HALL.

[57039.]—**Firing Mines.**—The best way to do this is with fuses. A cylindrical case of cardboard or other suitable material is filled with guncotton, and the wires pass through one end and are bored for a short distance and joined with a fine piece of platinum wire. The current passing through this fuses it and ignites the guncotton. The India-rubber, Guttapercha, and Telegraph Works Co. sell a constant battery for mining and blasting purposes. I do not know what it is like, but daresay it would satisfy the querist's requirements.—BUNSEN.

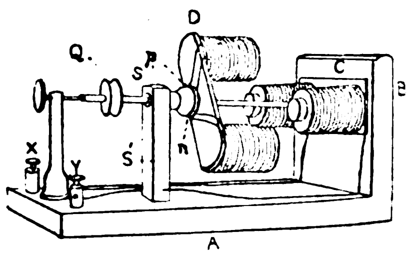
[57040.]—**Voltaic.**—One of the simplest means of showing motion produced by electricity is by the apparatus known as Barlow's wheel: A is a wheel of copper, movable on a stirrup, S. The edge of wheel dips into a cup of mercury, C. A powerful horseshoe magnet, R, is placed so that the wheel is exactly between the poles. The current enters at D, and passes to the mercury cup, it ascends the wheel to the stirrup, and from this back to the battery. The lines of force due to the magnet are at the point where the wheel dips into the mercury, perpendicular to the plane of the wheel, and consequently perpendicular to the radius by which the current ascends. Hence the rotation of the wheel.—BOBADIL.



[57040.]—**Voltaic.**—I send you a sketch of a small motor, which I think would answer your purpose. An electro-magnet, the legs of which are fixed into a base board. A soft iron armature, A B, fixed on a spindle, one end of which passes into a metal cup in the base, and the other end through the bent part of the electro-magnet at D. Two pins are fixed into the armature, against which pins a spring (E) is made to press alternately. The connections may be easily seen in the sketch. I should advise "Pith Ball" to put about four layers of No. 20 c.-c. wire on the magnet. If this will not suit, and the querist will let me know, I can give him descriptions of more complicated instruments.—ACCUMULATOR.



[57040]. — **Voltaic (Motor).** — Perhaps the simplest form of electro-motor which an amateur can make, to illustrate this special effect, is one consisting in two electro-magnets; one being fixed while the other is free to move, being supported by a spindle running between centres. The wires, which are coiled round the movable electro-magnet terminate in two semicircular pieces of brass, which are insulated from each other, and from the central spindle, which they encircle. Against these two half-rings of brass, press two springs of this sheet



brass, one of which is connected to a binding screw that places the motor contact with one pole of the battery; while the other spring joins the movable electro-magnet with one of the ends of the wires which surrounds the fixed electro-magnet. The other end of the wire, from the fixed electro-magnet, goes to the other binding screw, and from thence makes contact with the other pole of the battery. In the annexed cut, A is a wooden base, about 5in. long by 2in. wide, B a wooden upright, about 2¼in. high by 4in. wide. To this latter is screwed the fixed electro-magnet C, made of two short pieces of soft iron rod, soldered down to a piece of iron hooping. The dimensions of these pieces of iron are 1¼in. long by ¼in. diameter. The movable electro-magnet, D, is made in precisely the same manner, and is of the same dimension. Both are wound with about three layers of No. 20 cotton-covered copper wire. The wires from D are connected respectively to the two half-rings, which form the split collar, *p*, *n*, against which press the two springs, S, S′. The spindle rests on centres, and has a pulley, Q, by which the motion can be transmitted where desired. The current from the battery enters (say) by the binder X, traverses the coils of the fixed magnet, leaves them near B, and passes up the spring S′, enters the movable magnet, and causes it to be attracted by the fixed magnet. It comes out by the wire P, and, descending by the spring S, returns to the battery by the binder Y. For the motor to work properly, the springs and split collar must be so arranged that the springs find themselves pressing on the brass portion of the split rings at all times, *except* when the poles of the movable magnets are exactly opposite the fixed magnets; in which case they must be resting on the splits, or, in other words, contact must cease.—S. BOTTONE.

[57042.] — **Spark Coil.** — I should advise "E. B. F." to get Dyer's book "On the Induction Coil," which will give you a large number of experiments other than "spark through vacuum tubes."—THOS. H. HALL.

[57042.]—**Spark Coil.**—As "Bobadil" has kindly offered to help me, I may say my coil gives a ⅛in. spark. I would be glad to know what experiments I can perform with it, and if there are experiments of much interest which are better shown with a larger coil, I will get one. But does a larger coil require a larger battery.—SPARK.

[57043.]—**Spectroscope.**—If "Jolly Miller's" spectroscope were powerful enough, and its slit fine enough, it would show the thickest of the three lines double; it alone is the sodium or D-line. The two conspicuous, but much thinner, lines, close to it, on the red side of the spectrum are the chief lines of the rain-band. They are not always visible, and being, when present, always strongest in the light coming from the horizon, they thus betray their atmospheric origin, the light from that quarter having traversed a much greater thickness of air, and also denser air than that coming from the zenith.—W. HARDIE, Joppa.

[57048.]—**Hardening Dividers.**—Heat to a red heat, quench, rub clean with emery cloth, and hold over the flame of a spirit lamp till it shows blue, then quench.—THOS. H. HALL.

[57050.]—**Dynamo Construction.**—To W. H. EAVES, COVENTRY.—For 50 volts and 15 ampères make your A. 8in. by 4in. and wind with one layer of No. 16. This size is the same diameter, but half the length, of the 30-light armature (letter No. 24267), to which letter you can refer for size and thickness of discs, &c. The next letter on the 30-light dynamo will appear shortly, and from the instructions contained therein you will see the size of F. M., &c., that you require.—W. H. EAVES, Coventry.

[57052.]—**Weight and Stress of Beam.**—

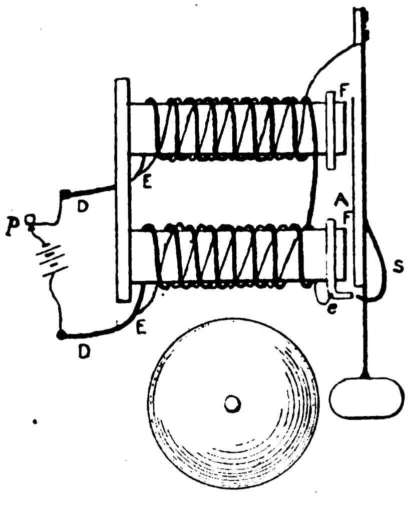
$$S = \frac{2 \times 100 \times 73}{100} = \frac{68600}{100} = 686\text{lb.},$$

with $\frac{1}{40}$″ deflection.—THOS. H. HALL.

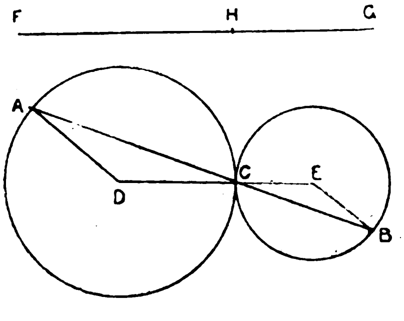
[57056.]—**Problem.**—If G. Fryer will reflect for a moment, he will be able to answer his own query. The number of men now living cannot exceed that of all those born during the last 70 years—seeing that the average duration of life is much under 70 years—while "the dead" comprise all who have died since man first appeared upon the earth; it is not, therefore, 50 per cent. in favour of the dead, but their number is manifold that of the living.—GAMMA SIGMA.

[57055.] — **Electric Bells in Series.** — In answer to the questions of your correspondents and their remarks, which evidently refer to the Jolin patent system of electric bells, we, as owners and sole manufacturers of the above, beg to say that we shall be most happy to give any of your readers full information if they will write to us on the subject, as the description would take up too much of your valuable space. We find no difficulty about the quality of iron: your correspondent probably does not know that soft wrought-iron is always used by all good makers of bells for the cores. Instead of complications, our bell is simpler than an ordinary one, and much cheaper to make; perhaps it is not generally known that it costs no more to wind two wires than one in the way coils are now wound by machinery. Will your correspondent explain what he means by "counter currents."—P. JOLIN AND Co., Electricians, Bristol.

[57055.]—**Jolin's Electric Bell.**—When the push P is pressed, a current flows through the coil D, magnetising the cores F, which attract the armature A; but on the spring S touching the contact *e*, the circuit in E is completeted, the magnetism of the cores destroyed, and armature released.—FRA. BROADBENT, Hammersmith.



[57058.]—**Science Examination, May, 1885—Mathematics, Stage II.**—Let D and E be the centres of the given circles which touch at C. Let F G be the given straight, less than the sum of the diameters of the circles. It is required to draw through the point C a line A B equal to F G. Divide F G in H so, that F G shall be to H G in the same ratio as D C to C E (Euc. VI. 10). From C as centre, and radius F H, describe a circle cutting the circle A C in A, and from C as centre and radius H G describe a circle cutting the circle C B in B. Join C A, C B. Also join D A and E B. Then since A C : C B : : D C : CE therefore A C : C D : : C B : C E; and since C D = D A, and C E = B E, therefore A C : A D : : C B : B E. Hence the triangles A C D, B C E are equiangular (Euc. VI. 5); and, therefore, the angle A C D is equal to the angle E C B. And since D C and C E are in one straight line, therefore A C and C B are in one straight line, and from the construction, A B is equal to F G, and it is drawn through the point C as required.—J. E. GORE.



[57059.] — **Power.** — The power or potential energy necessary to raise the weight up stairs at an angle of 60° would equal $\frac{\sqrt{3}}{2} \times 110 \times 22$

$$= 1210\sqrt{3}$$
$$= 2093{\cdot}3 \text{ foot-pounds.}$$

If chain pulleys were used, the power would equal (when they are as 1 to 24) 24 × 110ft.lb. = 2640ft.lb. I have not calculated what the friction would be; but as the number of pulleys is not given, it will suffice to say that the whole power would increase as the number and weights of the pulleys.—NESTER.

[57063.]—**Specific Heat.**—Suppose $\theta°$ is the temperature of the mixture, we have the following equation:—$5 \times 79 + 5\theta = 25\ (50 - \theta)$, where 79 is the latent heat of liquefaction of snow. Solving we find $\theta$ is equal to 11·83° Cent.—H. L. C.

[57063.]—**Specific Heat.**—Let $x$ equal resultant temperature, then the temperature of the water falls $(30-x)$ degrees, and in doing so gives out $(30-x)$ 25 grm. units; the temperature of the snow rises $x$ degrees, and in doing so absorbs $(79{\cdot}4 + x)$ 5 grm. units of heat; but the heat absorbed equals that given out, therefore—

$$(79{\cdot}4 + x)\ 5 = (30-x)\ 25$$
$$397 + 5\ x = 750 - 25\ x$$
$$30\ x = 353$$
$$x = \frac{353}{30}$$
$$= 11{\cdot}76°$$

This may be verified by experiment.—DAVID STEPHEN.

[57064.]—**Bisulphite (not Bisulphide) of Silver — Roseleur's Solution for Simple Silvering.**—Dissolve 4 parts common washing soda in 5 parts distilled water, and place solution in a deep narrow vessel containing about ¼in. depth of mercury; stand a long glass tube in the bottle, its lower end, of course, resting in the mercury, and pass through the tube sulphuretted hydrogen gas, which make in the usual way in a Woulff's bottle, sulphide of iron, and dilute sulphuric acid, and continue to pass the gas through the soda solution till it is found to redden blue litmus paper. Stop the flow of gas as soon as this is observed, as the solution must not be allowed to become decidedly acid. The soda solution must now be carefully poured off, leaving the sediment, and after standing 24 hours again tested for acidity, and separated from the sediment, if any. If it still reddens blue litmus paper decidedly, put in a few more soda crystals, until the paper is only changed to violet. If it renders red litmus paper blue it is too alkaline, and more gas must be passed into it. When you have got your soda solution just right (bisulphite of soda), prepare your silver solution by dissolving any quantity of nitrate of silver in distilled water, and add by degrees to your first solution as long as the precipitate at first formed is dissolved. The moment you have a precipitate which refuses to dissolve add no more, as it would be simply waste. Now you have converted your bisulphate of soda solution into one of bisulphate of silver, and are ready to begin work. The solution is used cold and will produce the most beautiful coatings, light or heavy, according to the time of immersion, on almost anything, particularly brass, copper, and bronze, and will work for years. When the silver gets exhausted by continual wear, simply add more nitrate solution. For particularly important work it is wise to dip the goods, after cleaning and before plating, in a weak solution of nitrate of mercury. "Argent" will see, therefore, that the process is one of silvering by immersion. I do not know if it could be used for what I may call silvering by transfer, the method, of course, most used for barometer dials. However, the experiment might be easily made. If the result seemed satisfactory, I should certainly varnish it for security. I have received a postcard signed "Another Reader of the ENGLISH MECHANIC," requesting me in this place to reply to a few additional questions on silver-plating. I think it would have been better to have inserted his queries, or sent address, so I might have answered him by post. However, I may say, in reply, that I gave the hyposulphite solution in reply to query 56584 simply because it seemed of the kind the querist was seeking, and carefully guarded myself from recommending its adoption. I said it was fair—not good. In reply to a second query, the best method of (true) silvering on glass is, I believe, that of Boettger, which consists of two liquids—(*a*) Into 40oz. boiling water throw 48gr. Rochelle salt, and add gradually a solution of 1dr. of nitrate silver in 1oz. water. Boil ten minutes, and filter when cold. (*b*) Dissolve 1oz. nitrate silver in 1oz. water, and add liquid ammonia till the precipitated oxide is just redissolved. Then add 12oz. water, and filter. A mixture of equal volumes of these two liquids coats glass (Boettger says) in the course of ten minutes with a bright shining layer of silver. I believe, however, the time taken depends on the temperature of the solutions, the above speed being the result of a temp. of 30° C. It is, however, safer to use the solution cold, although the action is not so rapid. In reply to the next question, it is quite possible to deposit platinum, but the result is rarely satisfactory.—PERCY W. STANLEY, 119, Manchester-road, Poplar, E.

[57066.]—**Reducing the amount of Lime in Chalk Water.**—"C. H. D." can obtain a copy of the specification of Clark's patent process at the Patent Office, Southampton-buildings, Chancery-lane, London. The so-called "chalk" is held in solution by carbonic acid in the water. By adding quicklime to this water, the excess of carbonic acid attracts the quicklime, and both the new compound and that previously held in solution are deposited in the form of very finely-divided chalk, which has to be removed by filtration through several layers of stout canvas. The apparatus requires frequent, almost daily attention; but is very effective, and where several householders combine, the cost is not very onerous.—GAMMA SIGMA.

[57068.] — **Dynamo.** — To W. H. EAVES, COVENTRY.—By winding your A. with a single layer of No. 18 you will get about 35 volts and 8 ampères, which current will light four 20 c.-p. lamps. Make your magnets of the best wrought-iron, and wind them with from 20 to 25lb. of No. 18. My second letter on the 30-light dynamo is partly written, and will be in the Editor's hands in a fortnight. I am very sorry I have not been able to send it before, it having been delayed from time to time by pressure of business.—W. H. Eaves, Coventry.

[57070.]—**Telephones.**—I think I can help the querist with his instruments. No. 38 s.c. wire is generally used, but 40 would do, I should think. Of course less 40 would be required than 38. I think about 280ft. would be sufficient. No battery is required with these: they are simply connected. They will not speak far. What size was the 1,000ft. of wire used in the experiment?—Bunsen.

[57073.]—**From Mr. Rogers.**—If "Accumulator" will publish his address, I will send him a working sketch of the ammeter I described, which can be moved about or carried in the pocket without injury.—F. M. Rogers.

[57075.]—**Parchment Paper.**—This has been given many times in back numbers. Dip unsized paper into dilute sulphuric acid, and then into ammonia or clean water.—Onbr. Juthos.

[57075.]—**Parchment Paper.**—I suppose you mean vegetable parchment, such as is sold for the purpose you require it. This is made by passing white blotting paper through a bath of sulphuric acid of about 140° Twaddell, and afterwards well washing in pure water. The exact strength of the bath is only to be obtained by experiment, and it will dissolve the blotting paper if not right.—Quod Dixi Dixi.

[57079.]—**Windway.**—I cannot help your correspondent "A.B.C." for two reasons: First, because I don't know how to convert a cavity-board into an arrangement suitable for the paper "music"; and, secondly, because I will not assist anyone to spoil a good piece of work in producing a botch. If your correspondent wants a 3½ octave automatic instrument, surely he can make a board to carry the reeds without spoiling a two-row American organ board. It would be an easy matter if he were going to use the barrel arrangement, with levers to depress the pallets.—Organon.

[57079.]—**Windway.**—If "A. B. C." intends to adopt two sets of reeds instead of one, I should advise him to adopt the lever principle, with pallets, &c. If "A. B. C." goes beyond the compass of three chromatic octaves (that is, 37 notes), I am afraid his instrument will be considered clumsy in the eyes of some people. It is only a question (at least, in my opinion) whether the querist wants music from his proposed instrument, or a very limited number of tunes, with harmony equally limited in its variety of effect.—G. Fryer.

[57080.]—**Siphon.**—The failure of your siphon is probably due to an accumulation of air in the long limb, either sucked in through some leak in the pipe or given off from the water. You must surely mean that the end of the leg is 36ft. below, not 31ft. above the bottom of the well.—W. A. S.

[57080.]—**Siphon.**—In "Surveyor's" data, some error has surely crept in. The last statement should read, I imagine, 36ft. below bottom of well, instead of "31ft. above bottom of well." In all probability accumulation of air is the cause of stoppage. Remedy, as the air in the pipes has always a tendency to reach the highest point, a suction pump should be put on the highest part of the siphon, and blow-off valves at the top of all upward curves in the progress of the pipe.—B.Sc., Plymouth.

[57080.]—**Siphon.**—Your siphon would be certain to cease working in a very short time, because air is certain to accumulate at the top of the summit level. The water in all siphons gives off air under the conditions set up, and the partial and subsequent entire cessation of the flow is due to the air accumulations. These first reduce the size of the stream flowing over the summit level, thus being equivalent to reducing the size of the bore, and as soon as the globule of air attains a diameter equal to the bore of the pipe the flow ceases entirely. On a past occasion, where a large siphon was used to clear the water out of a railway tunnel, the siphon invariably ceased working in a few hours from accumulation of air. As the siphon cost a tithe of a pumping engine, we tried several plans, and finally managed to get on an appliance to extract the air as it accumulated.—Invicta.

[57080.]—**Siphon.**—There appears to be a misprint in the query, as the outlet is stated to be 31ft. *above* the bottom of the well; under which conditions, of course, the siphon would not commence to work. From the data given, it would appear to be 36ft. below this point. The failure of the siphon is most likely due to air or fixed gas (probably carbonic acid), held in suspension in very minute quantities in the well water. When the ball-cock is closed and water in the pipe at rest, this air or gas under the influence of pressure in the pipes, possibly assisted by change of temperature, would tend to disengage itself from the water, and travel in very minute bubbles to the summit of the pipes, where a small accumulation would stop the action of the siphon. If, instead of closing the ball-cock the siphon were allowed to run, it would probably continue to do so for an indefinite time, the water carrying away with it the contained air or gas. The writer would be interested to learn whether this suggestion is successful.—R. R. N.

[57081.]—**Watch-Maker's Bow.**—To make a good bow there is nothing like whalebone. The best way is to got hold of an old carriage umbrella, which will afford enough for two or three dozen. For watch-work the bow should be scarcely a foot long, and horsehair should be used. It is a great mistake to have the bow too stout, and, consequently, too much tension. When not in use, it should be nearly straight, and when on the ferrule only sufficiently tight to carry the work safely, as there is no resistance when pushing the bow from you. The knack of easing the graver off the work in this back stroke is soon acquired by practice.—Escapement.

[57083.]—**Freemasonry.**—If "Z." looks upon Freemasonry as a mere benefit society, the less he has to do with it the better for the Craft. If he becomes a Mason, he should do so, hoping to do good, and receive nothing in return. The expense incurred depends upon the lodge he joins. It need not cost him more than five and a half guineas, inclusive of regalia. If "Z." is initiated, and yet receives no pecuniary benefit from the charities, I imagine he will find himself more than adequately rewarded both morally and socially; always provided he enters Freemasonry in a right spirit.—P.M., P.G.C.

[57084.] — **Shunt Dynamo.**—To Mr. Bottone or Others.—In order that there should be a current, a complete go and return path must be open for the electricity to flow along. When the brushes are not pressing against the commutator, the road is not open, and no current passes, the fields are not magnetised, and apparently little or nothing takes place. The origin of the current lies in the trifling residual magnetism of the iron cores. This magnetism derives it being, if the cores are really very soft, from the magnetism induced by the earth. In ordinary cases, a small amount of magnetism is set up in these cores either by percussion during manufacture, or by the use of the battery. However produced, this magnetism is always very small in amount, and would give but little effect if the current set up in the armature on rotation were led directly to the outer circuit. But, in the dynamo, this infinitesimal current is led round the cores of the field magnets, and, in circulating round them, sets up a higher degree of magnetism, which, if the motion is kept up, sets up in its turn a higher electromotive force, and so on, until the limit of saturation is reached. The brushes have nothing to do with the generation of the current: they are the sluice gates, which, when in proper position, allow the current to flow. See my book on "The Dynamo."—S. Bottone.

[57088.] — **Emigration.** — In reply to "An Anxious One," the writer has spent some nine or ten years in Canada and the United States, mainly as wood-carver and cabinet-maker, and is pleased to give the benefit of his experience. He by far prefers the States to Canada, and, if refinement and more home-like circumstances be a consideration, he prefers the Eastern (say Virginia, for instance) to the Western; but if able to "rough it," and money-making be the object, he would recommend some of the younger States or Territories. As to what country will offer the best opening, I consider it a question impossible to answer. It is like asking, Is there any opening for a cabinet-maker in all Europe? No one can say without a vast deal of travelling over the whole Continent. The writer would recommend "Anxious One" to decide as to *where* he will go on other grounds—climatic, for instance, &c.—and then make the best of it. He would also advise some time spent as a journeyman in different parts of the country till he has a fair insight into their ways of doing things, and also giving him time to decide where he would like to locate. The Americans are very go-ahead, and make large use of machinery, which of course is hard on hand labour, except in some small country towns and villages, where a fair workman might do well. The best part of the writer's experience there perhaps was while putting up good furniture at the country gentry's own houses, working on the premises and boarding with the family.—Virginia.

[57092.]—**Ginger-beer Plant.**—I don't know the botanical order to which this plant belongs, but I believe it is a fungus of some sort. Ginger-beer is made with it by simply putting it into a bottle and filling the bottle up with bits of whole ginger and sugar to taste. It must be kept lightly corked; when it blows the cork out it is ready to drink. It must not be left more than a day in the bottle with the plant, or it turns bitter. Use white loaf sugar, not brown, which makes a most abominable concoction. I have drank quantities of ginger-beer made by the plant, and I am still sufficiently vigorous to answer this query. The plant grows enormously (that is the grains increase in number), and has to be separated into more bottles at intervals, as it doesn't do to have too much in one bottle—R. A. R. Bennett, Walton Manor Lodge, Oxford.

[57092.]—**Ginger-beer Plant.**—This plant belongs to the genus Scitamineæ or Zingiberaceæ. Gingerbeer is generally made from the common ginger (*Z. officinale*), and is distinguished as the narrow-leaved ginger, which is largely cultivated in the East Indies. The root stock—the ginger of commerce—is of the thickness of a man's finger, knotty, fibrous, and fleshy when fresh. The stems it sends up are reed-like, the leaves being linear-lanceolate, and smooth. The flowers are produced on short leafless stems, and are of a whitish colour. Gingerbeer is an effervescing drink made by fermenting ginger, sugar, and some other ingredients, and bottling before the fermentation is completed. Ginger in all its preparations is extremely safe and harmless for the palate, and is occasionally used as a domestic remedy, in the shape of ginger-tea, candied ginger, &c.—Nester.

[57098.]—**Warehouse Lift.**—This question is rather vague, as the speed at which load is to be lifted governs the cost; 5cwt. lifted 60ft. per minute = 112 × 5 × 60 = 33,600 foot-pounds, or just over one horse-power. To drive a lift at this speed, and overcome friction, &c., about 1¼ horse-power is needed. If "W. J. D." will say what speed will suit him, I will send a sketch, and give rough estimate of cost. Is the lift to work direct through floor, or outside by means of a jib?—F. M. Rogers.

[57101.]—**Spectra.**—It seems to me that all you want to know is the names of the substances which will produce various-coloured lines in the spectroscope. Put the instrument facing the flame of a spirit-lamp or Bunsen burner, and get someone to shake into the flame some strontium nitrate; this will give a brilliant scarlet line. Calcium nitrate gives a brick-dust line; barium nitrate will give a green line; copper chloride gives a blue line, and so on. You won't get single lines unless you use the chemicals; for whatever substance you burn (as paper, &c.), everything is so strongly impregnated with sodium that you will always get the yellow line.—R. A. R. Bennett.

[57102.]—**Air and Fuel.**—"Vulcan" should remember that although the air presses on all bodies with a pressure of between 14lb. and 15lb. to the square inch, yet the pressure is equal in every part alike. Now, to take his own illustration, say, in the case of a factory steam boiler, the pressure on the column of air issuing from the chimney is the same as that pressing on the underside of the fuel on the grate bars. I am in this eliminating the slight difference in actual fact due to the conditions of draught. Combustion being entirely the outcome of a liberal supply of oxygen gas by forcing in air, either by the aid of a bellows, or the assistance of a tall chimney stack, the oxygen contained in the air is brought into contact in larger volume with the fuel, and therefore the more rapid combustion. Supposing it were possible that the top of a chimney discharged the products of combustion into a vacuum the air pressure of, say, 15lb. would rush in so fast that the supply of oxygen would be so abundant that no grate bars would remain unfused many seconds. One more illustration. A copper ball, such as is used in every water cistern, is so thin that 2lb. or 3lb. pressure on the outside in excess of that inside would collapse it. But it never does collapse, because the interior being filled with air, an equlibrium is set up. The same state of things exist with your smith's fire when the bellows are not in motion.—INVICTA.

[57104.]—**Actuarial.**—Smart's Tables give £5 8s. 8·9d. and £5 15s. 7·9d. as the annuities for 30 years (half-yearly payments), which £100 will purchase at 3½ and 4 per cent. respectively.—BETA.

[57104.]—**Actuarial.**—To make the calculations asked for by "Annuitant" would only be wasting time, and of no general benefit. He should call on insurance companies who make annuities a speciality and ask for their tables.—B.Sc., Plymouth.

[57106.]—**Galvanised Iron Pipes.**—Zinc is dissolved by pure water, and is attacked by water containing carbonic acid. The French Government have for some time past prohibited the use of galvanised tanks in their navy. Zinc carbonate is a white, tasteless powder, and is insoluble in water. It is sometimes prescribed as a tonic, in doses of from 2 to 10 grains, and would be injurious if it exists to any great extent. The only remedy is, I fancy, replacing the pipes with others of lead. In this case a carbonate would be formed, which would prevent the water from further contamination. If, however, the water be soft, a lead pipe would be oxidised by it, and the water would be highly poisonous. I would advise that some of the white substance and the water be submitted to a competent chemist.—F. M. ROGERS.

[57107.]—**Developing Formulæ.**—(1) Liquids should be measured with a glass measure, not weighed, although practically I don't suppose it would make any difference. (2) All developers do *not* require the same exposure. The sodic sulphite one has a far wider range than either the ammonia pyro or the iron developers.—B.Sc, Plymouth.

[57107.]—**Developing Formulæ.**—An ounce of water weighs exactly 1oz., and therefore your formula would be right, if you weighed the water—albeit it would be considerably less trouble to use a measure, if possible. But water is the standard of fluid measures and weights, so remember that your dodge won't answer for anything but water; some fluids, such as sulphuric acid, being very considerably heavier. The exposures required are by no means the same for all developers, some requiring less and some requiring more. The best plan is to stick to the one you find answers best—sodic sulphite for example.—R. A. R. BENNETT, Oxford.

[57108.]—**Home Trainer for Bicyclists.**—There is an engraving of one of these in Goy's Athletic Catalogue, which will, no doubt, give "Mechanic" a good idea.—ONER. JUTHOS.

[57108.]—**Home Trainer.**—Far better than any mere description is the printed description of the bicycle stand and home trainer combined in one which I think is made by Messrs. Singer and Co., of Coventry. It is a casting with two large turned and grooved rollers. On these the driving-wheel runs. Two series of stay rods hold the handle bars so that the machine is held vertically.—INVICTA.

[57109.]—**Focus of O.G.**—By all means have your o.g. 50in. focus rather than 40. The advantage in the longer focus is by no means to be despised. Do you wish to correspond with me outside these pages? If you advertise your address I will freely and gladly give you any information in my power, by letter if you prefer that. Ask freely and frankly, and as freely and frankly will you be replied to.—INVICTA.

[57110.]—**Dynamo for Electro-Plating.**—Yes; it is perfectly practicable for an amateur to make a plating dynamo. No battery is known that does not require much looking after or replenishing to do the work you need.—S. BOTTONE.

[57110.]—**Dynamo for Electro-plating.**—It is quite practicable to use a small dynamo for electro-plating, provided the machine is wound to give out a quantity current. This is accomplished by using thicker sizes of wire on armature and field-magnets than would be used were the dynamo for the electric light, while the current must, of course, be continuous. Where batteries are employed, they are usually Smee or Daniell cells, either used singly, or connected for quantity or intensity—the arrangement depending on the nature of the work. In every case, however, the article to be plated is connected to the negative pole in the depositing vat, and the anode (silver, gold, or copper, as the case may be), is connected to the positive pole.—BOBADIL.

[57112.]—**Wet-Plate Photography.**—Get "The Principles and Practice of Photography," by Jabez Hughes, price 1s., from Simpkin, Marshall, and Co., 4, Stationers' Hall-court, E.C. I hardly know which process is easiest, but the dry is most advantageous for many reasons too numerous to mention here, which I will gladly name if you like in "E. M.," or by post.—W. J. R.

[57112.]—**Wet-plate Photography.**—1, The treatise by Mr. Dawson, editor of the *British Journal of Photography*, price 1s., published by Mason, 186, Sauchiehall-street, Glasgow, gives full instructions; 2, dry plates for portrait work are far the easiest for an amateur to master; 3, dry plates will not keep any length of time, but I have taken good photographs with plates a year old.—B.Sc., Plymouth.

[57112.]—**Wet-Plate Photography.**—Obtain Jabez Hughes's "Principles and Practice of Photography," price 1s., or Stanley's "Photography Made Easy," price 9d. Both are highly practical. From the last, which was sent me abroad, I practically learnt the wet-plate process. Hughes's 1s. book is equally good, but more extended. I can safely recommend you either as reliable and clear. Wet plates are easiest, in my opinion, for an amateur. But when the manipulation is perfect for speed, you would want to use dry plates. When you are ready to adopt them, I can from personal experience recommend you good hand-books on dry-plate manipulation.—INVICTA.

[57112.]—**Wet-Plate Photography.**—One of the best books published now is "Hardwich's Photography," but I am not sure about the price, probably about 3s. 6d. from its size. Before the dry-plate process was perfected I did not attempt to take photos, being appalled at the sight of so much labour; but when the dry-plate process came out, I went at it tooth and nail. I think there is not much doubt as to which is the easiest, and the best also, to my mind. Wet plates are necessary for some kinds of work, but not the sort "Jay Why" is likely to come across. Hardly any (one might almost say, no) professionals use wet plates now. The dry plates will keep any length of time under favourable conditions, that is, they must not be kept in a damp place—the dryer the better.—R. A. R. BENNETT, Walton Manor-lodge, Oxford.

[57113.]—**Photography.**—The fault lies not in Fry's plates or the developer, but with the individual who is using them. State carefully your mode of procedure, and I will help you and put you right. "Show me your faults, and I will tell your successes."—S. BOTTONE.

[57113.]—**Photography.**—Try Wratten's "Slow," or, if they are too expensive, the "Britannia." The best developer for amateurs is the Standard of the New York Society, as modified by Mr. Beach; his formula is given in late numbers of the *Amateur Photographer*.—B.Sc., Plymouth.

[57113.]—**Photography.**—Try Miall's plates and Swan's developer, viz.:—(1) Pyro, 3gr.; water, 1oz., at time of using. Stock Solution.—(2) Liq. ammoniæ, ½dr.; bromide of ammonium, ½dr.; water, 5oz. Use equal parts of each. If the picture comes out too slow, add more of No. 2. Soak your plate before development.—W. J. R.

[57113.]—**Photography.**—I have "tried various plates and developers," and the very best plates that I have yet come across are "Marion's Britannia plates" (22 and 23, Soho-square). There is no doubt that first-rate results can be obtained from Fry's, when you know how to get them; but in my opinion Marion's are more certain in the hands of an amateur, so much so that I use them now to the exclusion of all other makers, and several friends to whom I have recommended them say the same. Use sodio-sulphite developer, it answers much best with these.—R. A. R. BENNETT, Walton Manor-lodge, Oxford.

[57113.]—**Photography.**—It is very probable that the curious and unexpected results you have obtained arise from variations in the sodic sulphite you employ. Of all the chemicals employed in the photographer's laboratory none is so uncertain in its composition. In the commercial article imported from Germany there is usually only about 50 per cent. of true sulphite of soda, the balance being an uncertain mixture of carbonate, sulphate, hyposulphite, and other impurities. It must, however, be remembered that pure sulphite of soda is itself strongly alkaline to litmus paper, and it is usual to neutralise this by the careful addition of sulphurous acid. However, as this is troublesome to prepare, and difficult to keep, it is well to use crystallised acid sulphite of potassium for neutralising the sodic sulphite instead, as it is quite permanent, and answers just as well. These salts may be obtained from A. Boake and Co., for whose address I refer you to the sixpenny sale column this week.—W. G.

[57113.]—**Wet-Plate Photography.**—All photographic dealers keep works on collodion picture taking. These can be had at about 6d. each. Dry plate is easier to learn for amateurs—mechanically easier—but the wet plate gives a more thorough knowledge of the chemistry of photography. Dry plates will keep for years.—S. BOTTONE.

[57115.]—**Faulty Telephone.**—See my reply to 57070.—S. BOTTONE.

[57121.]—**Mountain Snow.**—"Ignorant" must remember that the temperature of the air decreases 1° Fahr. for every 300ft. or 350ft. of altitude. Hence the temperature at the top of a high mountain would not contain sufficient heat to melt snow. The region of perpetual snow, the lower edge of which is called the *snow line*, is on account of the intense cold at the sea level at the Poles; but at the Equator, on account of the heat, it is 1,600ft. above the level of the sea; and in the intermediate spaces the snow-line will be correspondingly higher or lower as it is nearer the Equator or Poles.—NESTER.

## UNANSWERED QUERIES.

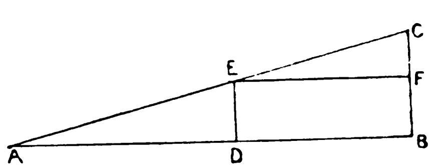
*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

56639. Winnowing Machine, p. 267.
56643. To Ostrich Feather Bleachers, 267.
56647. Spring Jack, 267.
56649. To "Sigma," 267.
56662. The Nottingham Caves, 267.
56663. Iron Planishing Machine, 267.
56664. Dynamo, 267.
56665. Strad. Model Violin, 268.
56670. Groynes, 268.
56674. Carbonado, Bort, Diamonds (Gems), 268.
56683. Magneto Machine, 268.

56837. Drill Chuck, p. 354.
56842. Lathe Query, 354.
56843. To Mr. Wetherfield, 454.
56845. Coil Springs, 354.
56861. Eccentric on Crank Shaft, 355.
56863. Flexible Material for Winding Round Piston, 355.
56864. Safe Making, 355.
56865. Bolts and Nuts, 355.
56866. Hand Drilling, 355.
56873. Terrestrial Eyepiece, 355.

## QUERIES.

[57122.]—**Problem.**—In the right-angled triangle, A B C, D E is parallel to B C, and E F to A B; A C, D E, and E F are given to find A B. A pure trigonometrical formula required; "trial and error" not allowed; perhaps, however, more than one formula may be required. In practical terms these may be stated thus: A C a ladder 50ft. long; D E F B a porch 10ft. wide and 20ft. high, the ladder touches the edge of the porch. To what height will the ladder reach on the wall A B?—R.



[57123.]—**Hand Fire Extinguishers.**—I have been much puzzled to find out what is used to generate carbonic acid gas, in order to create the pressure which expels water from the above. Having no means of testing the substance myself, I should be much obliged if some kind friend would give the information.—H. L. C.

[57124.]—**Lifting Bar.**—In lifting horizontally with my hand, a bar of iron which lies upon the ground, weighing, say, 5lb. to a height of 4ft. I perform the work easily by taking hold of the bar by its middle, thereby doing 20ft.-lb. of work. If I lift the bar by taking hold of it at its end, it requires much more strength to lift it; yet, in this case, I do not gain time, space, leverage, or work done. How is this? And is not the hand a lever, fulcrum, power, and weight in the matter, and what of the bar?—NORFOLK.

[57125.]—**Photo Scrap Book.**—What is the best way of keeping photographic views of different sizes? If stuck in an album the leaves generally crumple and look untidy, besides, an album has the disadvantage of being at the disposal of one, or at the most, two persons only at one time. I thought of mounting them on cards of uniform size, and having a case made to fit. If this is the best plan, what size cards should be used, and of what thickness, and what is the best gum to use for sticking the photos on?—F. A. R.

[57126.]—**Obach's Galvanometer.**—What is the form of the Tangent galvanometer? Is Obach the inventor, or an instrument maker, or both?—B. S. T.

[57127.]—**Lactic Acid in Whey or Milk.**—Will any reader kindly inform me of any instrument whereby the presence of lactic acid in whey (or milk) can be determined, and of the various degrees as the acidity advances?—NO SIG.

[57128.]—**Storage Battery.**—Will some of our readers kindly give full particulars how to make the above suitable for lighting a 5-c.p. incandescent lamp for 10 hours, the battery to take up as little room as possible? I have never either seen one or read particulars of how they are made, so that as plain an explanation as possible will be esteemed a favour.—WEEDNA.

[57129.]—**Steam-Engine for Farm Work.**—On a farm there is a threshing and churning machine worked by the ordinary horse-gear. A pony can either thresh or churn quite easily, pulling at the horse-shaft, 9ft. 6in. from the centre, and going round 2½ times per minute. The churn has about 72 revolutions per minute, produced by intermediate gearing-wheels, and the thresher about 400, driven by a belt from a large pulley on the wall-box shaft. What I want to know is, the diameter, length of stroke, and revolutions per minute of a steam-engine (horizontal) that would both thresh and churn at the same time, with a boiler pressure of 35lb. per sq. in.; also size of vertical boiler with cross tubes that would be required. Of course, I would use intermediate gearing or pulleys to bring up necessary speed of churn and thresher. Would a steam-engine be cheaper to work than a gas-engine? I should have to make my own gas. I have a 7in. screw-cutting lathe, and could do a good deal at fitting up an engine.—YOUNG FARMER.

[57130.]—**Pump.**—I have water at the bottom of a field; I wish to get it to the top, a distance of 450 yards with about 30ft. rise.—FARMER.

[57131.]—**Bidwell System.**—What is meant by running tramcars according to the Bidwell system?—X. Y. Z.

[57132.]—**Electro-Motor.**—Can any harm be done to a shunt-wound motor by suddenly reversing the direction of the current through it, when running at full speed, to act as a brake to stop its motion?—W. E. H.

[57133.]—**Removing Tin from Scrap.**—Would any brother reader tell me how to remove tin from scrap, and recover the tin? Full particulars will oblige.—M. F. K.

[57134.]—**Easton's Syrup.**—What is this, and for what diseases is it recommended?—TRINKLEID.

[57135.]—**Varnishing Fancy Woods.**—I have made a small box veneered with fancy woods, principally rosewood. It has been varnished with "carriage varnish," which has dried hard upon all the woods except the rosewood. Upon it I cannot get it to dry. The rosewood has been cleansed and revarnished several times, but always with the same result. It seems to emit a gum which prevents the varnish drying. Can any reader suggest a cure?—T. J. A.

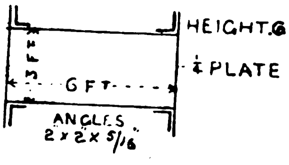
[57136.]—**Problem.**—Will any reader work the following? A cubic foot of water weighs 1,000 ounces avoirdupois; a pipe, whose bore is 3½ square inches, discharges 252lb. per minute. Find the velocity per hour of the issuing water.—JUDY.

[57137.]—**Reviving Ormolu Ornaments.**—Would some obliging correspondent put me in the way of cleaning and reviving some French ormolu, consisting of candlesticks, pen tray, &c.?—ORMOLU.

[57138.]—**Hair Monograms.**—I have some hair of a friend which I wish to put in a locket in the shape of a monogram. I shall be glad if any of my fellow readers of this valuable paper will oblige me with information how to do it myself, or as to the best place to get it done.—H. N.

[57139.]—**Amateur Modeller.**—Would anyone sympathise with me and tell me of something in the above way to be going on with until I find something more suitable for me in the "E. M.," as I find the articles just now appearing in the "Amateur Workshop" are rather beyond me? Will someone take compassion on me?—SIMPLETON.

[57140.]—**Safe Load.**—Will some correspondent please give rule for calculating safe load on a structure of this section? Also, what difference in calculation would it make if the casing were filled with water, supposing the bottom were closed?—S. B. BARD.



[57141.]—**Gas-Engine.**—To "INVICTA," "J. H.," AND OTHER PROFESSORS OF THE GAS-ENGINE.—I have had offered to me, and possess full working drawings of, a gas-engine, patented by a gentleman the name of Rodgerson. The article is of a very novel type indeed, and not being very versed in the merits of a gas-engine, I must ask the opinion of others. The arrangement is, a power cylinder and a charging cylinder, placed side by side, the products of combustion pass round a jacket in the charging cylinder, thereby heating the gas; the governor is placed so as to govern the gaseous charge immediately previous to its entering power cylinder, and after it has left charging cylinder. The novelty in the engine, however, is the mode of introducing the charge, and igniting it, the processes being by means of slots in the cylinder, and ports and slots in the piston, which entirely obviate any slide-valve and other frictional parts, by means of an arrangement similar to the regulator of a pump, which on the return stroke of cylinder, forces fresh pure air into cylinder to cool it, whilst a like arrangement acts at front of cylinder, which is similar to ordinary steam cylinder. If the drawings would like to be seen, I should be glad to send them, and also measurements to the Editor, as I feel they would interest a good many readers. The engine is extremely simple, and any reader could make one for himself, so long as he pays a Royalty of £1 to the patentee.—W. BUNDY.

[57142.]—**Planing Machine.**—Can "J. H." say how to make a good cheap foot-power planing machine?—W. BUNDY.

[57143.]—**Dr. Eder's New Sulphite of Ammonia Developer.**—Will some correspondent who has tried this developer, kindly say whether successfully or not, as I find it impossible to get any image without the addition of ammonia, which is not mentioned in the formula given in the ENGLISH MECHANIC last week?—J. J. S. C.

[57144.]—**Bright Silver Plating.**—Would anyone kindly give me information how to make a solution for silver plating, bright, without brushing?—A CONSTANT READER.

[57145.]—**Gas Engine.**—I bought a two-man gas-engine, Hutchison's patent, from the London Gas Engine Co., Dalston Junction, London, about three years ago, and circumstances prevented me starting it till now. I find it won't go: it gives an explosion every now and again and blows out the light; the result is it can't keep itself moving. I am informed the company is defunct. Can any of "ours" give any particulars about this engine, and why the explosions do not take place at every turn of the crank, and what are the merits of Hutchison's patent, if there is such a patent? The engine is perfectly useless to me. I shall be much obliged for any information—M. C. J.

[57146.]—**Instantaneous Shutter.**—To MR. LANCASTER.—Will Mr. Lancaster tell me, (1) if the Le Merveilleux is rapid enough for an instantaneous shutter, and would the shutter made to fit the instantograph fit Le Merveilleux? (2) Wouldn't it be possible to make movable stops to the lens of Le Merveilleux?—it is so very dark for focussing in very dark places, without a larger stop; this is the only drawback to his otherwise perfect apparatus.—R. A. R. Bennett, Walton Manor Lodge, Oxford.

[57147.]—**Geometrical. — Science Examination, May, 1884; Mathematics, Stage I.**—Given the distances of the angles of an equilateral triangle, to a point within it, to construct it.—BETA.

[57148.]—**Small Shaping Machine.**—Can any readers give a sketch of small shaping machine, such as could be driven from flywheel of lathe?—L. BALDWIN.

[57149.]—**Brightening Small Goods.**—I read in Watt's "Electro Metallurgy," that a few drops of bisulphuret of carbon, added to a silver solution, will impart brightness to the article in the bath. This would be of great service to me, as I have something to silver which cannot be scratch-brushed; but on applying to a manufacturing chemist, of whom I generally have my goods, I was informed that bisulphate and bisulphuret are the same thing. Will you kindly let me know if it is so, as the bisulphate which he sold me; will not produce the effect which it is stated by Watt to do? Also can you let me know of any easy method of brightening small goods, such as earrings, studs, &c.?—J. H.

[57150.]—**To Mr. Bottone.**—Having completed a small dynamo, Jones's upright castings and laminated A., F.M.'s, 9in. by 5in., A. 2in. diameter, 1lb. 20 s.c. wire on A., and 5lb of 16 d.c.c. on each limb of fields; pulley on A., 2in. diameter; driving wheel (plenty power) 26in. diameter; speed, 100 revolutions per minute, *i.e.*, driving wheel. Now when the band is put on A. pulley, the current seems almost nothing; it would not light up one 20 c.p. Swan lamp. I tried three and four lamps in parallel arc, with no better result. I have followed instructions in your work on the dynamo as to winding, &c. Insulation to my knowledge is perfect, also connecting up. Will you kindly say if speed is too fast or slow, and whether being too particular about A. insulation or not, is the fault? In other words, I put four or five layers of cotton between iron and wire of A.? My conducting wire to lamps was No. 16 rubber c., is this too small? Would a few convolutions extra on one limb of one field be at fault, as this is so? How many 10 c.p. lamps should I light? Connections:—Positive brush, to inside wire of F.M.; outside wire, to other brush, and from brushes to lamps—is this right? Kindly say what resistance each lamp should have, also where the fault lies, and oblige.—ONE IN A FOG.

[57151.]—**Problem.**—Can any kind reader work the following? I find that I can engage 15 workmen for 11 weeks, or 31 workmen for 5 weeks at uniform wages, and in either case pay the wages exactly by means of the interest now accumulated on a certain sum of money, and that which will arise during the particular period of engagement. For how long could I engage nine workmen on the same principle?—JUDY.

[57152.]—**Incandescent Lighting.**—Is it possible to light incandescent lamps, and drive a shunt-wound motor on the same circuit, the current being generated by a shunt-wound dynamo? The motor has to be frequently stopped and reversed.—W. E. H.

[57153.]—**Problem.**—Will any kind reader work the following? In a field in which grass grows uniformly, suppose that 31 oxen can consume 8¾ acres in three-quarters of the time in which 15 oxen would consume 5¼ acres, and that 22 oxen would require three days longer to consume 7½ acres than 20 oxen would require for 6¼ acres. In what time would the 31 oxen eat up the 8¾ acres?—JUDY.

[57154.]—**Horse Taming or Breaking.**—Could any of your readers kindly advise me? I have a very fine pony, about 14 hands high, which has acquired a will of its own, it also kicks in harness. Beating it only makes it worse, and it has now commenced to kick with its fore feet. I understand there were two professional horse tamers lecturing in one of the circuses in London lately. Can anyone say, from experience, whether their secret is worth the £5 5s. charged, and if it has a lasting effect on the horses? Is there any really good book on the subject?—M. H. J.

[57155.]—**Microscopic.**—Last evening as I turned over the pages of our "E. M.," I found at page 542, for Feb. 11., 1881, a letter on testing microscope objectives, in which it is stated as a test for a ½in. that it will, if good, show the flagella on a monad with the C and better with the E eyepiece. I thought I had good objectives; but my ¼ or ⅛in. will not even show this, and it is little better than glanced with ⅛in.; indeed, I understood that the flagella of this minute organism was adduced as a test for his new ⅛in. by a distinguished optician. Will some friend say if ½in. objectives are now made to be capable of this perfection? I have never seen such, but then I live in the country far away from the voice of science, unless that I may call the hum of the threshing machine or the clatter of the mowing machine scientific intonation. If a ½in. glass will do what previously we required a battery of objectives to perform, there need no longer be the trouble with nose-pieces constantly changing, &c., as all can be done by simply sliding in our various eyepieces. I shall be impatient to know what our scientists will answer; as for joy of this hidden treasure, I feel like selling all I have and buying this multum in parvo objective.—E. B. FENNESSY.

[57156.]—**Gauging Railway Waggon Axles.**—During an investigation the other day into the cause of several railway waggons leaving the rails, I understand one of the company's waggon inspectors said, when gauging the wheels of a load of coal, that one axle was a little strained, but nothing to speak of, and he had no doubt that was due to the waggon being under load. Now what I should like to know is, (1) Should the axles of waggons be deflected when under load and not when empty? (2) If deflection takes place at all, does it continue while the wheels are revolving, and (3) when the gauge shows the wheels are 1¼in. wide on the one side, how much is the axle bent, and also any other information respecting above subject will be gratefully received by a—THREE YEARS' SUBSCRIBER.

[57157.]—**Steam Pipe.**—I have heard that if iron steam pipes are connected to a copper boiler, the copper corrodes the iron. Will some reader inform me if it is so, and if so, how the difficulty can be got over?—J. L.

[57158.]—**Bird Taming.**—I want some information respecting the taming of small birds, as practised by those who use them for exhibition purposes, and as the subject will be of interest to many, I hope you will allow the inquiry to be made through the columns of "ours." I want to get an aviary of small birds, all of them so tame as to come on the finger at any time, and I feel sure that some of our readers can supply a description of how it is done. I have tried to get the information from the Italians who are to be found at seaside resorts with performing birds tame enough to be let out of the cage without the slightest disposition to fly away. This is especially noticeable with the green Budgerigars, a naturally wild bird that can never be tamed by petting, and yet these people tell me that they tame them and teach them to perform in a very short time, though they will neither say how they do it, nor sell the birds. A good living might be made by those who understand the subject, by taming them for sale as pets. I have often advertised for them, but only once succeeded in purchasing a really tame small bird.—W. P.

[57159.]—**Watch Query.**—I have a watch (gold verge) probably over a hundred and twenty years old, maker, S. Nickisson, London, in good order except inasmuch as it wants a new hair spring, the collet only remains; curb pins in edge of cock restrain balance wheel to an arc of 35deg. I have put on a new spring, but it is evident it is not suitable, as the watch gains half an hour each hour as nearly as may be. Will some practical watchmaker tell me the defect and give directions for remedying it, and also give rules for fitting hair springs, generally, how strength and length are found?—and oblige—CARIBBEAN.

[57160.]—**Copper Balls.**—Will Mr. Davies or some kind reader account for the decay of the solder used in putting the shells together for supply cisterns where warm water comes in contact with same, and the remedy?—and oblige—ONE IN TROUBLE.

[57161.]—**Wooden House.**—I have for some time thought of building myself a wooden house (not a shanty). Can any correspondent refer me to examples, or give hints?—ZYLOS.

[57162.]—**The Micro O.G.**—To "ROS CRUS."—I should like to thank you for the information you have given. Having followed your instructions, with a little practice I found it possible to grind and polish small lenses, working them to any curve. Instead of using pitch to stick the discs on to the chuck, I found Lapidary's cement to work better: it has a higher melting temperature and more holding power. For grinding and polishing I use leaden laps finishing with a mixture of rottenstone and rouge. I had a great difficulty to overcome scratches when putting on the fine finish, until I found out they were due to fine specs of glass which broke off the edges and got under the polisher. Will you kindly supplement your information by more? You say (24413) "Grind a plano convex flint of 3·5in. radius, and a double convex to match;—when cemented these are our middle." Do you mean cement them in the tube, or together? If the latter, how is it done? Having made the o.g., will you kindly say what other lenses are required to complete the microscope, and how placed, and if all the lenses have the metal turned over the edges to fasten them in? Having had some experience with a lathe, the screwing and fitting will not be so great a difficulty as the lenses. Again many thanks; through your kindness I may now become master of an instrument, for the present state of our trade (jewellery) made the purchase of one rather remote.—J. T.

[57163.]—**Employment at the Arsenal.**—In what manner should an engineer proceed to obtain employment in the arsenal at Woolwich?—J. G.

**Every Workman** connected with the Building Trades requiring a Situation should advertise in "THE BUILDING NEWS," published every FRIDAY, price Fourpence, at 332, Strand, London, W.C.

"THE BUILDING NEWS" is the Principal Journal representing Architects and Builders, and has the largest circulation of any Professional Journal in the kingdom.

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The charge for Advertisements for Situations is One Shilling for Twenty-four Words, and Sixpence for every Eight Words after.

**Holloway's Ointment** is not only fitted for healing sores, wounds, and relieving external ailments, but rubbed upon the abdomen it acts as a derivative, and thus displays the utmost salutary influence in stomachic disorders, derangements of the liver, irregularities of the bowels, and other intestine inconveniences which mar man's comfort.

## ANSWERS TO CORRESPONDENTS.

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*** *All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

### HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

*** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, July 29th, and unacknowledged elsewhere :—

W. H. NELIS.—Alvan Clark.—E. J. Warmington.—Westinghouse Brake Co.—G. S. Forbes.—B. A.—Clutch.—J. D.—W. B. P.—Dr. Royston-Pigott.—M. A.—Magi.—F. M. S.—Improver.—Improvement.—H. A.—H. F.—T. R. Clapham.—C. R. Marten.—Thermo.—Rector.—Quarryman. — Coral.—Nawt.—K.—T. Handel.—T. Watt.—Bacchus.

A. M. J. (Brasing bandsaws has been described many times. The best plan is to use the tongs with heavy beaks, which are made white hot, and grasp the ends of the saw until the spelter runs. If you must use gas, Mr. Fletcher, of Warrington, can supply you with a suitable apparatus; but we suspect that he will not recommend gas for such a job as a bandsaw. 2. The best material is a sort of water-glass; but it is better to purchase such things of those who have the requisite appliances for making sound goods. See, however, p. 297, No. 845, and the indices generally.)—SUBSCRIBER. (For methods of sharpening razors, see p. 311, No. 793, and the indices.)—GAMMA. (Would it not be a gratuitous advertisement? See indices for methods of making small batteries. Patents are often sold, and the articles become known by the name of the purchaser.)—TAY. (Spongy iron is the ore reduced to the metallic state without fusion. You can gather information about it by referring to back volumes under the heads Spongy Iron and Filtering.)—OHM. (The principle is simply producing a current by rotating a coiled armature in front of magnets. If you refer to p. 295, you will see the handle.)—E. E. S. (Marine glue, which requires heat to melt it; or the mixture of quicklime and white of eggs. The latter must be used quickly.)—ENQUIRER. (You should look through the back volumes. It is done by immersing the article, first thoroughly cleaned, in a solution of gold or silver, placing a piece of clean zinc in contact. The coating is not very durable, and the process is not adopted for good work.)—L. R. (See the indices of recent volumes. Several model boilers have been illustrated in the last four or five volumes, and you will probably be able to decide for yourself which pattern you will attempt.)—FRRAZER. (Pictet's domestic ice machine illustrated on p. 243, Vol XXXVI., will probably suit you; if not, look up the subject in back volumes. You know, of course, that a rather expensive plant is required.)—J. K. (See any treatise on mensuration, or refer to back numbers, in which some problems of the kind have been answered.)—W. E. H. (We do not know whether the American plan is patented; but should think it most likely that it is. The differences are probably in details. We have already mentioned the electrical railway at the Inventions.)—CHAS. COTON. (There are no "books" on the subject. You will find a good deal of information in back volumes—especially Vol. XX., pp. 197, 225, 250, and in Allen's "Commercial Organic Analysis.")—IMPROVER. (If we recollect the work you mention is the only one on the subject. At any rate, we know of no other. If you put a definite query in our columns, no doubt you will obtain the required information; but how to forge the ironwork for locomotives is too vague.)—CONSTANT READER, Wednesfield. (If you were a "constant reader," you would know that Prof. S. P. Thompson has published a work on "Dynamo-Electric Machinery," and that some of it appeared in our columns. The work is published by E. and F. N. Spon, Charing-cross.)—SYLVANUS WEAR. (When there are so many good books on the subject, it would be invidious to mention any as the best. You will find certain works recommended by correspondents in back volumes; but as a matter of fact, Longmans, Lockwood, Macmillan, Cassell, Spon, and other publishers issue standard textbooks, which are quite suitable for candidates for the South Kensington Examinations.)—A CONSTANT READER. (The "day eyepiece" is exactly what you want. Why not look through your back numbers.)—G. FAYER. (A "line" is one-twelfth of an inch. 2. Try the effect of a warm flat iron, interposing some thick blotting-paper. If repeated attempts will not remove it all, apply ether and the blotting-paper to soak it up with the grease.)—E. EDWARD TAYLOR. (We do not think you will succeed in getting a railway company to take it up, for the simple reason that there are several devices of the kind which they could use if they felt inclined to.)—WATER DRINKER. (The taste of the tar will go off after a time.)—SUFFER. (Try a little magnesia and regulate your diet better, using oatmeal porridge instead of bread, and avoiding smoked and salted flesh.)—POROUS POT. (Use a mixture of pitch and rosin.)—SIGNAL. (Many of our readers could oblige you with full particulars of the block system, but we should not be able to spare space. Briefly, it consists in dividing a line into sections and blocking it by signals sent from one box to another. The line is normally "blocked," and a signalman puts his signal "off" when he receives telegraphic notice of train on line, unless, indeed, he wishes to stop the train. when he leaves his section blocked. The details differ on different lines, and there are patented systems. See Barry's "Railway Appliances," Longmans.)—J. B. (Shake in through a paper funnel, and apply heat to drive any air-bubbles out.)—YOUNG MECHANIC. (Several in back volumes. See pp. 14, 65, Vol. XXIX., or go and look at them in the Inventions.)—K. Z. (A Barlow lens will not always improve definition. It is an achromatised negative or concave lens, placed within the converging rays of an object-glass, about 4in. from the field lens of the eyepiece. It produces an increase of magnifying power without necessitating an increase in length of tube. The cost can be easily ascertained from opticians' lists.)—TAILER. (The symptoms of painter's colic, due to lead poisoning, are costiveness, violent pains about the navel, and convulsive spasms in the intestines. The best means of prevention is the use of sweetened water as a beverage, slightly acidulated with sulphuric acid.)

## CHESS.

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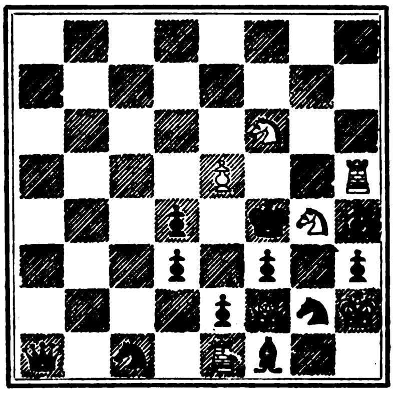
ALL Communications for this department must be addressed to J. PIERCE, Langley House, Dorking.

### PROBLEM DCCCCL—"ON THE MOVE."

*Black.*



*White.* [7+11

White to play and mate in three moves.

SOLUTION TO 948.

| *White.* | *Black.* |
|---|---|
| 1. B-Kt 4 | 1. P takes B (*a*) |
| 2. Kt-B 5 | 2. Anything |
| 3. Q or B mates | |
| | (*a*) 1. K takes B (*b*) |
| 2. Q-K 2 (ch), &c. | |
| | (*b*) 1. K-K 4 (*c*) |
| 2. B takes P (Q 6) (ch), &c. | |
| | (*c*) 1. B-B 5 (*d*) |
| 2. Q-Q 3 (ch), &c. | |
| | (*d*) 1. Anything else |
| 2. B-Q 3, &c. | |

### NOTICES TO CORRESPONDENTS.

CORRECT solutions to 947 by F. O'N. H. (awkward), A. A. E. Lecluse (very good), G. T. Stringfellow.

To 948 by F. O'N. H. (tough), A. A. E. Lecluse (excellent in all respects), Streetgate (good; a new departure;—but main play incorrect after first move—ED.) A. S. Olver (good), and H. Culmer (1. Kt-Q 6 wrong however after 1. $\frac{}{\text{K takes B}}$).

To 949 by F. A. Vincent, A. A. E. Lecluse (rather good), Streetgate, A. S. Olver, Rev. W. Anderson (Old Romney), and H. Culmer.

W. A.—By main play of course we meant *your* main play: if 1. $\frac{}{\text{K takes B}}$ 2. $\frac{\text{Kt takes P}}{\text{B takes Kt}}$ and there is no mate. This is what you originally sent.

MR. VINCENT has gained the first prize in the Second ENGLISH MECHANIC Game Correspondence Tourney, having won all the fifteen games except three (with Messrs. Blake, Nash, and J. Pierce) which were drawn. The other prizes are not yet settled.

## USEFUL AND SCIENTIFIC NOTES.

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**Effect of Acid upon Iron.**—The effect produced upon the appearance of iron by the acids employed in the process of etching presents some peculiar characteristics, depending upon the kind of iron treated. Soft or sinewy wrought iron of excellent quality is attacked so equally by the acid, and so little acid is separated, even after several hours' action, that the surface remains bright and smooth; fine-grained iron acts the same, the surface being still smoother, but a little darker; coarse-grained and cold short iron is attacked much more violently by acid than that just mentioned—in ten minutes, especially with cold short iron, the surface is black. After thirty minutes a black gloss can be washed off, and the surface will remain black in spite of repeated washings, and exhibit numerous little moles; certain parts of the iron are usually penetrated deeper, while others, although black and porous, offer more resistance. By allowing the acid to act for an hour or so, and then washing, drying, and polishing with a file, a distance picture is obtained. As is known, malleable cast iron rusts more easily than wrought iron, and it is an interesting fact that the action of the acids is also violent, the surface being attacked very intensely. Grey pig-iron acts like steel, and the etched surfaces have a uniform grey colour.

**Elective Alcoholic Fermentation.**—It is a fact that in a mixture of levulose and glucose the fermentation does not go on equally in the two sugars. Hitherto the question has remained unsettled whether the sugars are changed successively or simultaneously and at equal rates. M. Bourquelot asserts that not even the purely physico-chemical conditions of the fermentation have been worked out. He has worked at mixtures of maltose with levulose and glucose with levulose. In a first series of experiments conducted at ordinary temperatures, it was found that these sugars ferment simultaneously, though at unequal rates. Levulose changed more rapidly than maltose, but less rapidly than glucose. But this relation was not maintained, so that if yeast possess an elective faculty, this alters from time to time—a conclusion which appears to be absurd. M. Bourquelot has determined that the so-called elective fermentation is dependent on the temperature, state of dilution of the fluids, and the amount of alcohol formed during the fermentation; that the rate of fermentation depends on the physico-chemical conditions, and not on any selective power of the yeast. Sugar, in order to be converted, must come into direct contact with the protoplasm of the yeast cell, and must, therefore, traverse the cell wall. The conditions which determine the rate of osmosis of the cell wall are, without question, both physical and chemical. The results thus obtained are in harmony with theoretical considerations. A full account of the investigations may be read in the *Répertoire de Pharmacie* of July.

**Inhalations in Phthisis.**—During recent times we have heard a great deal of the value of antiseptic inhalations in the treatment of phthisis. A further clinical investigation has been undertaken by Dr. Renzi, of Naples. He has employed inhalations of four kinds: First, of idioform and essence of turpentine, of which two to six drops every hour or two hours of a liquid containing one part of iodoform to twenty-five parts of spirit of turpentine were used; fourteen patients were submitted to this treatment. Secondly, iodine volatilised every day in a bedroom 30 cubic mètres in capacity in the amount of ·40 to 2·10 grammes, heated in a capsule by means of a sand bath; three observations were made. Thirdly, sulphuretted hydrogen, evolved by the action of sulphuric acid on powdered sulphide of iron in such proportion that every cubic mètre of atmosphere in the chamber should contain seventy-five cubic centimètres; seven cases were thus treated. Lastly, sulphurous acid, made by burning sulphur in a closed chamber, so that there should be forty-three cubic centimètres of the gas in a cubic mètre of the atmosphere. Dr. Renzi has found that the first two methods of treatment ameliorate the local condition and general nutrition, without modifying the pyrexia, diarrhœa, or nocturnal sweatings. Inhalations of sulphuretted hydrogen and sulphurous acid seemed to increase the general strength, improving the nutrition, and increasing the quantity of urine discharged. Sulphuretted hydrogen had a special influence on the respirations, which were diminished in frequency; it also exercised a beneficial influence on the cough; but the fever, diarrhœa, and diaphoresis were not relieved. Of all the inhalations, the author decides in favour of turpentine and sulphuretted hydrogen.—*Lancet.*

## CHARGES FOR ADVERTISING.

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|---|---|---|
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| Every additional eight words .. .. .. .. | 0 | 6 |

Front Page Advertisements Five Shillings for the first 40 words, afterwards 9d. per line. Paragraph advertisements One Shilling per line. No front page or paragraph advertisement inserted for less than Five Shillings. Reduced terms for series of more than 6 insertions may be ascertained on application to the Publisher.

ADVERTISEMENTS in EXCHANGE COLUMN—for

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|---|---|---|
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*** It must be borne in mind that no Displayed advertisements can appear in the "Sixpenny Sale Column." All advertisements must be prepaid; no reduction is made on repeated insertions; and in cases where the amount sent exceeds One Shilling, the publisher would be grateful if a P.O.O. could be sent, and not stamps. Stamps, however (preferably halfpenny stamps), may be sent where it is inconvenient to obtain P.O.O's.

The address is included as part of the advertisement, and charged for.

Advertisements *must* reach the office by 1 p.m. on Wednesday, to insure insertion in the following Friday's number.

## TERMS OF SUBSCRIPTION.

PAYABLE IN ADVANCE.

5s. 6d. for Six Months and 11s. for Twelve months, Post Free to any part of the United Kingdom. For the United States, 13s., or 3 dols. 25c. gold; to France or Belgium, 13s., or 16f. 50c.; to India (via Brindisi), 15s. 2d.; to New Zealand, the Cape, the West Indies, Canada, Nova Scotia, Natal, or any of the Australian Colonies 13s.

The remittance should be made by Post-office order. Back numbers cannot be sent out of the United Kingdom by the ordinary newspaper post, but must be remitted for at the rate of 4d. each to cover extra postage.

Messrs. JAMES W. QUEEN and Co., of 924, Chestnut-street, Philadelphia, are authorised to receive subscriptions for the United States for the ENGLISH MECHANIC, at the rate of 3 dols. 25c. gold, or Thirteen Shillings per annum, post free. The copies will be forwarded direct by mail from the publishing office in London. All subscriptions will commence with the number first issued after the receipt of the subscription. If back numbers are required to complete volumes, they must be paid for at the rate of 4d. each copy, to cover extra postage.

Vols. IV., VII., XXVI., XXVIII., XXX., XXXII., XXXIII., XXXIV., XXXV., XXXVI., XXXVII., XXXVIII., XXXIX., and XL., bound in cloth, 7s. each. Post free, 7s. 9d.

All the other bound volumes are out of print. Subscribers would do well to order volumes as soon as possible after the conclusion of each half-yearly volume in February and August, as only a limited number are bound up, and these soon run out of print. Most of our back numbers can be had singly, price 2d. each, through any bookseller or newsagent, or 2½d. each, post free from the office (except index numbers, which are 3d. each, or post free, 3½d.)

Indexes for Vols. I., VI., VII., VIII., and IX., 2d. each. Post free 2½d. each. Indexes to Vol. XI. and to subsequent vols., 3d. each, or post free, 3½d. Cases for binding, 1s. 6d. each.

## NOTICE TO SUBSCRIBERS.

Subscribers receiving their copies direct from the office are requested to observe that the last number of the term for which their subscription is paid will be forwarded to them in a PINK Wrapper, as an intimation that a fresh remittance is necessary, if it is desired to continue the Subscription.

## OUR EXCHANGE COLUMN.

*The charge for Exchange Notices is 3d. for the first 24 words, and 3d. for every succeeding 8 words.*

**Good Value Offered** (cash or instruments) for all kinds of sound or repairable Scientific Appliances.—Caplatzi, Science Depot, Chenies-street, near British Museum. Established 1862.

Handsome **Pipe Organ**, 7 stops, 1½ octave pedals, hand and foot blower; suit chapel; room wanted. Exchange American Organ or Piano.—Wales, Hemsworth, Yorkshire.

A splendid double-barrel **Gun**, all complete, with machines, to be exchanged for a 4 or 4½ centre Lathe; iron bed preferred.—Address, T. Bullock, 169, John-street, Workington.

Three-pint **Bottle Bichromate**, perfect; pint Smee, two Medical Coils. Exchange the lot or part; offers wanted.—Lord, Victoria street, Radcliffe, near Manchester.

Six-cell Edco **Battery and Motor**, in good order. Exchange for Bicycle, Drilling Machine, or good Lathe, or anything useful.—T. S. Barratt, 40, Bentinck-street, Ashton-under Lyne.

Three-draw **Telescope**, by Ripley and Son, electroplated, 1⅜in. object-glass: wanted Drawing Instruments.—Joiner, 4, Temperance-terrace, White Horse-lane, South Norwood.

Duplicate silver **Waltham Watch** of the Melbourne Exhibition, cost 10 guineas, price £4 10s. Part exchange; Drawing Instruments or offers.—Address above.

**Harmonina** wanted, about 3 octaves, keys width of piano, or portable Harmonium; also good Music. Exchange.—H., Southcote House, Onslow-road, Richmond, Surrey.

Wanted, a Singer **Hand Sewing Machine**, must be in good condition. Approval desired. Exchange.—F. O. Bell, Belleville, St. Mark's, Cheltenham.

**Aquarium**, octagon form, with sloping top, 16 by 15, without top; would exchange a strong Parrot's Cage or first-class Microscopic Objects, or offers.—R. M., 24, Park-road, Clapham, London, S.W.

I have a very fine, sweet, mellow-toned old **Violoncello**; it has been in the Dyson family for 120 years, suit solo player, value £9 9s. Would exchange for a front-steering Tricycle, don't mind if a little out of repair. Also new bow for same.—Address, Eli Dyson, Thomas-street, Lindley, Huddersfield.

Vols. I. to XIV. "**Mechanic's Magazine**," superior bound, good as new; 10 Vols. "Family Friend," bound: in exchange for small Lathe. Also wanted, cheap, illustrated book on turning.—W. J., 78, Viaduct-street, E.

**Dynamo Machine**, with hand-power wheel, cost £5 10s. Will take £3 10s., or would exchange and pay difference for one that has been used for electro-plating, and capable of depositing not less than 1 dwt. of copper per hour.—J. Dawson, 56, London-road, Sheffield.

Rare opportunity.—Splendid 5in. **Slide-rest**, also Lathe, Bed Standards, and Treadle, by H. Milnes; offers wanted.—Apply to F. Underwood, Beverley.

**Eyepiece**, Huyghenian, astronomical, third-inch, with sun-glass, cost 15s. Wanted, 2in separating Micro-Objective.—Bartlett, 3, Ainslies Belvedere, Bath.

**Dulcimer** for anything useful.—C. CUSWORTH, 30, Ellington-street, Barnsbury, London, N.

"**English Mechanic**," Vols. XIV., XV., XVI., XVII., complete; Vols. V., VII., IX., XI., XII., not complete, and duplicate numbers; list sent; what offers?—Post Office, Lower Ford-street, Coventry.

Wanted, **Lists**, Engineering, Architectural, and Scientific Books; Civil Engineers' "Proceedings," early vols., "Engineering," any vols. Exchange Instruments, or cash.—Z. C., 62, Loddiges-road, Hackney.

Splendid model Horizontal **Slide Valve Engine**, inch stroke, all brass, with 3-grooved pulley, balance crank, and heavy flywheel, and lubricator on cylinder, new, on mahogany stand, cost 50s. Exchange for Lathe-heads, 3 to 5-inch centre.—J. Jackson, 135, Trafalgar-road, Burnley.

## THE SIXPENNY SALE COLUMN.

*Advertisements are inserted in this column at the rate of 6d. for the first 16 words, and 6d. for every succeeding 8 words.*

**Motor Castings**, materials for Electric Bells, Batteries, Galvanometers, Intensity Coils, Microphones.—King, Mendham, and Co., Bristol.

**Insulated Wire Table**, showing size, weight, resistance per foot, feet per ohm, &c., price 3d.—King, Mendham, and Co., Bristol.

**Standard Ohm**, in box, copper poles, guaranteed correct to ten thousandth of ohm, 21s.—King, Mendham, and Co., Bristol.

Wimshurst **Influence Machine**.—Sole Manufacturers of Improved Pattern. Numerous testimonials as to thorough efficiency.—King, Mendham, and Co., Bristol.

**Galvanometer Cards**, improved for tangent and ordinary combined, 2½in., 8d.; 4in., 10d.; 6in., 1s.; post free.—As above.

Write for **King, Mendham, and Co.'s** large new and reduced Price List, post free 4 stamps.

**Trouser Lengths**, 5s. each. Cheap Cloth for Ladies' Dresses, Mantles, Boys' Suits.—Hewitt, 27, Winfield Mount, Leeds. Patterns free.

**Electric Depot**, 10, Deansgate, Manchester.—Electric Breast Pins, 25s. Electric Bells, 4s. Induction Coils, 8s.—Millar, Proprietor.

**Chemical Apparatus**. — Catalogue, 90pp., 500 illustrations, posted 2d.—W. Hume, Lothian street, Edinburgh.

**Photographic Apparatus and Chemicals** for professionals and amateurs. See new illustrated catalogue, post free.—Hume, Lothian street, Edinburgh.

New Illustrated Price List of **Screws, Bolts, and** Nuts for Model Work, drawn to actual size, sent on receipt of stamp.—Morris Cohen, 132, Kirkgate, Leeds.

**Do we get Heat from the Sun?** No! Every one interested in science should read this little work. By R. Humphreys. Post free, 1½ stamps.—11, Cambria-street, Fulham, S.W.

**Oils**.—Lard and Olive Oils (substitute for). Reliable information. Stamp for reply.—J. M., 6, Hamlet-street, Bootle, Liverpool.

**Old Scientific Instruments**, Broken Model Engines, &c. For estimate of cost for repairing, relacquering, &c., send particulars to H. P. Lovegrove, Optical Works, Slough, who makes this class of work a speciality.

**Vermilion**, best, 2s. 4d. lb.—PINNELL BROTHERS, 214, Whitechapel-road, London, E.

**Gas Engine Oil** (best), 2s. 6d. gallon.—PINNELL Brothers, 214, Whitechapel road.

**Lathes. Lathes.** Cheap and good. Satisfaction guaranteed. List two stamps. Best make.—Robinson, Catherine-street, Sheffield.

**Sol-fa Dance Music** for any instrument, post free, 7d.—Brown, Music-seller, 1, Grahame-street, Leith.

**Fretwork**.—Catalogue of every requisite, with 600 illustrations, free for 6 stamps.—Harger Bros., Settle, Yorks.

**Marvels**.—Double Opera and Field Glasses, from 5s. 6d. Lists, with engravings, free.—J. B. Dancer's Depot, 63, Hamstead-road, Handsworth, Birmingham.

Tudsbury and Sons' Improved "High-tension" **Wimshurst Machine**, with their new Compound Ebonite Plates.—Edwinstowe, Newark.

**Planing**, not exceeding 10in. by 10in. by 8in.—B. W. Clegg, 18, Belinda-street, Hunslet, Leeds.

For **Model Work** (wheel-cutting in brass only); also Boring, Turning, and Screw-Cutting.—Clegg, as above.

**Violin** for sale, magnificent solo tone, perfect preservation, labelled "Antonius Stradvarus, 1690," with case and bow, suit lady or gentleman; 25s.; cash needed; approval with pleasure.—Mrs. Stokes, 50, Myddelton-street, Clerkenwell.

**Household Dyes**, 20 colours, cheap, cleanly, and expeditious. Sold by the manufacturer in 1d. and 6d. packets; gross, 7s. and 42s. Sample 2 or 7 stamps.—T. E. Hoyle, Blackley, Manchester.

**Mirror Galvanometer**, 1,900w., 35s. Polarised Relay, 250w., 15s. Rheostat, 21w., 10s. 6d. All new. Photo. 6d.—Vincent, 57, Princess-terrace, Regent's Park, London. Letters only.

**To Chemists and Aerated Water Manufacturers**.—Pure expressed Lemon Juice, three shillings per gallon.—J. Meadows, Distiller and Cordial Manufacturer, 44, Humberstone-gate, Leicester.

Steel **Name Stamps**, 3d. per letter. Figures (set), 2s. 4d. Letters, 6s. 4d., per post.—E. F. Baldwin, Robinswood-hill, Gloucester.

**Model Steam Engines**, made or repaired, separate parts fitted up, boilers made to order; sets of castings of every description.—Lucas and Davies, 21, Charles-street, Hatton Garden, London.

**Boiler**, vertical, 1-horse, £6. Engine, £3; in excellent order.—79, Dudley-road, West Bromwich.

**Batteries**.—To the Trade. Pint Bunsen's, Daniell's, Bichromate, 8s. dozen; other sizes in proportion.—See below.

**Electro-Motors**, 14s., 24s., and 75s. doz. List free.—J. Hanks and Son, Seaforth, Liverpool.

**Mesmerism**.—Complete written instructions. Success guaranteed. Fee, 2s. 6d.—Professor, 32, Clarendon-road, Anfield, Liverpool.

**Forges**, portable, quite new, circular and square, from 50s. each; bargains.—Lowe, Wallis-road, Hackney Wick.

**Patents, Designs, Trade marks.** Notice.—James Stevenson, The People's Patent Agent, 20, High Holborn, London, W.C.

**Incandescent Lamps** (carbon), 2 to 8 candle-power, 2s. 6d. Trade supplied. Swan's 20 c.p., 4s. 6d.—Patrick.

**Arc Lamps**, several second-hand, £2 each. Powerful Motor or Dynamo, £3; ditto, superior, £4 10s. Clearing out.

**Air Pump**, double-barrel, rack, massive brass fittings, on Spanish mahogany; cost £8; price £3 10s.—Patrick.

**Illustrated List** of Electrical Apparatus, 2 stamps.—Patrick and Sons, 529, King's-road, Chelsea, S.W.

**Fishing Bait**.—"Red Ching."—This celebrated Chinese bait received first prize in Fisheries Exhibition. Will keep for years. Salt and fresh water fish, attracted from a long distance in large numbers by its peculiar odour and colour, take the bait voraciously. One packet will take bushels of fish.—Post paid, 1s. 2d.—Agent, Dr. Evans, Importer, Shirley, Southampton.

**Oxygen Gas**, compressed in cylinders, handiest and safest for limelight.—Clarkson, Compressed Gas Chemist, Bartlett's-buildings, E.C.

**Oxygen Gas**, compressed into iron bottles, liquid nitrous oxide and carbonic acid.—Clarkson, Compressed Gas Chemist.

**Oxygen Gas**, compressed into iron bottles; prices on application.—Clarkson, 28, Bartlett's-buildings, Holborn, E.C.

Astronomical **Telescopes** of all kinds and Apparatus or Fittings made by A. Clarkson, 28, Bartlett's-buildings.

**Eyepieces**.—Huyghenian of any power to fit any telescope, 15s. each. Sun Diagonals, £1. Star Diagonals, 30s.

Astronomical **Telescopes**, second-hand, by best makers.—Clarkson, 28, Bartlett's-buildings, Holborn, E.C.

Bisschopp **Gas Engine**, 2-man, in splendid working order, price £20.—Stelfox, Woodland-hill, Gipsy-hill, S.E.

Parts of professional-made six-stopped **Organ** for sale cheap.—Ferguson, 5, Somerset place, Rotherhithe.

**American Organ and Pedal Actions**, complete or separate. Cheapest in the trade.—Tarr and Co., Argyle-street, Swansea.

**Lathe**, 5in. centre, screw-cutting, partly finished, cheap.—R. D. Smith, Fazackerley-street, Chorley.

Engineer's **Stocks, Taps, and Dies** from ¼in. to ¾, equal to new, cheap.—R. D. Smith.

**Blocks and Rope**, pair of strong 4 sheave, perfect, 25s. Worth double.—R. D. Smith.

**Blacksmith's Tools**, about 7cwt., punches, swages, sets tue iron, &c., 1½ per lb.—R. D. Smith.

**Shafting, Pulleys, and Hangers**, several lots cheap. State wants.—R. D. Smith.

**Lathe Heads**, 10in. centre, back-geared, 60s.; worth double.—Rigby D. Smith, Fazackerley, Chorley.

**Iron Planing** by steam, 30 by 10 by 10in. Speciality, gas engine valves.—Patrick, Engineer, Chelmsford.

**Search your Back Columns** (from May 8) for Stanley's weekly announcements; you will be amply repaid.

Brass **Model Engine Castings**, rough or finished, see new list (stamp).—Wood, Dalley-street, Broughton, Manchester.

**Patents, Designs, and Trade Marks** procured on very moderate terms.—P. M. Rogers, 21, Finsbury-pavement, E.C.

**Hand Drilling Machines**, strong and well made, ⅝ holes, from 30s.—S. Brechino, Mareham-le-Fen, Boston.

Good ordinary **Perambulator**, with best fellied wheels, 13s. Wicker Bassinette, reversible and china handle, rubber tires, splendid carriage, 44s.—Thomas Ellingworth, Leighton Buzzard.

**Iron Printing Press**, chase 6⅜ by 4⅜, about 10lb. of type in case, 25s.—Below.

Powerful **Induction Shocking Coil**, with brass tube regulator and handles, platinum pointed, 10s.—Below.

Horizontal Slide-Valve **Engine Castings**, ¾in. bore, cylinder finished, 9s. Amateur's cylinders bored, &c.—Below.

Silk-covered **Copper Wire**, No. 26, per dozen yards, 4 stamps, post free.—Mackett, King-street, Maidstone.

**Photography**. — Reliable **Sodic Sulphite** for Developing.—The anomalous results obtained with this salt arise from the presence of impurities in the commercial article. 1lb of pure Special Sulphite, in handsome glass stoppered bottle, box included, sent, carriage free to any address in the United Kingdom, on receipt of Postal Order for 3s. 6d. Orders cannot be booked.—A. Boake and Co., Stratford, London, E.

Wanted, Screw-cutting **Foot Lathe**, 5in. centre preferred.—Description and price to George Binks, 138, St. Paul's-street, Hull.

**Model Engine Castings**. — Makers of Model Engines should send for a Set of Hughes' Iron Castings. Best and softest metal. Lowest prices in the trade.

**Horizontal Engine**, 1¼in. bore, 2½in. stroke, 5s. 6d.; 1⅛in. bore, 2in. stroke, 5s. Working Drawings, 1s.

Double Cylinder **Horizontal Engine**, 1⅛in. bore, 2in. stroke, 10s. Double Cylinder Vertical, 7s. Working Drawings, 1s. 6d.

Vertical **Launch Engine**, 1in. bore, 1½in. stroke, 3s., post free. Double cylinder, 5s. Working Drawings, 1s. 6d.

Half horse-power **Vertical or Horizontal**, 16s. Working Drawings, 2s. Three-quarter horse double-cylinder Horizontal, 17s. 6d.

Send for **Catalogue**, 2d. Six Lithographed Designs, 3d.—Hughes, Mersey Dockyard, 17, Smith-street, Kirkdale, Liverpool.

**Electric Indicators**, Bell, &c., royal letters patent.—Halbart Works, 27, Penton-place, Pentonville-hill. Price list trade.

Electric, Pendulum, or **Drop Movements**, 24s. per doz. Handsome Circular 3in. Bell, 4½ mahogany French polished base, 6s.—Above.

**Hammond's Patent Mitre Frame Cramp** is the best, cheapest, and quickest Cramp for all mitre frame makers; it cramps the four mitres in one action, and so arranged that they can be nailed at the same time; price 22s.; sent on receipt of money orders payable to G. R. Hammond, Snodland, Kent. Diagram sent on application.

Powerful Portable Seaside Astronomical and **Terrestrial Telescope**, 3 inch (bare) object-glass, with sun-glass and brass tripod stand; fits into mahogany box 16 inches by 5 by 4, perfect condition; by Dollond; cost £20; price £7.—Address, Mercator, 15, Bridge-road, Stockton-on-Tees.

**Gas Engine**, vertical, 1 horse-power, Crossley's make, Otto and Langen's patent; bargain, £20.—Apply, Mercator, 15, Bridge-road, Stockton-on-Tees.

Largest size Ross Binocular **Microscope**, 6 eyepieces, 6 selected object-glasses, quantity of apparatus, mahogany cabinet; cost £86; price £40.—Address, Mercator, 15, Bridge-road, Stockton-on-Tees.

**Piles**.—Worst cases cured first application. "Indian Ointment," 13 stamps. "New African Tonics." Packets, 60 stamps (in proof for short time, 30.)—Thomas Palmer, St. Helen's, Auckland, Durham.

**Read the Lines of the Hand**.—Chart, with full particulars, 7d.—H. Dyke, 21, North-street, Taunton.

Half H.-P. **Horizontal Engine**, new, perfect beauty, engineer made; also 4in. centre Bench Lathe, iron bed, new; must sell; great sacrifice; price £5 10s., or separate; inspection invited.—Apply or write, 166, Siddals-road, Derby.

**Lathe**, 4in. centre, 3ft. planed bed, standards, flywheel, crank, chucks, and drills; first 30s. will have it; given away. Seen after 3 p.m. Saturday.—102, Teviot-street, St. Leonard's-road, Poplar, E.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
*FRIDAY, AUGUST* 7, 1885.

## LOCOMOTIVE MANAGEMENT.*

THE work on the locomotive engine which Mr. Sinclair has written does for the American railway man what Mr. Michael Reynolds's books have done for British drivers and firemen. Originally intended to be confined to dealing with locomotive running alone, it gradually expanded until it became a practical treatise on the running and management of locomotive engines, showing the performance of different kinds as regards economy and despatch, and giving directions regarding the care, management, and repairs of all locomotives and their connections. The author is, or rather was, a knight of the foot-plate, and from an early period in his career made a practice of noting down facts about the working of his engines, with the view of studying out at leisure anything which was not quite clear. This practice he continued when appointed to take charge of the roundhouse at the mechanical headquarters of a railway in Iowa; and, as most of our readers will understand, Mr. Sinclair soon obtained a mass of raw material, which he presents in a useful, not to say valuable, shape in the book before us. The information given is couched in simple language, and no attempt is made to instruct in mechanical engineering in anything beyond elementary problems. Mr. Sinclair has observed that the practice of applying to books for information concerning their work is rapidly spreading amongst the engineers and mechanics of the United States, and to such men, earnestly toiling up the steep grade of Self-Help, he dedicates his book. In this country the "locomotive engineer" is called the driver; but there is no reason why he should not earn the title "engineer" by a diligent study of such works as this. At one time all that was expected of a driver was to bring his train in to the minute without damage and with the minimum amount of wear and tear; but the driver who would aspire to take a foremost place nowadays must understand the principle of his engine thoroughly, be perfectly familiar with the laws of steam, be able to do such jobs as setting the slide-valves, and know almost intuitively when anything is wrong, and where to look for it. In other words, the successful driver is the man who gets most work out of his engine at the least expense, and always keeps time—except, of course, when delayed by circumstances beyond his control. Mr. Sinclair suggests that young drivers and firemen would do well to take the advice of Socrates, and gain knowledge by persistently asking questions. The young driver should never feel ashamed to ask for information when he needs it, and cannot succeed in solving the problem without it; and he should not be discouraged by a rebuff, for, as a rule, those who refuse to answer courteously-put questions are in the dark themselves. In the United States men are taken on as firemen who are without a previous mechanical training, and Mr. Sinclair advises them to take every opportunity of watching the operations performed by the skilled mechanics at the repair-shops, and especially such operations as are likely to be required from the driver whilst on the road. He also advises them to study works dealing with the special subject, and speaks of the "silly prejudice" of those drivers who boast that all their knowledge is derived from actual experience; such men, he says, never learn much, and they keep the ranks of the mere stopper-and-starter well filled. In this country a driver must of necessity have had much experience, for if he did not start as fire-boy, he certainly commenced as cleaner. In the United States, in the early days, it was considered essential that the driver should be a mechanic, and graduates from mechanical institutes were considered competent as soon as they were perfectly certain about how to start and stop the engine. The late A. L. Holley used to tell a story of one of these engineers, who in a severe winter got firmly stalled in a snow-bank. In its struggles to get free, the locomotive became short of water, and Holley, going to see what chance there was of progressing, found the "engineer" shovelling snow down the smoke stack. But even if a driver has all the "science" necessary, he must also possess other qualities, some of which may be acquired by training, but others not the least important, must be inborn and natural to the man: hence it is the uniform practice of managers nowadays to allow no one to act as driver who has not served for some time as fireman. In the Western States, however, Mr. Sinclair tells us that men are selected for firemen in a rather haphazard way, but on the older roads the European practice prevails of picking out men who have acted as cleaners or been trained on engines running about the yards. A fireman's chief duty is to keep the furnace level and as bright as possible all over, so that the steam-making powers of the boiler are not checked. To do that he must supply coal frequently, and throw it just where it is wanted, and in the case of an express engine with a heavy train that will necessitate the handling of the shovel about every two minutes, and the lifting and placing of more than a ton of coals in a trip of, say, 80 or 90 miles. Such work involves considerable physical exertion, and even those who have had some experience on shunting engines are sorely tried in their first trips with the expresses. The blinding glare of the furnace, the swinging of the engine, and the rather cramped position of the body, soon convince the aspirant that he has undertaken no light task; but happy is the fireman who earns the commendation of the driver after a week's practice. To give an idea of the work to be done, and of the order in which it is done, Mr. Sinclair describes a trip with a fast freight train, and another with an express, introducing incidentally all the points necessary to be observed, such as cutting off, arrangement of the injector and the fire, knowledge of speed, the use of sand, &c. Mr. Sinclair states that it is advisable to keep the steam as near blowing-off point as possible, because then less water is evaporated, and less fuel will be consumed than when running with a low head of steam. A high steady pressure and carefully adjusted expansion are two points which the first-class driver always studies. When fairly started he will link up so that the cylinders get just enough steam to compel the pistons to do their work, and will set his injector to deliver just the quantity of water that is equivalent to the steam being used. Where the road has many up and down grades, or where it has numerous spots at which speed must be slackened, frequent alterations are needed; but the careful driver prepares for these exigencies. On the down grades, when no steam is required, he opens the injector full and closes the regulator, at the same time dropping the links and giving the valves full travel to prevent them being forced off their faces by the compressed air, which would be produced by the motion of the pistons if the links were left in the cut-off position, and also to avoid the risk of drawing cinder dust from the smoke-box into the cylinder. So, when speed has to be reduced, no more brake-power is applied than is necessary; but advantage is taken of all opportunities to keep a full head of steam to be used when the hills have to be climbed. To prevent waste of steam by blowing-off, the driver will let the injector have full play on down grades, and check it when he is using steam freely on a hill, and he will at all times keep an eye on the cut-off, to prevent, as far as he can, the exhaust putting an extra back pressure on the pistons. This little feature of the exhaust is not well understood by novices—nor, for that matter, are experts at one about it. Wide nozzles give free exit to the exhaust, but reduce the velocity of the gases through the tubes; while inordinately constricted nozzles cause back pressure in the cylinder, and produce so violent a blast that they draw the gases through too quickly, and cause the loss of much available heat, while tearing the fire to pieces. Mr. Sinclair contends that double nozzles are preferable, because the single ones impart a tendency to the steam to shoot over into the other cylinder, and so cause back pressure, while the engineer who can reduce the smoke-box temperature by 100 degrees is worthy to rank as a master in his calling, In his earlier chapters Mr. Sinclair contrives to compress a great deal of information about the ordinary work of the locomotive and its two attendants; but when we reach Chapter X. we come to special details, items in the long list of ailments of the engine. Thus shortness of water and pump disorders are sources of trouble to the driver, for they may lead to a burnt firebox, about the greatest disgrace that can happen to him. Chapter XI. deals with injectors, an appliance for feeding water into the boiler which has now almost entirely supplanted pumps. Some designers still use a pump on one side; but they have an injector as well, and the driver is supposed to use the pump only when the injector fails. In the United States the modern practice is, we believe, to dispense with pumps altogether, as injectors rarely fail nowadays, and if one does the driver has always another with which to keep up the feed until he can repair his working injector. Many drivers, however, prefer to work their injectors alternately. Mr. Sinclair, from practical experience, understands all the vagaries of injectors, and there are not a few railway experts in this country who can find a wrinkle or two for them in his book. As a rule, the water supplied for locomotive use along the road is fairly good in this country, but the American driver has to make the best of what he can get, and sometimes he finds himself in want of water "fifty miles from nowhere." Here is a note of Mr. Sinclair's: With water that contains grit, check-valves set in a horizontal position are worthless, and sand, which is trouble enough in a pump, ruins an injector by destroying the tubes. The methods of remedying the defects of the injector are clearly pointed out by the author of this book, and explained by examples which in most cases have occurred in his personal experience. A diagram of the injector principle is given, and full explanations with illustrations of such improvements or modifications as the Sellers' injector, the Monitor, and the Korting injector, and the Hancock inspirator, an apparatus that will feed water of high temperature. A chapter on the care of boilers and fireboxes is almost of purely technical interest, as are those in which various kinds of accidents and the best means of remedying them are described; but the general reader will have his ideas broadened by the perusal of these notes, for they will give him a better notion of the demands which are occasionally made upon the driver. The chapters on the valve-action, the shifting-link, on setting the valves and laying out link-motion, will be useful to others besides railway men; while those on the Stevens valve gear, the Joy gear, and power of locomotives and train resistances will give information to many who are interested in locomotive design and work. Pambour's formula for calculating tractive power is given; but when it is required to find the horse-power developed by a locomotive, Mr. Sinclair says it is usual to employ the indicator. That is rarely done in this country, we imagine, for tractive force is easily calculated by the formula, and the indicator is a useless refinement when the horse-power actually exerted can be readily tested on the road by the dead weight hauled. The formulas for calculating train resistances have been found misleading in American practice. Thus, according to D. K. Clark's formula, the total resistance to a train running on the straight level at fifty miles an hour is 22·6lb. per ton; but Prof. P. H. Dudley with his dynagraph car found the total resistance at fifty-one miles to be 11lb. The resistances, in fact, differ so much in different conditions that Mr. Sinclair says that nothing but a loose approximation can be arrived at, unless indicator or dynamometer tests are made. Experiments made with a freight train on the Erie road in 1881 showed that the total resistance on the straight level varied from 3·25lb. to 4·5lb. for speeds under 20 miles an hour; but those resistances will be considerably augmented by cold weather, and varied also by the condition of the track and the rolling stock. The Westinghouse air brake and the Eames vacuum brake are fully described—the former with much detail and several illustrations. Mr. Sinclair gives also a chapter on the indicator, and urges its use daily on locomotives, as the "graphic tale of the diagram would force out of practice the ordinary habit of running engines with the steam throttled, and indubitable proof of ruinous back pressure would make contracted nozzles intolerable." The use of the indicator may be necessary in American practice; but it is doubtful whether any loco. superintendent in this country would think it worth while to have his drivers taking diagrams. We have, however, said sufficient to show that Mr. Sinclair has written a book which will interest many, while it will be found of great value, if thoroughly studied, by all who have anything to do with locomotive management.

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* Locomotive Engine Running and Management. By Angus Sinclair. New York: John Wiley and Sons; London: Trübner and Co.

# HISTORICAL NOTES ON THE CASSEGRAIN.—III.

By Dr. Royston-Pigott, F.R.S.

(Formerly Fellow of St. Peter's Coll., Camb.)

## The Great Southern Telescope.

THE Australian trial of this splendid instrument, as reported, must have produced a painful impression both in Ireland and England. The Dublin Report was that 37 M was broken into a heap of stars so large and brilliant that it quite lost the character of a cluster. The planetary Nebula 46 M brought out most strikingly the light-collecting power of this telescope; for it (which in most telescopes is a faint disc) was revealed as a ring bright even on the dazzling ground of the surrounding stars, which here were as brilliant as the components of the Pleiades appear in ordinary instruments. With respect to the Nebulæ, Lord Rosse considered its performance in bringing out the details of the Orion Nebula, 1 M (the Crab) and 51 Messier (the Great Spiral) quite satisfactory. The committee also declared the instrument perfectly fit for the work for which it was designed; that Mr. Grubb had fulfilled his contract, and that no time should be lost in packing it for Melbourne. They also added the remark, after minute examination of the excellence of the telescope and the perfection of the machinery, that Mr. Grubb had been more influenced by the desire of producing a perfect instrument than by any desire of pecuniary advantage.

Mr. Lassell presented a separate report. This gentleman having already made and mounted a 4ft. mirror, was particularly able to criticise. Of the objects already mentioned, he stated those of the greatest altitude were shown the best. The night of the 19th was cloudless, yet the air was quite unfit to test the powers of telescopes of large aperture. "Under the circumstances I considered the vision highly satisfactory, and I should anticipate that in a fine and tranquil state of the atmosphere the performance will justify very sanguine expectations. Uranus was accompanied by two satellites, which were, indeed, more conspicuous than I expected to see them. In conclusion, I freely express my opinion that the entire instrument is a great triumph of mechanical engineering and optical skill."

Yet the Cape Astronomer again wrote: "I am not satisfied with the performance of this great instrument, and I do not think the mirrors are at all perfect in figure. I have not yet seen anything like good definition of a planet with the lowest power (220). Of course, we get plenty of light even with the Nebulæ; but no definition with bright objects."

It appears several things happened to mar the fine definition accomplished by Mr. Grubb in Dublin.

1. The big mirror (A) had been grievously mismanaged. Instead of naphtha, or the strongest alcohol, being applied to dissolve out the whole of the lac varnish, a weak alcohol* was used, which only dissolved the resinous portion of the lac, leaving an intractable film of wax, which rapidly deteriorated the polish and optical performance.

2. The small convex was re-polished by an inexperienced hand, which would assuredly ruin the delicate hyperbolic figure, and it was, most likely, badly adjusted.

3. A black annulus was applied to it.

4. The eye-stop was considerably deranged.

In September the mirror became almost useless, and the second mirror (B) was substituted for it. With this were two small convexes (*a*) (*b*); the performance with (*b*), untouched by the polisher, was excellent. On March 31, 1870, the report from Melbourne was: "Mirror (B) performs very much better, and the telescope will now, doubtless, compare favourably with others of its class and dimensions. . . What has been done unmistakably shows that it is capable of grasping the work for which it was originally intended."

A slight error was detected in the mirror B—a cruciform image given to the star when used with the convex (*a*) repolished at Melbourne. The most scrupulous care is absolutely necessary in supporting a mirror on a polishing machine so as to avoid all uneven strain, so that the figure may be equally perfect when it is removed. Besides this, there is no evidence that the complicated system of balls and levers for supporting the big mirror was ever properly examined or adjusted.

(On one occasion, when I first mounted my Cassegrain, a blade of grass, on a hill about a mile off, appeared double. It took some laborious trials to detect the cause—a slight strain on the large mirror.)

Mr. Le Sueur stated this stellar cross was not permanent, showing inequality of strain.

Well, after all this painful revelation, the gentlemen most directly responsible for the character and quality of the monster glass were greatly moved to defend their original opinion. First, and foremost, Dr. Robinson, of Armagh:

"As for Mr. Le Sueur's doubt regarding the figures of the speculum A, and the small mirror which he regarded as jointly affected with spherical aberration, I remark that he himself had seen many difficult test objects with that speculum in Dublin, and he was present when the remarkably clean and sharp discs of large stars were shown. . . . . A piece was cut out of the large speculum, which Mr. Grubb polished and varnished; the varnish was perfectly removed leaving no trace whatever, and no mealy appearance. If Mr. Le Sueur had provided himself with a quantity of fine carded cotton and absolute alcohol, and, soaking rolls of the cotton in the spirit, had gone patiently and carefully over the surface, it seems very probable he would have obtained a white and brilliant surface.* In any case, the use of water was quite improper. If the yellow stain be tarnish, it might yet be removed by rubbing with slices of lemon, provided no lac be present."

There remains another consideration—Temperature. A mirror, especially a metallic one, performs with the greatest *éclát* only when used at the same temperature at which it was originally finished. Now, even in a glass mirror, a very few degrees change the figure and spoils its best performance. What, then, must happen at Melbourne, where very often the temperature varies 50° in a day and night? The expansion would tend to convert a parabolic into a hyperbolic figure! It would seem desirable, therefore, to figure such mirrors at the mean temperature of the site. Sir J. Herschel suggested muffling the large mirror up with thick blanketing just before sunrise, and stuffing the hollow front with woollen mattresses to keep off that terrible temperature of 130° in the day time. It was covered over with a sliding zinc roof, forming, I should think, a perfect oven at times. The accounts of the performance of metallic reflectors are so far instructive as to show the only true conditions of definition. Sir W. Herschel wrote a good deal about the performance of his reflectors under different atmospheric conditions:

"Oct. 10, 1780 (6h. 30min.): Having just brought out my telescope, it will not act well. A quarter of an hour afterwards it performed well; half an hour's exposure improved it." He deduces the following principle: "That, in order to see well with telescopes, it is required that the temperature of the atmosphere and mirror should be uniform and the air fraught with moisture; either a frost after mild weather, or a thaw after frost will derange the performance till either the frost or mild weather is sufficiently settled that the temperature of the mirror may accommodate itself to that of the air."

Mr. Browning has persistently declared a wooden observatory inimical to the performance of reflectors, and that if its air is even two or three degrees above the outer air, the mirror will not show its best definition to perfection.

Dr. Robinson's dictum, that the pupil of the eye in man does not exceed one-fifth of an inch, requires confirmation. When an observatory has been carefully darkened for viewing nebulæ, I have observed the pupils of visitors under a dim light greatly larger than this, expanded to the utmost limits permitted by the *iris*. And in viewing faint nebulæ, this is expanded marvellously—almost like those of the owl or cat in the dark; but as soon as the light brightens it contracts, and in some persons appears never to exceed the one-tenth of an inch!

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* Methylated spirit.

* In the Feb. number of *Monthly Notices* of R.A.S., Mr. Lassell states he removed lac varnish perfectly after eight years, and that brilliancy was perfect.

One of my friends is endowed with the most marvellous keenness of sight I have ever witnessed. After a time viewing the great cluster in Hercules, he exclaimed: "I see the stars right up to the very centre!" Then he proceeds to count those in the streamers. On another occasion he sees about 20 stars in the centre space of the Ring Nebulæ in Lyra, besides a crowd of stars edging it and scattered through it. It is evident the pupil of his eye goes on expanding, and gets more and more sensitive with gazing. It is the same with the microscope. He describes irregularities in the celebrated lines of the *Amphipleura pellucida*, as shown by Powell's new $\frac{1}{12}$th. invisible to most people. A dim light thus gives great advantage, by allowing the pupil to expand, which enables the retina to engage a larger pencil of rays. The black spot, seen in the emergent pencil of a low eyepiece, is extremely inconvenient when excessively large. Inadvertently, I gave Mr. Calver an order for a 6in. Newtonian of 24in. focus with a 2in. Kellner; the black spot assumed a portentous diameter. It was a miniature of the flat reduced only twelve times, whilst the diameter of the full pencil was exactly ½in., and what a Cyclops eye it would require to embrace such a beam of light. The telescope with this low power was darker than a small *finder*. With a deep eyepiece of ¼in. magnifying 96 times the light *increased*, the black spot minimising to insignificance, and the emergence 6 ÷ 96 = $\frac{1}{16}$in. The eye then easily embraced the whole pencil. With a 1in. eyepiece the pencil became one quarter broad, and on a faint object the eye would take in the whole light.

In designing the great Melbourne Cassegrain the Astronomer Royal for Ireland expended laborious thought and calculation. His first object was to produce a pencil with the lowest power capable of entering the eye. For this purpose the small convex was so chosen as to be the least possible to intercept all the rays from the big mirror (48in.), and the most exquisite figuring was demanedd to reproduce an enlarged image formed by the big mirror when enlarged from 5 to 6 times at the final image, independent of the eyepiece.

| | |
|---|---|
| The focus of the field lens of eyepiece | 16in. |
| " " small convex ...... | 74·71in. |
| " " eye lens............ | 3·2in. |
| " " parabolic mirror.... | 30½ft.* |
| The aperture in this was............ | 8·05in. |
| Distance of surface of convex to focus F of parabolic.............. | 61·0in. |
| Distance of focus F from focus of convex.......................... | 13·71in. |

This result 13·71in. is the value of $x$ insisted upon in previous articles.

$$\text{Field of view in general nearly} = \frac{\text{Cotang. } 1'}{\text{mag. power}}$$

$$= \frac{3438}{220} = 15\tfrac{1}{2}' \text{ (minutes).}$$

Or about half of the moon's disc.

The diameter of the emergent pencil is easily calculated. With 220 its size is exactly 1-220th of the big mirror, or 1-220th of 48in., which is ·022″, or a circle slightly exceeding 1-5th of an inch, whilst the black spot, which is the image of the hole in the mirror 8·05, is just about the 1-27th of an inch, which reduces the area of the emergent pencil to nearly 1-6th of an inch.

In the paper composed by Dr. Robinson no datum is given as to the focus of the lowest eyepiece. It may, however, be calculated from the formula already given in these articles.

Thus magnifying power M is connected with the great focus F, and the convex focus $f$ by an equation involving the focal length E of the eyepiece; so that—

$$M = \frac{F}{E}\left(\frac{F}{f} + 1\right) = \frac{366}{E}\left(\frac{366}{74 \cdot 71} + 1\right)$$

Or—

$$220 = \frac{366}{E} \times 5 \cdot 1.$$

Hence—

$$E = \frac{366}{220} \times 5 \cdot 1 = 8\tfrac{3}{8}\text{in. (nearly).}$$

This eyespot is a very important factor in distinct vision. In my Cassegrain it was a constant source of trouble and annoyance, for unless centricity were secured, so that the black spot was exactly central, the definition was marred. It never seemed long to maintain its normal position. Sliding eye-stops were at last applied. Our valued and experienced correspondent, "Prismatique," seems painfully alive to this glaring fact.

In the next article I propose to deal with this point.

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* 30½ft. = 366in.

## THE INTERNATIONAL INVENTIONS EXHIBITION.—XIV.

### Cutlery, Ironmongery, &c.

GROUP XXIV., located in the West Quadrant, is devoted to cutlery, ironmongery, &c., but the "etcetera" covers a rather wide range, for surgical appliances and dentists' materials are included. Perhaps the most interesting exhibit in connection with cutlery is the "forge" of Mappin and Webb, in the South Promenade, where the processes of forging, grinding, and hafting table-knives are to be seen. Such an exhibit could not be located in the buildings; but it is a mistake, to say the least, not to have catalogued it in the group devoted to cutlery, for it is practically the only exhibit in the branch which has much interest for visitors. The skilful manner in which the workers hammer out knife blades from the red hot steel rods is worth seeing, for it shows what can be done by the trained eye and hand in shaping a piece of metal, and repeating the operation as often as required, the pieces being almost exact in their similarity. Some surgical instruments of course come under the head of cutlery, and that perhaps accounts for their being placed in this group; but they are not of much interest to those outside the profession, and not a few of the other exhibits connected with this branch fail to attract attention from the absence of information in the circulars or descriptions supplied by the exhibitors. For instance, it is not easy to understand what connection Dr. Wright's pulmonic candles have with "cutlery, ironmongery, &c.," but we suppose they come under the "etcetera." Still, even then we are at a loss to know why they are exhibited, for though we gather from the circular that Eucalyptus enters into their composition, it is singular that the printed reports of four "professors" and the quoted opinions of the medical papers omit the very particulars which are required in an exhibition of inventions. Dr. Wright also shows an instrument for the production of "spray," which appears to be simple and efficient, and to consist of a small air-pump easily worked by the thumb pressing on a spring plunger. Turning, however, to the exhibits which properly belong to the process, we note some fine samples of decoration on tin-plate by Mr. H. Rees, of Bolingbrooke-villas, Wandsworth-common, S.W. The effects that can be produced by the method of "crystallising" the tin on these plates are well known; but Mr. Rees has gone beyond the simple processes, and shows what can be done in making tin-plate ornamental. Mr. Clark, of Oxford-street, exhibits a collection of "clippers" and hand shearing tools, which are tolerably well known by this time as useful appliances in the stable and garden, if few have adopted the hair-cutter and beard and whisker-trimming device. They are efficient tools, whether applied to horses, sheep, or grass lawns, and the shaving and hair-cutting modifications may also find patrons. The principle consists in making one blade slide over the other, both having cutting teeth. Mr. John Tyson, of Pleasant-street, Liverpool, shows a useful tool (portable) for facing up the flanges of steam pipes; but why it is located in this group it would probably puzzle the officials to explain. A cone bearing supports the pedestal from the interior of the pipe, and a tool fixed in a revolving arm faces up the flange. It is not wanted in the shop; but it will be found useful at sea and in places where machine tools are not available: Lieut.-Col. Hartshorne, Eaton-terrace, S.W., shows an ingenious combined tool, which is made by Hill and Son, of the Haymarket, and which will commend itself to all who have any experience of camping out or "roughing it," as it is termed. The Americans are celebrated (in a way) for combination tools; but this tool can, we think, take the first place, for it contains a hammer, a hatchet, wire nippers, a saw, which when put at right angles serves as a T-square, a 12in. rule, which also forms a straightedge, four files of different degrees of cut, a pair of compasses, screwdriver and crowbar—in short, it is a *multum in parvo*, weighing 2¾lb., and a tool that every traveller or sojourner in out-of-the-way places would find useful. Jelley, Son, and Jones, Blackfriars-road, S.E., show sash fasteners, locks for railway doors, and an improved slipping hook for horse harness. This safety-link is of the jointed pattern, the hinged end bedding into the neck, where it is held by a collar having a sort of bayonet fastening. A quarter-turn of this collar releases the hinged part of the link, which at once opens out and frees the pole-chain or other portion of the harness. Chubb and Sons' Lock and Safe Company, Queen Victoria-street, have a fine collection of their well-known locks, and a door fitted with their new push-and-pull arrangement. In this case the handle does not revolve, but on pulling it a lever acts on the bolt and turns it within the frame of the lock. The door closes with the slightest push. Mr. G. Plumpton, of Warrington, exhibits his patent gasfitters' combined pliers and screwing tackle, comprising screwing stock, dies, taps, reamers, tap wrench, wire-cutter, tube-cutter and shaver, turnscrew, widener, &c., the separate pieces fitting into or between the handles of the improved pliers, and saving the gas-fitter the trouble of carrying about several rather heavy and cumbrous tools. Kaye and Sons, of High Holborn, exhibit a collection of locks, noticeable amongst which is their patent frictionless mortise latch with a lever lock. The latch, without a lock, can be let into a door ¾in. thick by boring a hole ⅜in. in diameter to take the tube in which the spindle is placed. The catch itself is in the striking-plate, and when the door is closed, it revolves quickly into a hollow in the face of the lock, and holds the door firmly. When the handle is turned it presses the spindle in the tube, which pushes the catch from its hold by an almost frictionless action. Another novelty shown by the Messrs. Kaye is their patent economiser watering pot, which is fitted with a valve and spindle on the principle applied to engineers' oil-cans, so that the flow of water is stopped directly the thumb is removed from the button. The shape is neat and handy, and the improved watering-pot will be appreciated in greenhouses and other places where plants are closely arranged. E. and J. M. Verity, High Holborn, exhibit their N. M. T. ("no more trouble") blind action, which requires no rack or fastening for the cord. The bracket carries two little pulleys above, and slightly on each side of the pulley on the roller; over these pulleys the cord passes and under the roller pulley, consequently a pull on either side of the cord lifts the roller off the break, and it revolves with the minimum of friction. As soon as the cord is released the roller drops on the break and the blind is held in the position desired. An automatic looking-glass pivot consists of a wedge-shaped piece on the pillar, and a fitting to match on the frame, so that the weight of the glass keeps it in any position to which it may be placed. Messrs. Verity also exhibit the Heli-spherical Chimney Terminal, designed apparently to impart a spiral motion to the smoke, and by receiving the wind at an angle of 45° to obtain more or less of an exhaust motion. Melhuish and Sons, of Fetter-lane, E.C., besides a large collection of useful tools and cabinet brassfoundry, exhibit a novelty in Elliot's pneumatic door check, which consists of a piston working in a cylinder, and connected by links to the door. As the latter is opened, the air is compressed in the cylinder, and consequently acts as a spring to close the door, while slamming is prevented by the resistance offered to the return motion of the piston. The patent stair-rod eye will commend itself to housewives. It consists of an ordinary eye, or something similar, and a cover of brass perforated to allow the rod to pass through the eye. When the stairs require cleaning or painting, the eye-covers are removed, and the dirty appearance which the ordinary fixed eyes soon present is avoided. The patent knocker-bell consists of a bell with a pivoted hammer, operated by a spindle passing through the door and the boss or anvil of the knocker. For each knock there is also a ring. The arrangement can be adapted to any knocker. Mr. W. Pike, of the Albion Hotel, Lanark, exhibits his patent alarm bell door knob, in which any attempt to turn the handle outside causes the bell to ring. The bell is fitted to the inner handle, and does not ring when the door is opened from the inside, while it seems to be impossible to tamper with it, so as to prevent it ringing. The arrangement is applicable to till drawers, cupboards, &c. Castors, locks, and sash fastenings present the chief features of novelty in this group. The Patent Ball Castor Company, Upper Thames-street, E.C., exhibit Box's device, in which the ball is made of chilled iron, polished. Mr. Jones, of Duke-street, Chester, exhibits an improved globe castor, in which the upper surface of the ball bears against a number of steel balls placed in an annular groove. Mr. A. C. Fountaine, 3, Bennett-street, Fitzroy-square, W., exhibits a patent frictionless castor for furniture and machinery, which resembles the old style in external appearance, but is provided inside with strong bearing plates and three or more small steel balls, thus giving perfect freedom of motion under the heaviest weights. Douglas and Co., of Queenhithe, E.C., exhibit their patent springless locks and night latches with small keys. We referred to these locks, as applied to railway-carriage doors on p. 293, but in the simplest arrangement a weight is used instead of a spring to keep the bolt or catch out. Douglas's patent mortise-lock is actuated by pulling, pushing, or turning the handle, the spindle having a twist which acts as a quick-thread screw. The arrangement adopted for railway-door latches and locks by the one movement,—the mere swinging-to of the door being sufficient. Mr. W. White, F.S.A., of Wimpole-street, W., exhibits a springless lock, also acting by means of a weight. The handles are hollow, and are held to the spindle by a nut placed inside, the knob having a movable portion to enable the nut to be screwed home. Mr. W. A. Gill, Arthur-street West, also exhibits patent lock furniture, in which the knobs are screwed on the spindle, and prevented from turning back by a key which slips over the spindle and on to a stud. The key is prevented from slipping off by the rose. Amongst other exhibits deserving notice is a patent double-action lever lock and key, by Mr. J. H. King, Linthorpe-road, Middlesbrough, in which there are levers above and below the bolt, and the key is, so to speak, double, and must move both sets of levers into position before the bolt can be shifted. Mr. C. S. P. Wood, of Birmingham, exhibits a safe containing his patent improvements; it is said to be wedge, drill, and fire-proof, and is fitted with a lock which, judging by the key, has two sets of levers, both of which must be brought into proper position before the bolt can be shot. Mr. W. J. McCormack, of Paignton, shows his improvements in stocks and dies, in which the dies are cut at the ends of short cylindrical rods, which are driven towards the centre or withdrawn by means of a nut with a flange working on the stock. There are four dies, and the nut works two on each side, so that screws of different dimensions can be cut by adjusting the dies. Mr. Boyd, of Southampton, exhibits his patent forged screws from $\frac{1}{2}$in. diameter up to the largest size required for ship-building. These forged screws have been proved by Lloyd's test to have an increase in holding power of 50 per cent., and they are well adapted for ship-building in wood, for fastening rails to sleepers, &c. It may be mentioned that they are largely used by the Government, and Sir W. G. Armstrong and Co. Mr. W. Morley, Walmer-road, Plumstead, S.E., exhibits his patent nuts, bolts, and washers as applied to models. For instance, one bolt of an eccentric strap carries a washer with a rib on the bottom face let into the underlying surface of the strap, thus making it rigid. In the upper part of the washer is a locking-pin, which turns up into one of the grooves of the nut after it is screwed up tight. When the nut attempts to get slack, it forces the locking-pin against the shoulder of the washer, which acts as a dead stop. Amongst the sash-fasteners attention should be specially directed to that exhibited by Mr. F. Lea, of Buckingham-street, Strand, in which the lever is made to bring over a shield plate as the fastening is made. This shield is a real protection against the burglar's knife, because the lever can be turned nearly half-way home before it begins to move the shield back. There are a number of other "inventions" of more or less interest in this group, for instance, the automatic fastener of Leake, Barnett, and Co., Arthur-street, W.C., in which a little tongue catches into suitable slots in the door frame, a device which can be arranged either vertically or horizontally; the gas soldering iron of G. W. Wilkinson, St. Mary Abbott's-terrace, W., in which the copper bit is heated by an atmospheric burner, the heat of which is regulated by the pressure or supply of the gas; and the method of locking the boards of washing, wringing, and mangling machines, patented by the Standard Manufacturing Company, of Derby. By this arrangement the boards are locked in position when in use, and when the machine is not wanted they are turned up against the rollers and again locked, thus avoiding accidents to fingers and preserving the rollers. This duplex locking arrangement will be usefully applied in other directions. Mingled with the exhibits in this group are several stands containing surgical appliances,—the stand of Mr. J. W. Cousins, of Portsmouth, for instance, being specially deserving of notice for the number of inventions displayed, though they are chiefly of interest to the profession.

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# THE AMATEUR WORKSHOP.—X.

## Planing Machines.—Cross Slide, &c.

FIGS. 94, 95, 96 give views of the cross slide of our small machine, suitable for self-acting motion in the horizontal traverse only. If it were desired to make the vertical feed self-acting also, the slide would have to be widened to take in the extra spindle with its bevel wheels, as we shall show when we come to talk about tool boxes. This second motion is seldom introduced into machines so small as this. In the figures the lugs, *a*, *a*, take the tightening bolts, which pass through the slots in the vertical slide (Figs. 94, 95) for setting the slide steadily in position while the tool is cutting. In the larger machines, screws whose heads are sunk below the slide faces are employed in preference to those passing through lugs. The strips, *b*, *b*, steady the slide in its vertical movements, and the slight swell, *c* (Fig. 95), at the back is for the purpose of increasing its rigidity.

The *pattern* of the slide is shown in section (Fig. 97), and is so simple that a few notes relative thereto will be sufficient.

In the first place, then, piece A, prepared to 2ft. $3\frac{1}{4}$in. by $4\frac{3}{8}$in. by $\frac{7}{8}$in., forms the basis of our work. Upon it we screw piece B, 2ft. $3\frac{1}{4}$in. by $1\frac{7}{16}$in. by $1\frac{3}{4}$in., and piece C, 2ft. $3\frac{1}{4}$in. by $1\frac{7}{16}$in. by 2in. (the reader will, by comparing the pattern dimensions with those of the finished slide on Figs. 95 and 96, observe as we go along where planing allowances are made). These dimensions, $1\frac{3}{4}$in. and 2in., include the hollow on the inside of the pattern. Piece E is prepared to the section, Fig. 98, piece F to the section of Fig. 99, and both skewered on. The hollows and the recesses and the rebated portion in piece A are then planed through from end to end with rebate and round planes. Two end pieces, G (Figs. 94, 97), $1\frac{7}{8}$in. thick by $1\frac{1}{2}$in. wide, are fitted and fastened in.

Upon the back, two thin strips, 6in. by $2\frac{3}{4}$in. by $\frac{1}{8}$in., are fastened, their inner edges being set at a distance of $17\frac{1}{4}$in. from the centre line (Figs. 97, 100). These are to form the sliding faces, which move on the vertical guides. Two angle guide strips to Fig. 101 are fastened within the facings (Figs. 95, 100, *b*, *b*), and the swell piece, C, to the cross section of Fig. 97, in its central portion, but rounded off to nothing at the ends, occupies that portion of the back which lies between the guide strips. The four lugs to Fig. 100 will be fastened on, but no holes cast in them. Two facings (Fig. 100), each measuring 2in. by 2in. by $\frac{1}{8}$in., will be attached to the back of the slide, flush with the ends to receive the lugs or nuts for the elevating screws. A shade of taper should be given to all edges in the direction of the front face.

The pattern of the distance bar will be formed of three sides and two ends (Figs. 94, 95), all tapered $\frac{1}{32}$in. on their inner faces. The length of the pattern body, that is, measuring over the plain ends will be $17\frac{1}{4}$in., but on these ends four chipping strips, $\frac{1}{2}$in. by $\frac{1}{8}$in., will be attached, those next the curved edges alone being skewered on. The curved edges have a lighter appearance than edges left quite straight.

I have shown mitre wheels for moving the elevating screws. Of course, they are not necessarily mitres; in fact, in heavy machines wheels of unequal size are always used, giving gain in power,—to overcome the difficulty of moving cross slides weighing ten or fifteen hundredweight. In the heaviest machines of all, a couple or three combinations of bevel gear are used to overcome the resistance of the weight and the friction, the first pair of wheels being moved by a hand wheel placed within comfortable reach of a man standing on the ground, while a spindle passes diagonally from these to the wheels at the head of the vertical slides. Belt pulleys at the ends of the cross spindle are also employed, but are unsatisfactory in their action, owing to the frequent slip of the belt.

In regard to our particular machine I should say:—Use the gearing which is procurable with least expense and trouble, whether it be mitre or unequal bevel, remembering only that the bearings must be modified to suit the wheels. If no wheel castings are readily accessible, and a pattern must be made, use mitres as drawn, because one pattern will then answer for the pair. The wheel figured here is suitable for the slide it has to lift, and is made as follows:—

Draw out the wheel in section to full size to the dimensions of Fig. 102, and make three thin templets in wood (Figs. 103, 104, 105) from that full-sized drawing. By means of these templets turn a block of dry mahogany to the sectional outline, embracing the extreme dimensions measured over the outsides of the teeth, so that these will be cut from the solid block. The face marked A and the teeth faces B will be turned at the first chucking, and the inner pitch line will be run round to $2\frac{1}{8}$in. diameter, and the line also representing the tooth roots to $1\frac{7}{8}$in. diameter. A shallow recess $\frac{1}{2}$in. in diameter bored in the centre of the face A, will serve to chuck the pattern the second time, while the back C is turned to the templet (Fig. 105) and the actual pitch line, $3\frac{3}{8}$in. bare in diameter, and the root line, $3\frac{1}{8}$in. diameter, put on.

Divide the larger pitch diameter into 18 parts = the tooth centres. Project two of these points of equal division radially to the edges by means of lines passing through double bisecting radii struck equidistantly from centres measured to an equal distance on opposite sides of those points and cutting the pitch line (Fig. 106). Carry the lines so obtained in the same way up the tooth points and over to the smaller diameter until they cut the pitch line there. Thus we shall have two pitch centres radiating truly from the common focus or centre of the wheel, and by starting from the points so projected over, we can divide out the smaller pitch circle into 18 equal parts. The thicknesses of the teeth are then marked upon their larger and smaller ends, shown to full size in Fig. 102, and their curves are struck by the radii and from the centres there given. Where the striking point falls outside the circle of the teeth, as happens in the case of the root radius, a block of wood is fitted to the sweep of the tooth points and slid round, and the centre for the divider leg rests upon that. The instructions given relative to the working of tooth flanks in article VI. p. 160, will apply to these also, except that by reason of these being bevelled, a little more care is needed to ensure accurate results. A boss will be screwed upon the back of the wheel $1\frac{7}{8}$in. in diameter by $\frac{3}{8}$in. thick. I should not put a core print on for the central hole, but drill it in the lathe through solid metal.

The cross slide will weigh 62lb., the stretcher bar 15lb., and the four mitre wheels 9lb., and a fair price would be from 12s. to 14s. per cwt.

Having the castings, the first thing to do will be to make a fit between the stretcher ends and the facings prepared for their reception. (Fig. 94.) This will be readily accomplished since we have the small surfaces only of the chipping strips to work upon. These will be brought to such dimensions that the slots in the vertical slides for the tightening bolts shall be quite parallel with one another. If these have been cast in accurately, the stretcher would finish to $17\frac{3}{8}$in. and the facings would stand $\frac{1}{16}$in. above the sides of the plate. The stretcher rests at each end also upon the joggles *f* (Fig. 94), and one $\frac{3}{8}$in. stud (Figs. 94 and 95), in each end will hold the parts together.

If the slots in the vertical slides are not so true

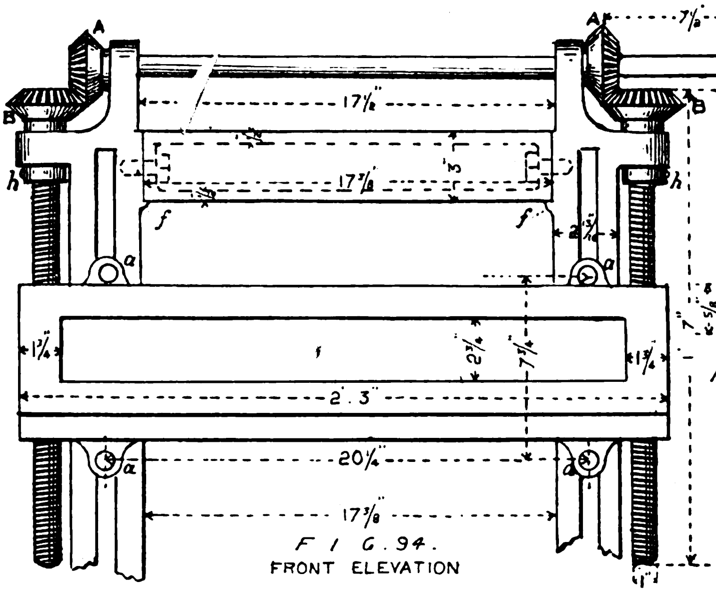

FIG. 94. FRONT ELEVATION

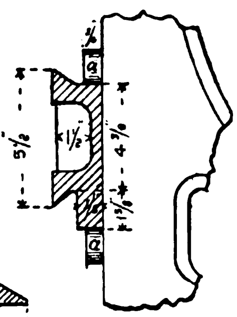

FIG. 96. SECTIONAL END VIEW

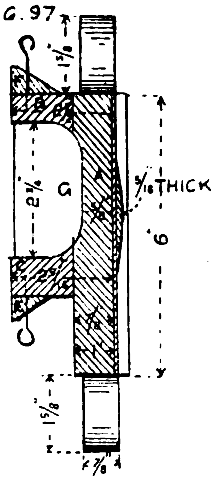

FIG. 97.

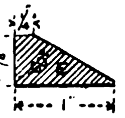

FIG. 98.

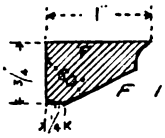

FIG. 99.

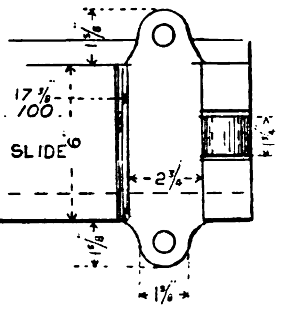

FIG. 100. BACK OF SLIDE

FIG. 103.

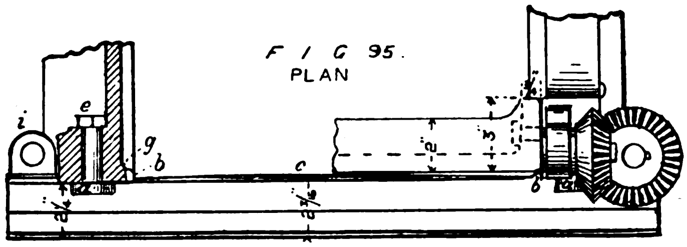

FIG. 95. PLAN

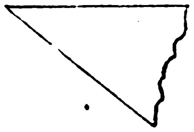

FIG. 104.

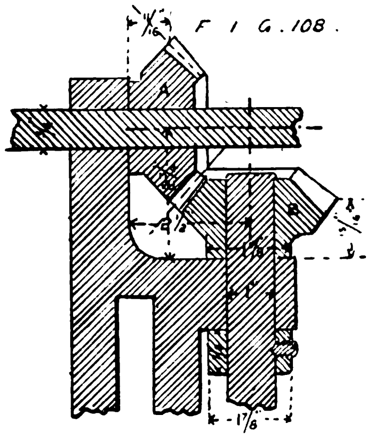

FIG. 108.

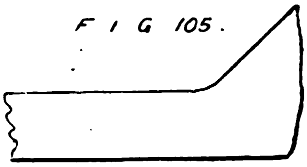

FIG. 105.

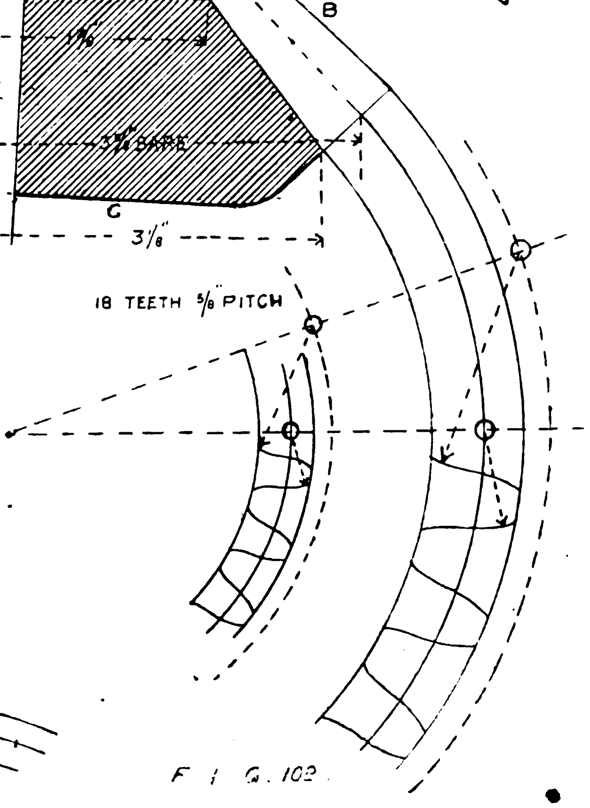

FIG. 102.

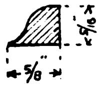

FIG. 101.

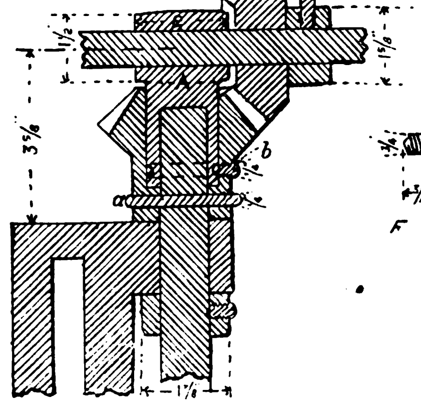

FIG. 109.

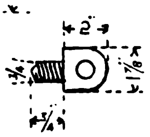

FIG. 110

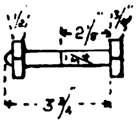

FIG. 107.

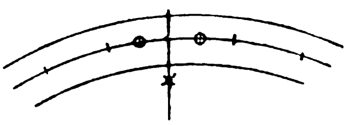

FIG. 106.

as they should be—if, for instance, the cores have curved slightly in the length, or have dropped a little, or if the surfaces are rough and lumpy in places, they must be brought parallel and true by filing, the measurement being taken across from slot to slot with a strip of wood, while the actual width of the slots themselves is checked with a gauged bit of metal slid along within them. The facing at the back (Fig. 95) *e* will be roughly filed up parallel with the front face.

Next after this, the cross slide will be chipped and filed over. Take the working face on which the tool-box slides first of all, and get that straight and free from winding. The V'd edges, worked to templates similar to those drawn on p. 554, Figs. 30, 31, of the last volume, will follow next, and the ends of the slide will also be filed square. Afterwards, the sliding-faces on the back will be filed parallel to a distance of 2¼in. from the face. The backs of the lugs are continuous with these faces, and are therefore filed flat and true at the same time, to insure their close bedding on the slides, without which good fitting the lugs are liable to become pinched off when being tightened up. The guiding edges *b*, are also brought to a good fit, with the narrow strips *g* cast upon the vertical slides. According to our design, these guides should measure 17⅜in. over when finished, and the strips *g* on the slides should work up to 1⁄16in. thick, in order to be this distance apart.

Care must be taken to keep them parallel, not only with each other, but also with the slots for the tightening bolts.

The cross slide should now be set in place, and with a bent scriber, the width of the slots be marked upon the backs of the lugs, and a hole drilled in the centre of each lug—in the one direction about 7¾in. centres—and with edges corresponding in the other direction with these scribed lines. Make four bolts to the dimensions of Fig. 107, and put the cross-slide temporarily in place. Their nuts are made thin—½in.—purposely, to allow the tool-box to slide in front of them.

The bevel gearing will now engage our attention. The two wheels marked A (Figs. 94 and 108), will be bored to ¾in., and the two marked B to 1in. From the pitch line to the back of the boss, the wheels A will, when faced, measure 1⅛in., and the wheels B 1⅜in. A keyway ¼in. by ⅛in. will be filed in each. The horizontal spindle, Fig. 94, will be turned from a piece of wrought bar to ¾in. diameter, two flats for keys filed in positions to correspond with the keyways on the wheels, and one end filed square to take the winding handle.

The elevating screws, Fig. 94, would be better if made of steel, but wrought iron is commonly employed. By adopting the right and left-handed arrangement of wheels shown in the figure, right and left-handed screws are rendered necessary. But if the wheels are put both right or both left-handed, both screws will be right-handed. The threads should number four or five to the inch, no advantage being gained by having fine threads, but rather the contrary, since in the tool-box itself we have the means of exact adjustment. The collars *h*, *h*, Figs. 94 and 108, are for the purpose of preventing any upward thrust of the screws, with consequent injury to the wheel teeth if the cross-slide happens to get tight through non-slackening of the bolts, or other accidental hitch occurring. They are slipped on after the screws are put in place, and the set pins keep them in position.

I have drawn the screws square-threaded, as they are in manufacturers' machines. But many who do not possess a screw-cutting lathe, and who would rather that the work were all their own, could cut V-threaded screws with stock and dies, which, if not quite the orthodox thing, would answer the purpose, and would last as long as the amateur himself. A thread of this length could be cut in sectional portions of three or four inches at a time by the exercise of a little patience.

Fig. 109 shows how the hood bearings may be attached to the tops of the screws, so that they can be fitted up in preference to those on Fig. 108, if so desired. The top lug is omitted from the pattern in that case. The bottom of the bearing A is prolonged, and becomes a bush within the crown wheel. The crown wheel is kept in place on its spindle by a pin, *a*, driven through both boss and spindle, while the prolongation of the hood-bearing is grooved circularly to receive a set-pin, *b*, taking into it from the wheel boss, so that while the wheel is free to revolve around the stem of the bearing, the latter cannot move up or down upon the head of the screw. The wheels on the horizontal spindle are kept in place by set screws.

Lastly, there are the lugs, (Figs. 94 and 100, *i*,) which are the nuts for the elevating screws. These I prefer to make of wrought iron, separately from the slide, rather than as a portion of the casting itself. A ¼in. screw, ¾in. long, tapped into the centre of the facing pieces, Fig. 110, will hold them securely. As the chances are against their standing square when screwed up in place, the filing of the facings affords a readier means of adjustment than the turning back of the shoulders at the termination of the threads. When the nuts stand square in place, the centres of the elevating screws will be obtained either by measurement or by levelling up carefully and dropping a taper pointed plumb bob down from the centres of the screw lugs in the vertical guides. When the centres are marked, remove the nuts to the lathe for drilling and screwing.

## VENTILATION AND LIGHTING OF COAL-MINES.

THE recent explosions in coal-mines have drawn renewed attention to the old questions of improved means of lighting and ventilating the workings. The present system of ventilation may be briefly described as drawing air through the workings, and not a few writers on the subject have pointed out that the method is radically wrong. Given the area of the workings, it is an easy matter to calculate how much air must be drawn through them to keep the atmosphere in a breathable and safe condition—provided only that the amount of gas yielded by the working face is known; but that is just where the difficulty arises, for no coal-mine in the world always gives off the same amount of gas in any specified time. The differences in the pressure of the atmosphere indicated by the fluctuations of the barometer materially affect the quantity of fire-damp given off from the face, but the most serious difficulty is the sudden outburst of pent-up volumes of gas when released by the action of the miner's pick. "Blowers" have ever been a sore trouble to the miner, for if they do nothing more they frequently extinguish his lamp; but, unfortunately, they too often produce all the conditions necessary for an explosion. Ventilation by suction is no remedy; we require the plenum method—a pressure of air always maintained in the workings, whatever may be the atmospheric pressure. Col. Shakespear has recently in our columns and elsewhere called attention to this matter, and, as it is now conceded that no lamp yet devised is altogether safe in the presence of "blowers," it remains to be considered what can be done by working coal-mines on the pressure system of ventilation. As Col. Shakespear points out, ventilation by suction is mischievous, because the current travels in lines from point to point like a running stream, omitting bays, sides, crevices, and the like, which harbour accumulations of gas as creeks do water. Now the real and true check to colliery explosions is by delivering air under pressure at the face of the coal, which would expand, and, penetrating all parts of the mine, make its escape up both or either of the shafts. How that is to be done in the best manner is for experts to determine; the one objection to it is the extra cost, but it may be doubted whether that need be so great as has been assumed. In the one case we have an exhaust fan at the up-cast, drawing air through the workings; in the other it would be necessary to lead the air by pipes to the face of the coal, and consequently the delivery ends would need frequent shifting. Another matter of great importance is the use of gunpowder in "shot-firing." It may be considered that some seams of coal are difficult to break down, and cannot even be worked with commercial success unless some economical method of breaking down the coal and stone is available; but there cannot be much doubt that coal-dust is a potent factor in explosions, and that whenever a "shot" is fired in dusty mines there is great risk of a disaster. Hence it should be insisted upon that whenever blasting operations are to be carried on, all the "roads" in the vicinity of the "shot" should be thoroughly watered, and the "shots" themselves so arranged as to produce the minimum of flame. Faraday and Sir C. Lyell in 1844 drew attention to the risk of spreading explosions in consequence of the presence of coal-dust, but little has been done, and the only radical remedy seems to be to prohibit the use of any agent which produces a flame for the purpose of breaking down coal. The lime cartridge was thought to have solved the difficulty, and it certainly is most efficient in some mines, but at present it has not found much favour with miners. With safe "blasting," safe lighting, and pressure ventilation, explosions in coal-mines ought to be very rare, if they happened at all—though there is always the ever present danger of the surreptitious match. There seems to be a tendency to imagine that electricity will provide a safe means of lighting coal-mines, even the distant workings; but it would be a great mistake if colliery owners were compelled to adopt that method. Mr. Sydney F. Walker, who has had considerable experience with the electric light in mines, and is not likely to have any sentimental objection to its use, pertinently says there are grave practical difficulties in the way of the use of the electric light at the working face, where it would be of most service, both from the additional light given and from the greater need of a safety-lamp at that point. The working face is constantly moving (in one method of working ever receding), and the operation of getting the coal in its most marketable form entails the constant falling or shattering of huge masses, so that no fixed lamp would be of the least service or could live long. On the other hand, up to the present, so far as he is aware, no portable electric lamp giving a good light for the time required has been produced which is of a reasonable weight and size, so that the collier can handle it and place it in position where his light is most required. By reducing the amount of light on the one hand, and its duration on the other, a few so-called mining electric lamps have been produced; but they would be useless for practical mining work, as they only last a few hours at the outside, while their cost is out of all proportion to that of the existing forms of lamp. In his opinion, the outcome of electric lighting in mines for the working face will be that supply mains will be led to convenient points near, and the collier will attach a pair of small wires to them and his lamp to the other end of his small wires, and use it as he likes. Main leads or wires seem the most feasible plan, but, as every electrician knows, the great difficulty is that on making and breaking contact a spark passes, and the electric spark is of such a temperature that it will inevitably fire any explosive gas in its vicinity. Several collieries have their shaft bottoms and main roads lighted by electricity, but the difficulty of using incandescent lamps at the working face is the risk of sparking when contact is made or broken. If the pressure system of ventilation were adopted, and adopted so thoroughly that explosive mixtures could never form, electric lighting in mines would, we believe supplant the whole race of safety-lamps, but at present the use of incandescent lamps would involve the risk of firing the gas at the working face, and in suitable conditions of causing an explosion. Compulsory legislation is, however, to be deprecated, for, as Mr. Walker says, if the electric light and other forms of electrical energy are to be utilised, as we hope, in mines, factories, and our homes, it will only be after having won their way in a fair field, and not under the wing of any grandmotherly legislation. The early progress of new inventions, more particularly electrical, is too often seriously retarded by inefficiency, arising from their promoters either not knowing or not fully appreciating the difficulties they have to contend with; and in his opinion compulsory legislation would greatly increase the chances of such inefficiency, with the result that the law would either be repealed or become a dead letter.

## STABILITY AND SPEED OF VESSELS.

### A Problem in Mechanics.

THE following paper by Mr. F. J. Patten has been written in view of the forthcoming contest for the *America* Cup, and will be read with interest by all yachtsmen and builders of models. It is from the *Scientific American Supplement*:—

The various requirements of use have given rise in water craft to the trial of nearly every form of floating body, each possessing qualifications designed to serve a certain purpose, and generally gained at the expense of a corresponding loss in points equally important for another. In view of the great variety of shape that still prevails, it is at once apparent that in order to arrive at definite conclusions regarding a particular feature, such as a boat's stability regarded as a floating body, or its speed as a moving one, the discussion must necessarily be confined to a comparatively small class of the same general type. In the class selected for our consideration, we observe that certain incentives in the construction of this small class alone have led to great variety, both in rig and model, determined not only by the results desired, but in a great measure by the individual ideas of the mechanic or builder as to what particular arrangement of parts would seem most conducive to the desired end, whether speed, stability, sea-going qualities, or room; and even while having the same results in view, we still witness an apparently endless struggle for supremacy between two varieties of the same class. They are diametrically opposed in principle, and will be at once recognised as the broad and shallow boat on the one hand and the narrow and deep craft on the other.

Let us endeavour to analyse this problem from a purely theoretical standpoint, and ascertain what theory teaches of practical value concerning the respective merits of these two species of the same general class of sailing craft. Let us see if the pure mechanics of the problem point to any practical advantage that one may possess over the other, and to what particular end that advantage is most conducive. To make the investigation intelligent and logical it will be necessary to consider, first, the simple mechanical principles involved, and deduce the results to which they point, comparing them with practice or the observed results of experience. It should be a matter of interest with every gentleman who sails a yacht to known and understand, as far as exact knowledge may go, the action and result of the different forces he makes subservient to his pleasure; and while there is perhaps no more complicated problem than a definite statement of every successive cause and effect that results in the flying yacht, still a consideration of the principal forces at work, and how they may be rendered most effective, is not only within the bounds of possibility, but is also comparatively simple, and equally within the reach of the mechanic who builds, the yachtsman who sails, and the physicist who investigates the forces of nature. Concerning both the shallow and deep draught boat much has been written, but it is perhaps safe to say that little has been written from a standpoint sufficiently general to be thoroughly impartial; for if not advocating one side of the disputed question to the extreme prejudice of the other, then perhaps, with the view of reaching a certain class of readers, the treatment has been so popular as to be wanting in thoroughness, or, on the other hand, from the standpoint of the physicist all practical considerations have been overlooked. It will be our purpose to address the general reader, while it is also proposed to view this question in the simple light of a problem of mechanics, and ascertain what may be learned from an analytical yet, if possible, a strictly practical consideration of the subject. To avoid the error incident to a confusion of terms, as well as a misconception of the principles involved, it will be necessary to begin our inquiry with the pure mechanics of the subject, and endeavour to obtain, first of all, clear ideas as to the meaning of certain technical expressions in common use as well as the theoretical and practical value of the quantities they represent. To do this let us first suppose a body in a fluid of greater relative specific gravity, which is the physical condition of any vessel afloat in the water. In the simple case chosen there are forces at work whose united and resultant action, as in all cases, determines the position the body will assume, first with respect to the surface of the water or "plane of flotation," and, second, with respect to its own "axes" and "planes of symmetry," meaning those lines and planes in a body about which its mass is evenly balanced. In practice the vertical plane passing through the stem and stern post is a plane of symmetry, because the mass of the vessel, in any position, is evenly distributed and balanced with respect to it, and in practice it is the only plane of symmetry the vessel contains. The position which the body finally acquires in the water, when left to itself undisturbed by any external forces, is one of equilibrium, or rest; and this position, under the circumstances named, is in practice obtained where the plane of symmetry of the vessel is vertical, at right angles to the plane of flotation, and the centre of gravity of the entire mass is at the lowest possible point. In such a simple case, which is that of any vessel afloat and at rest in the water, certain forces are at work which must be in equilibrium among themselves, or else motion would ensue until a position of rest were reached. As will be seen later, there are various positions of equilibrium, resulting, however, from the action of an external force or the resultant action of many of them, which, together with the first mentioned, bring about a new position of equilibrium. Neglecting for the present any external force, a vessel at rest in the water as described is acted upon by its own weight, a force directed vertically downward through the centre of gravity of its entire mass. This force will be recognised at once as the entire weight of the vessel, including everything in or upon it.

A reaction against the downward force results. It is the upward thrust of the displaced water, just equal in amount to the entire weight of the floating vessel, and contrary in direction. This upward force is known as the "buoyant effort," and results from the displacement of the water by the vessel settling down into it until a point is reached where the "buoyant effort" is just equal and contrary to the weight of the vessel. In this assumed position of rest these two forces are the only ones at work: they are equal in intensity and contrary in direction; holding each other in equilibrium, they produce rest.

The intensities, points of application, and directions of these two forces under different circumstances determine the question of equilibrium or resulting position of all floating bodies. The forces for discussion will then be:—

First.—The weight of the vessel. It is necessarily constant in quantity; its intensity remains always the same, and comprises not only the weight of the hull, but everything in or upon it, masts, spars, rigging, and sails, as well as movable cargo. The point of application of this force, or the point where it acts and its effort is felt, is the centre of gravity of the entire mass. Its direction is vertically downward through this point. The force is therefore known, and its effect may be ascertained, for all its elements are given. No matter what the position of the vessel, this force remains invariable in its intensity, direction, and point of application.

Second.—The "buoyant effort." The action of the water to support a body wholly or partly immersed in it is called the "buoyant effort." It acts simultaneously with the first-mentioned force; is just equal to it in intensity and contrary in direction, acting upward. Like the first, its intensity is always constant, because it is always equal to the weight of the displacement water—*i.e.*, the weight of a volume or bulk of water corresponding exactly in shape and size to the submerged portion of the vessel, and comprising a quantity of water, in whatever position the vessel may assume, just equal in weight to the weight of the entire vessel with everything in or upon it, and is commonly known and described as the vessel's "displacement." The point of application of this force, however, or the point in the vessel at which it acts, is variable in position, which is very important, for this point moves with every motion of the vessel from side to side of the plane of symmetry, but its position can always be ascertained from any given position of the vessel. All this will be clear from a consideration of the nature of this force. It is always the upward thrust of the displaced water, and, therefore, acts vertically upward through the centre of volume or figure of the water displaced, or, what is the same thing, through the centre of of volume of the submerged portion of the vessel, which, of course, changes as the vessel in rolling or careening submerges more of the hull on one side of the plane of symmetry, and removes from the water a corresponding amount (in volume) on the other. It will be clear, however, that as this amount of displaced water must always be the same in weight at all times, the submerged part of the vessel must always be the same in volume or bulk, no matter what its position or configuration. This point, the centre of volume of displaced water, will, it is evident, never coincide with the centre of gravity of the vessel, but will always be above it, below, or to one side, as the vessel changes constantly from one position to another in rolling about or pitching, and thereby changing the configuration and shape of the submerged part. For any given position of the vessel, however, the point through which the buoyant efforts acts can be determined with close approximation.

The second force may therefore be regarded as known, its intensity, direction, and point of application being given. The point, variable in position, through which this second force acts is called the "centre of buoyancy," being the point through which the buoyant effort acts. The two forces considered being in fact but a single one, the weight of the vessel and the consequent upward reaction the water opposes to it are the only original forces at work in the system—*i.e.*, in the floating vessel regarded as an independent system of forces. Left thus alone, they produce equilibrium, and the vessel floats at rest. If the vessel is now subjected to the action of any external force, or many of them, the equilibrium of the first two is at once destroyed, another force is introduced into the system which compounds itself with the first two, and a new position of rest, one in which all three forces are in equilibrium among themselves, must result. It is this second or new position of equilibrium, the determining circumstances of which are of practical value. We have, then, a third force external to the system of vessel and water which acts upon it combining itself with the forces considered, and producing results dependent entirely upon the new conditions. In practice there are generally a variety of external forces that affect the vessel, but they all have a single resultant, which may be found and treated as a single external force, thus giving definite data to the problem. A moment's consideration of the subject will show that of all the external forces that may affect the position of a vessel in the water, there is always one in practice—the action of the wind—compared with which all others are insignificant in value. For instance, it affects but little the careening force of the wind for a man to walk from one side of a good-sized yacht to the other, or how comparatively little does the sudden shock of a wave to windward affect this force. (No reference is here made, of course, to little sailing tubs and cat boats, in which the smallest forces at work compare in magnitude with the larger ones that determine the boat's stability.)

The external force, then, for our consideration at present will be regarded as the assumed resultant action of the wind upon the entire sail area. Its point of application will be at the "centre of effort" of that area. The force will be assumed to act parallel to the horizon; but should it not, it could be resolved into components, horizontal and inclined, of greater or less relative value according to the inclination of the sails and the direction of the wind with respect to their surface (assumed flat). This horizontal component, in most cases the actual force of the wind, careens the yacht, while the inclined one acts parallel to the surface of the sails, and its effect is lost. This third or external force completes all those involved; others, of course, arise, but their action is comparatively insignificant. The point of application of this external force is known. Its intensity is also known, being so many pounds pressure to the square foot of sail exposed, depending upon the velocity of the wind, and directed at a certain inclination to the sail area. To simplify the discussion, its direction will be assumed horizontal and at right angles to the longer axis of the vessel, or practically abeam. No matter what direction the wind comes from with respect to the vessel, it will have such a component, susceptible of measure with greater or less approximation; and it is this component whose action when combined with the other two it is desired to investigate and ascertain what new conditions of equilibrium arise and what arrangement of the first two forces is best calculated to meet and resist the action of the third. The foregoing statement of the forces and principles involved is perfectly general in character and equally applicable to all cases, and must determine the position under given circumstances of any vessel afloat, whatever its shape, size, or mass. The question of the relative stability of two yachts consists, then, in the determination of the resultant or ultimate action of all the forces at work, internal or external, under the same circumstances for each. The question involves also in a measure the determination of how, under given circumstances, the action of any external force, as the wind, may be best met and resisted, or used, by the combined action of the known interior forces at work. The external force will, of course, have to be assumed. It is necessarily the resultant of several, each of which depends for its direction and intensity upon a variety of data, which can only be approximated in value.

(*To be continued*).

## PHOTOGRAPHY AND THE SPECTROSCOPE.—I.[*]

By Capt. Abney.

EVERY lecturer, when he begins, must have a text of some description, and I propose to make my text for the lectures a plate exposed to the spectrum. You see before you a spectroscope comprising a collimator, two prisms, and a camera, with a lens of 13in. focal length, and in this slide is a sensitive collodion plate.

The spectrum of the hot carbons of the electric light is upon the focussing screen which you see before you, and I will simply expose this plate, and refer to it from time to time as my lecture continues.

The plate is given six seconds' exposure to the light of that spectrum, and now in the subdued light coming from this lantern, whose sides are covered with translucent orange paper, I see the picture is coming out under the action of the ferrous oxalate developer. After fixing, we see that we have the photographed spectrum on the plate.

This is the text on which I have to hang my lectures. We have three things to consider. First of all, we have got the light, then we have the apparatus, and then the sensitive material on which the spectrum is taken. The white light from the carbon poles, in passing through the apparatus, is spread out into a coloured band, which we call the spectrum; and the spectrum has effected a change in the sensitive salt of silver, as is shown by the blackening on the application of what is called a developer. The cause of the change in the sensitive material is what I first address myself to.

To conceive a right notion of photographic action we must first of all conceive, in the most elementary manner, the structure of matter. The structure is beyond our actual visual acquaintance, but we may be able to visualise it from the way it behaves; we have to draw our conclusion about it from evidence of an experimental nature. What we want to get is a mental picture of matter. Physicists have come to the conclusion that homogeneous matter is composed of molecules, or small masses which are altogether similar one to another—*i.e.*, they have the same composition. In different matter these molecules have different weights. Further, it is believed that the molecules, or the small particles of matter, are themselves composed of atoms, which we take to be the fundamental unit of matter. Now, from experimental data, Sir William Thomson and others have come to conclusions as to the limits of the size of these molecules, and also as to their distribution in space. From the kinetic theory of gases, it is concluded that the diameter of a molecule lies somewhere between one twenty-five millionth part of an inch and one two hundred and fifty millionth part of an inch. Further, in gases it is conceived that the molecules are free to move in straight lines in any direction, the direction being altered only when the molecules collide; that is to say, when they strike one against another. In a liquid, the particles are bonded much more closely together, and the free path of the molecules is very much shorter. That is to say, that they cannot go from one place to another without very much more frequently coming into contact with other molecules; and the molecules pass from place to place at a very much slower rate than they do in gases. A solid, such as is our silver salt, is conceived to be such that the molecule has no free path, but is confined in a limited space in which it can oscillate, moving round a mean centre. As to the distribution of these molecules in liquids and solids, Sir William Thomson has arrived at very definite conclusions also. In a lecture at the Royal Institution, he said that he concludes that in every ordinary liquid, or transparent solid, or seemingly opaque solid, the mean distances between contiguous particles is less than one twelve millionth of an inch, and more than one two thousand five hundred millionth part of an inch. These are big figures, but still the distance apart is very small. "To form a conception of this," he says, "imagine a globe of water as large as an ordinary football to be magnified to the size of the earth, each constituent molecule being similarly magnified. The magnified structure would be more coarse grained than a heap of small shot, but probably less coarse grained than a heap of footballs." So you see that, by magnifying to this extent, you have a coarse-grainedness which, of course, is only relatively coarse grained after such an enormous magnification. Or you may put it in a different sense. If you magnify eight thousand diameters by an ordinary microscope—and that is about the limit to which a microscope will magnify—and if you magnify that eight thousand diameters again eight thousand times, you would be able to see the molecular structure of water. So much, then, for molecules. We will now turn to the atoms. These will not bear such a very large disproportion of size to the molecules as do the molecules to the smallest visible particles. We must, however, I think, conceive that every atom (and this is an important point) is charged with energy very much in the same way that the magnet is charged; only, instead of two poles, as a magnet has, each atom has only one pole. It is unipolar.

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[*] The substance of the Cantor Lectures delivered before the Society of Arts.

Now, suppose that this energy is something like electrical energy. We know that positive repels positive, and that negative repels negative. And, further, we know that the positive energy will attract what is called negative energy; and if the two be exactly equal when they combine, of course there will be a neutral state. But in the case of the atoms of matter, circumstantial evidence tells us that the amount of electrical energy which is upon a given atom of matter—if you like to put it in that way—is never the same as it is upon another atom of matter; that is to say, there is always a surplus of one over the other. Thus we may have an atom charged with what we may call plus 2 of energy, and another one charged with minus 1 of energy. Those two atoms, on coming together, give you a result of energy of plus 1, and this would again be capable of attracting another atom of matter which was charged with a negative energy, and so on. From chemical considerations, it would appear that plus and minus energies of different atoms, as I have said before, are never exact multiples of one another, and that when they are bonded together there is always an excess one over the other. A good example of the energy of the combination of atoms together may be shown by the combination between a gas, chlorine, which we have here, and the metal antimony, and you will see that when the latter, as powder, is thrown into the former the two combine with an evolution of heat, showing that a vast amount of energy is given out. The chlorine and the antimony form chloride of antimony; that is to say, five atoms of chlorine and one of antimony. You see the evolution of heat between those two; so much, in fact, that the chloride of antimony, as it was formed, was at a perfectly bright white heat. The case immediately before us is the silver salt. Let us experiment with that in a similar way. Into the chlorine I will throw some powdered silver, and I wish you to notice the difference between the results in the two cases. You see that the combination between the silver and the chlorine only produces a red heat, whereas antimony produced a white heat. In other words, the combination between antimony and chlorine is much more vigorous than the combination between silver and chlorine. If you had to separate the atoms of chlorine from those of the antimony, you would have to use very much greater force than if you had to separate the atoms of silver from the atoms of chlorine.

When two electrified bodies attract one another, they attract one another inversely as the square of the distance. That is to say, if there is a distance of one foot between them, they attract one another with a force of, say, 1. If they are 2ft. from one another, they only attract one another with a quarter that amount. Supposing atoms attracted one another according to the same law, then of course, they being so very close to one another, the attraction would be considerably greater than if they were visibly apart. But besides this attraction between atoms comprised in the molecules, there also seems to be a repulsive action, into which I will not enter more fully now, because that would be almost beside my subject; but I may say that besides the atoms attracting one another (we will take chloride of silver for instance) when they get within a certain distance of one another, they repel one another, and so there is a continual oscillation between the atoms composing those molecules.

In this circular glass trough of water is floating a little magnet, the magnet being held at the surface of the water by a cork. Passing round this coil, which is large enough to surround the trough, is an electric current from three Grove cells, and if I place it round the cell which contains the little magnet, and not quite on a level with the water, you will find that the single magnet goes into the centre of the water. It is repelled from the sides by the current that is floating round that wire. Well, now, we have here one magnet. Suppose I put another magnet in. The ends attached to the cork have poles of the same name. They repel one another to a certain extent, and yet the force from outside makes them go as near one another as possible. By moving this coil vertically we can make them separate and oscillate, and we can picture to ourselves the way in which two atoms in a molecule may oscillate, and be attracted, and yet repelled one from another. I put another little magnet in, so now there are three; and here, perhaps, we have a picture of chloride of silver, which I say is composed of one atom of silver and two atoms of chlorine. We can still make them vibrate and oscillate. Here we have a mental picture—at least, it is a mental picture to me—of the way in which the atoms of chloride of silver may be made to oscillate. Again, I take four, and we repeat the same thing. Here we have a picture of ammonia—three atoms of hydrogen and one of nitrogen oscillating. And so I might go on. I might put five or six or a dozen in, and we might get some idea of the way in which they would all oscillate.

Here, then, we have endeavoured to draw from visible phenomena a mental picture of the way in which atoms of a molecule are vibrating. I must, however, call to your mind that those magnets are vibrating only in one plane, whereas, of course, the atoms of a molecule are vibrating, not in one plane, but in space of three dimensions.

Now we will throw a spectrum on the screen. I am now going to send the light of the lamp through this bisulphide of carbon prism, and I need scarcely say that the prism has to play an important part in spectrum photography. The wave length of the red is about one forty-thousandth of an inch, and the wave length of the violet, which is on the left of the screen, is about one fifty-seven-thousandth of an inch. Each ray of light is transmitted in air at the rate of about 190,000 miles in a second. Thus the number of vibrations of the red rays is 500 million millions, and 700 million millions in the case of the violet rays, and this rapid succession of blows batters against anything upon which they fall. The mean violet, I may say, is the photographic light *par excellence*, and we shall recollect that such rays might beat upon the sensitive salt which we expose to it 700 million million times in a second. Therefore, you see, if you give an exposure of the 100th of a second you still have seven million millions of vibrations beating on the sensitive plate, so there is ample vibration to effect any change on the molecule of silver chloride, supposing always the amplitude (or distance of swing) is sufficient. Instantaneous photography will not be complete, I suppose, until you can reduce by a million times.

We may take it that an atom vibrates somewhat in the same way that a pendulum vibrates. Here I have a very rough contrivance to show what I mean. I set the pendulum swinging. Now picture to yourself that the bob is an atom, and picture to yourself, also, a wave of light falling upon that pendulum; if the wave of light be synchronous with the pendulum, it will increase the swing, or, in other words, it will increase the amplitude of the swing of the pendulum. For a rude illustration, suppose I take puffs of my breath as illustrating the beating of the wave of light, and suppose the atom to be at rest; I begin, and I blow; every time I give a well-timed puff to that pendulum, the pendulum increases in amplitude or swing. But if my breath does not come in unison with that pendulum, you see that very soon I should bring that pendulum to rest—in other words, unless the wave of light beats in unison with the atom, the amplitude cannot be much increased. It is true that as long as the breath strikes the bob as it is going away from me, the amplitude is increased; but if the puffs are regular and slightly more rapid or slower than the pendulum oscillation, the amplitude must eventually be diminished.

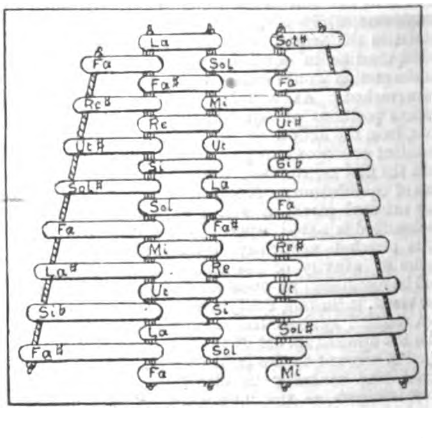
Here we are met with a difficulty, and a very great difficulty. I exposed the plate to the spectrum, and you see the blackening not only was where one wave of light synchronised with that atomic motion, but that there were a great many waves of light, extending from the ultra-violet as far as the blue which affected it. How are we to get over that? That is a difficulty which has puzzled a great many people. I would ask you again to form a mental picture of how that could possibly arise. I do not say that it is the correct way; but all I say is that you can form a picture in your own mind, can conceive of how it could be done. Here I have another pendulum, but in this case the bob is attached to an elastic band. The time of the vibration of a pendulum depends upon the length of the pendulum. Therefore, if during the time of the oscillation of the pendulum I alter the length, I also alter the rate at which the pendulum vibrates during any instant. I pull down the weight of the pendulum, and at the same time set it swinging, and you will see that during every part of this motion the length of the pendulum is altered so that a great many differently timed puffs of breath might be synchronous with the pendulum. It is not like this other rigid one, where it is of a definite length, but here the length of the pendulum keeps altering. I only ask you to form a mental picture of the way in which such a thing might happen. In this way you can picture to yourself how a molecule might vibrate, and still be synchronous with more than one vibration of light.

Proceeding another step, I may say at once that, to my mind, the theory of the photographic image is well established—that is to say, the theory as to the action of light upon molecules of silver—is as well established as, at all events, the wave theory of light itself. Now, I am going to show you an experiment which, perhaps, will help to illustrate what I mean by the vibrations of atoms. In this slide I have got a gelatine plate, and I have a little flat iron which has been made warm. It is rather too warm to be borne comfortably. Here I have a phosphorescent plate, which I propose to illuminate with magnesium wire, in order to give an even source of light; I press this flat iron against the back of the plate which is in this slide for a short time. I shall not let the plate cool; but while it is warm I will expose it to the phosphorescent light for about fifteen seconds. The plate is now allowed to become cold, and is developed. If everything has gone right, we ought to have something which shows us that the oscillations of the atoms of bromide of silver (which is the silver salt on this plate) have been given extra amplitude by the action of the heated iron to the back of the plate. I am afraid that I cannot show you the development in the light.

(*To be continued.*)

## THE XYLOPHONE.

LIKE most musical instruments, the xylophone, had its origin in very remote times. The Hebrews and Greeks had instruments from which the one of to-day was derived, although the latter has naturally undergone many transformations. Along about 1742 we find it widely in use in Sicily under the name of Xylonganum. The Russians, Cossacks, and Tartars, and especially the mountain population of the Carpathians and Ural, played much upon an instrument of the same nature that they called Diereva and Saloma.

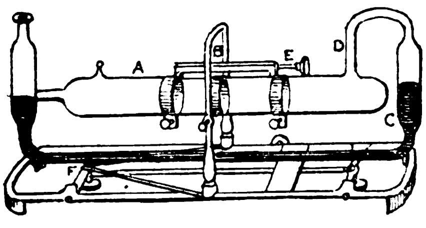


It appears that the xylophone was played in Germany as early as the beginning of the 16th century. After this epoch it was in use for quite a long period, but gradually fell into oblivion until the beginning of the present century. It was toward 1830 that the celebrated Russian Gussikow undertook a grand artistic voyage through Europe, and gained a certain renown and received many honours due to his truly original productions. Gussikow possessed a remarkable technique that permitted the musical instrument which he brought into fashion to be appreciated for all its worth.

As the name, "instrument of wood and straw," indicates, the xylophone consists of small pieces of wood of varying length, and narrow or wide according to the tone that it is desired to get from them. These pieces of wood are connected with each other by cords so as to form a triangular figure, as shown in the illustration, that may be managed without fear of displacing the parts. The whole is laid upon bands of straw designed to bring out the sounds and render them stronger and purer. The sounds are produced by striking the pieces of wood with a couple of small hammers. They are short and jerky, and, as they cannot be prolonged, nothing but pieces possessing a quick rhythm can be executed upon the instrument. Dances, marches, variations, &c, are played upon it by preference, and with the best effects. The popularity of this instrument is making rapid progress, and it is beginning to be played in orchestras in France, as it has been in America for many years. A method of using it has just been published, as well as pieces of music adapted to it, with piano, violin, orchestra, &c., accompaniment.

## A NEW FIRE-ALARM.

THE annexed figure represents an apparatus for closing the circuit of an electric fire-alarm by means of the expansion of air and the action of gravity. It consists of a glass cylinder, A, full of air, and mounted upon pivots in a frame, B, in such a way that it can tilt in one direction or the other like the beam of a balance. A glass tube, C, containing mercury is arranged parallel with the cylinder and connected with it. One of the extremities, D, of the glass tube communicates with the air chamber, so that the mercury in the column, C, of the tube rises or falls according as the pressure of the air in the cylinder, A, increases or diminishes. The position of the cylinder in the frame is variable, through the screw, E, so that the equilibrium of the system can be regulated at will.



When a fire breaks out and increases the temperature around the apparatus, the air expands in the cylinder and causes the column of mercury in C to fall; the equilibrium of the balance is destroyed, and one side of the apparatus descends until it touches the two contact springs, F. The electric circuit is thus completed, and sets in operation an electric bell or an indicator. The temperature at which the apparatus is to operate is determined beforehand, and the balance is regulated in consequence. The tubes descend with sufficient force to establish a perfect contact, provided the platinum points are clean. The apparatus returns to its normal position automatically as soon as the temperature falls and the mercurial column rises. The inventor of this apparatus is Mr. Pritchett.—*La Lumière Electrique.*

## SCREW-CUTTING ON THE ENGINE LATHE.*

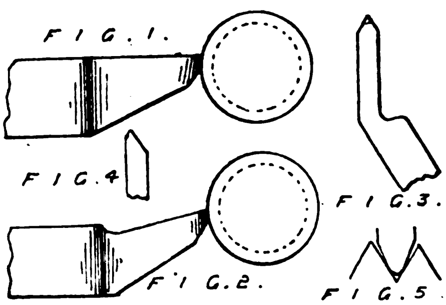
THE V-thread being that which is most frequently and generally used, the cutting of it is naturally the first to be considered. To produce a good job, a most necessary thing is to see that the piece we propose to cut is turned to the right size. To have a neat and perfect thread, it must be turned small enough to just escape coming to a full thread, and the surface should be finished reasonably smooth. If not turned small enough, and if the screw reqires to be cut still smaller after a full thread is attained, it is very sure to tear out and cut raggedly, and make a very bad-looking screw. This is especially true of cast iron, where I have sometimes seen half of the thread torn off by trying to cut beyond a full thread. If it ever happen that a thread is cut to a sharp point, and yet is not small enough, the top of the thread should be filed off before continuing the cutting.

If the screw to be cut is to be made the size of some existing screw, a pair of calipers with very broad noses covering the points of two or more threads will be found a convenience in determining the outside diameter. The screw to be cut should be turned somewhat smaller than the size indicated by these calipers, as the points of the thread swell and rise somewhat under the pressure of the tool in cutting. If the screw is to be cut accurately to any required size, it cannot be done with any certainty by these calipers, as the least difference in the sharpness and perfection of the points of the thread will affect the result.

A V-thread can be measured and cut to size more accurately by calipering the bottom or smaller diameter of the screw. The latheman should keep a pair of calipers for this purpose. The points of these calipers should be thin and V-shaped, somewhat more acute than the thread gauge, and the points should be ground off, so that they will never touch the bottom of the thread, Fig. 5. By the aid of such calipers, the expert workman should be able to cut a screw to the size of any sample screw with great nicety. It is not practicable to use the calipers with a knife-edge, and to measure the bottom of the thread, as the least imperfection in the points of either the calipers or the screw would mislead us. And, at their best, these calipers, on account of the pitch of the thread, do not represent its actual diameter, but only serve to compare it with the sample.

The difficulties in the way of a uniform and universal system of screw-threads seem practically insurmountable. The growing uniformity in the number of threads to the inch for any given size is to be rejoiced at as an approximation, but still we cannot state the actual size of any given screw in figures. We can state it, of course, just as we can state the length of a pendulum beating seconds in vacuo, and at the temperature of ice-cream, or the length of a degree of the earth's surface, and it will do us just about as much good. By the dissemination of the micrometer caliper, we are pretty well agreed as to how large an inch shall be, or any fraction of an inch; but no nicety of any measurement will enable a man to cut a 1in. screw here that shall fit a 1in. nut a thousand miles away.

From the nature of its work, the V-thread tool is the most tried of all lathe tools, and to get it right and keep it right, so far as the wearing of it is concerned, is very difficult. If you have a new sample of tool steel that you want to try, there is no better test for it than in a thread tool. If it will stand satisfactorily for that purpose, it will be good for any lathe tool. A thread tool must not be too soft, or it will wear away fast, and when worn it not only will not cut well, but the shape and correctness of the thread is immediately impaired. Upon the other hand, if the tool is too hard, the point will break, and cause great trouble in that way. The first cut over a screw is usually the most trying of all to the point of the tool, and it must not be crowded too much. It should be set so high as to leave scarcely no clearance in front of the point. This will secure to it the best possible support, and reduce the chance of breaking. At the same time, the top of the tool should be ground back to give the point as acute an angle as it will stand without breaking or dragging itself into the work. As a general thing, the sharper the tool is ground back on the top, the smoother will be the surface cut. Cutting metal, and rubbing it off, are two distinct mechanical operations.



The latter method of removing metal is employed more frequently than it should be. If the tool is raised much above the centre of the work to give it a better cut, it may be necessary to lower it by the screw at the back of the rest as the thread becomes deeper and the tool comes in nearer to the centre. If the lathe rest has no elevating screw, or other arrangement for adjusting the height of the tool after it is fastened in the tool post, then the front of the tool should be ground to stand nearly vertical, and the point set level with the centre of the screw to be cut, and to enable it to cut well and easily the top will require to be bevelled back more than if the tool were higher and with more clearance in front. Many mechanics are subjects of a little illusion—optical or otherwise—regarding the setting of a thread tool. Fig. 1 is about how I generally see a thread tool set. Fig. 2 would be condemned by half the mechanics I know, as far too rakish and piratical, and even positively dangerous. Yet the angle of the cutting face of the tool and the clearance in front of it are alike in both figures, while the advantage in other respects would seem to lie with the latter, as not requiring readjustment of height at different stages of the cut.

For general use in cutting threads, say up to six, I would use a tool not much thicker than the required thread, and usually bent to 30° to the right, Fig. 3. The bending of the tool gives it an offset, and makes more room for the rest in working up to a shoulder. There is generally but little trouble experienced from the springing of a thread tool, and for convenience of grinding and handling it is well to make it light. It is well enough to propose regrinding a thread tool by grinding the top, and so avoiding the difficulty of adjusting the V to gauge every time; but in practice it does not work well. The difficulty of making the second side of the V to gauge correctly with the first side is really no greater than that of grinding the end of a square-nosed tool true. The sides of the V are always accessible on any flat-faced grindstone or emery wheel, while if we begin to grind a little curved notch in the top of a tool to give it cut, as some still advocate, and too many still practise, we go but a little way in that direction before we encounter the impossible.

Where the thread is to be cut close up against a square shoulder, the tool should be ground away on the following side of the V until the leading side is left only just wide enough for the side of the thread to be cut, Fig. 4. Great care is required in cutting up close to a shoulder, as the tool must be withdrawn from the cut before the revolution of the screw entirely ceases. If we undertake to withdraw the tool from the cut after the lathe has stopped, we are very sure to break the tool, and not only have to re-grind it; but leave a piece of hard steel in the work upon which to repeatedly encounter similar shipwreck. In approaching a square shoulder with a thread tool, it is also well to see that no loose chips drop in between the shoulder and the advancing side of the tool. Where it can permitted, and usually it can be, a groove should be cut in the work with a round-nosed tool, for the point of the thread tool to run into, when it can be withdrawn with perfect safety. A round-nosed tool is much preferable to a square-nosed for this purpose, and leaves the work neater and stronger.

Except in the case of cutting close up to a shoulder, when the lathe should be stopped and pulled carefully up to the stopping point by hand, and at the same time the tool withdrawn from the cut just before the motion of the lathe ceases, no such careful stoppage is required; the tool can usually be withdrawn with one hand while the lathe is stopped or reversed with the other.

The angle to which it is best to grind the tool on the top for smooth and easy cutting must be determined by circumstances. It will vary with different metals, and also with different men. I pick up a tool which I know will do very satisfactory work in iron or steel, and I find the angle between the top and front to be 70’. Another tool that does very well in brass I find to be about 90°. I have used a tool in cutting copper as acute as 60°.

The stop gauge for regulating the adjustment of the tool at each cut is a convenience that will be used less and less as the workman becomes more expert. The amount the tool is fed in at each successive cut can be gauged with sufficient accuracy by noting the position of the handle upon the cross-screw. The stop gauge, I think, should only be used for the finishing cut for the purpose of producing a number of screws of the same size, and then allowance must always be made for the wear of the tool.

Taps should be cut with all the care of which the workman is capable, both in size, in the shape and inclination of the thread, and in the smoothness of the finish. When nearly cut to the size, the tool should be reground and readjusted with great care, and the thread should be cut so smooth and bright as to require no polishing after. I have a notion that polishing spoils a tap. We were using in our shop the taps of perhaps the best and most eminent American firm in that line. They were perfect in size and admirable in finish. They were, in fact, too nice. I do not know how else to explain their fatal fault. They required so much power to drive them that we were obliged to abandon their use. I verily believe that some home-made taps, rough as the tool left them, and black from the forge, would tap a hole with one-quarter the power required by these fancy taps.

In cutting threads of wrought-iron or steel, it is necessary to use some lubricating substance, and it must be confessed that for this purpose nothing is so good as oil. If the oil is not spread all over the screw, some spots being allowed to get dry, the result sought is worse than defeated. Pouring the oil upon the screw with an oil can is an extravagant and wasteful way: while using much more oil, it is not spread evenly, and the bottom of the thread, where it is most needed, is often not oiled at all. Ninety-eight and one-quarter per cent. of the machinists do it in that way. A better way is to apply the oil with a stiff, short-haired brush, like a blacking brush, and use the worst oil that you can find. I am not one of those who habitually sigh for "the good old days that are for ever past and gone, and what we never won't see no more;" but when I think of the genuine old whale oil that we used to have to cut screws with, there's where the sigh comes in, or, rather, out.

## RECTILINEAR PHOTOGRAPHS BY DISTORTING LENSES.

THIS would seem at first sight to be an anomaly. Notwithstanding this, it is not only capable of being done, but done without entailing much trouble. When a single landscape lens is employed in producing a view exceeding a very moderate angle, no defect whatever is appreciable, provided the subject be one in which there are no square marks or straight lines near the margin, as such would be represented with a greater or less amount of curvature. For landscapes or groups such single lenses, therefore, answer quite well. While we would hesitate to say that for the former purpose they are superior to any of the best compound lenses introduced for this purpose, we do not doubt they are at least equal to them. Except in the sole matter of curvature of marginal lines when overworked (by which we mean the including of too great an angle of view), the single lenses leave nothing to be desired. They work clean and with brilliancy, define well with a moderately large diaphragm, and give images sharp to the corners. When an architectural view, a map, or a chart, has been made or copied by a lens of this class, and the curvature or distortion is such as to be observable, the way to eliminate all error is to make a transparency from the negative by means of a camera with a single lens, by which an amount of distortion equalling that in the previous case is produced, the resulting photograph being absolutely rectilinear. With a transparency quite perfect as regards drawing, there is no difficulty in producing, by superposition, a negative from which all error shall be eliminated. It stands to reason that if distortion of a certain nature be produced by the use of a single lens having a diaphragm in front, distortion of an opposite nature will result from the employment of a diaphragm behind the lens. It follows, therefore, that if a view which has been distorted be returned through the lens by which it was so treated, it will, when arrested by the focusing screen, be found to be practically free from all distortion. This principle is a simple one, but it is not quite so well recognised as it ought to be. What is of importance to the photographer to know is this: that no matter how imperfect his photographic negative may be as regards curvilinear distortion, it can be cured, and that in a perfect manner.—*Photographic Times.*

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* By Frank H. Richards, in the *American Machinist.*

# SCIENTIFIC NEWS.

THE death is announced of M. Henri Milne-Edwards, the distinguished naturalist. He was born of English parents at Bruges in 1800, and his elder brother, the eminent physiologist, having settled in Paris to study medicine, Henri joined him, practised medicine for a time, and then devoted himself to natural history. In 1838, he succeeded Cuvier in the Academy of Sciences, and from 1841 he was Professor at the Jardin des Plantes, eventually taking the place of Geoffroy St. Hilaire. He resigned the chair of physiology in 1876, when his son Alphonse was appointed to it. He was President of the French Scientific Association, and published a large number of scientific works, the Royal Society list giving the titles of over 100 memoirs and treatises.

There is too much reason to fear that Mr. F. A. Gower, the inventor of the Gower-Bell telephone, whose experiments with balloons we recently mentioned, has met with an untimely fate. He made a successful balloon trip across the Channel in June, and continued his experiments in France, where he met with a slight mishap while awaiting an opportunity of returning in a balloon to England. Undeterred by this, he made an ascent on the 18th of July from Cherbourg, and since that date nothing definite is known of his whereabouts. A pilot balloon which he had previously despatched has been found and sent on to Hythe; and a balloon has been picked up without a car some 30 miles off Dieppe. It has been announced in some quarters that the unfortunate gentleman, after floating for many hours at sea, died from cold and hunger; but we believe that nothing definite is known as to his fate.

Mr. Robert F. Fairlie died on the 31st ult. in the fifty-fifth year of his age. His double-ended and double-bogie engines, known as Fairlie engines, have done good work, especially in Russia, Peru, Mexico, Canada, and New Zealand; but unfortunately his system was never carried out in its entirety. A few years ago, Mr. Fairlie made a trip to Venezuela to report on the construction of a system of railways on his plan for that country; but unfortunately was attacked by sunstroke and jungle fever, and had a long illness, from which he never really recovered.

Observations of Barnard's comet made at Nice by M. Charlois have been published in the *Comptes Rendus*. On July 11th the nucleus was found to be of the 10½ magnitude; it was surrounded by a slight nebulosity of confused appearance, about 1·5′ in diameter. MM. Thollon and Perrotin examined the comet spectroscopically on the 13th and 15th; the nucleus gave a very faint continuous spectrum, over which the ordinary-cometary bands could be momentarily distinguished. It appears that if the comet is not likely to be of much interest from its shape or brilliancy, it will still be notable on account of the greatness of its perihelion distance, which is much greater than was at first computed.

The report of the technological examinations of the City and Guilds Institute shows an increase in the number of students as compared with the previous year (3968—3635), and what is more satisfactory, an increased percentage of passes (2168—1829). The number of centres has been increased to 167 (three more); but the subjects of examination were 42 only as compared with 43 last year. The proportion of failures is, however, still much too large—45·3 per cent.—and shows that there is either a lack of teaching power, or that candidates come up who are really not acquainted with their subjects. The total cost of this year's examinations is £3,495, or a little less than 11s. per student, and it is expected that about 750 of this year's successful candidates will gain a full technological certificate by having also "passed" in science.

An object of considerable interest to engineers and power-users is now in full work at the Inventions. It is to be found in the middle court, and is called the Balanced Float Water Motor. The inventor, Mr. Sealy-Allin, claims 90 per cent. efficiency, and asks for tests. According to Molesworth, a water-pressure engine returns 80 per cent., a turbine 70, an overshot wheel 68, and a Poncelet's undershot wheel 60, and those figures are proved by experiments to be almost absolutely correct, although some trials of turbines are said to have shown more than 80 per cent. return. There will be more to say about this Balanced Float Water-Motor before the exhibition closes, as its endless chains and feathering floats not only promise long life, but the least waste in friction that can be hoped for.

The annual meeting of the National Fish Culture Association was held at the Aquarium, Inventions Exhibition, South Kensington, last week. The council reported that satisfactory financial arrangements had been concluded with the executive of the International Inventions Exhibition. The utmost had been done to present to the public an interesting and popular collection of fish, and to secure suitable specimens collected from various parts of our coasts by special fishermen. The council have widened the sphere of operations by forming at the commencement of the present year a national fish culture establishment for the purpose of conducting practical experiments in rearing various species of Salmonidæ and coarse fish. The report was adopted and officers were appointed for the ensuing year. On the motion of the Mayor of Hull a resolution was passed asking for public support to the society.

At the annual meeting of the North of England Institute of Mining and Mechanical Engineers held on Saturday last in Newcastle, the secretary read the report of the council, in which they stated that they were giving attention to the repeated occurrence of destructive explosions in coal-mines from causes the origin of many of which it was difficult to determine. Some of these accidents have occurred in collieries where every possible care has been taken to prevent them, and in pits where the amount of gas has been very limited and the ventilation good. The theory that coal-dust may be an agent in intensifying explosions has long been before the council, and some of the experiments on its effects were made by members of the institute. These experiments were not on a sufficiently large scale, or so conclusive in their results, as might have been desired; but they were sufficient to prove that coal-dust was an element of some danger. Recently the German government have taken the matter up on a scale suited to its importance, and the experiments seem to prove that the practical danger attached to the dust only is small, and that explosions of coal-dust can only be caused by blown-out shots when the dust is in very large quantities, and lying within 15ft. of of the shot. The secretary subseqently read a translation of a paper describing the results of experiments with coal-dust at Neunkirchen. It was found that a small quantity of water was not of any use. Dust, to be rendered inoffensive, must be mixed with at least two-thirds of its weight of water. It is sufficient to damp the dust to the length of the flame caused by the shot; but as this distance, with inflammable dust and a very small quantity of gas, might reach 55·76ft. and more, it will be difficult, in practice generally, to apply water. Blown-out shots, charged with 3¼oz. of powder and stemmed with the dust of dry coal, as those from Kohlscheid and Königin Louise, have given, without dust being sprinkled and without gas, a length of flame of 31·16ft., and these were augmented to 36·08ft. with 3 per cent. of gas. In no case has it been possible to fire dust held in suspension in the gallery by means of a lamp or with a strong flame of gas, the dust only burning in the flame, with a low crackling noise, without exploding.

Berghauptmann Joseph Fleischaus, of Vienna, has been appointed by the Austrian Government as president of a permanent commission for investigation into the causes of fire-damp explosions in collieries, their ventilation, the use of gunpowder in blasting, and other causes leading to the loss of human life in mining.

According to the *Photographic News*, the retina of the living eye has been photographed by Mr. Webster and Mr. Jackman, of Coggeshall, Essex. The negative was an extra sensitive gelatine plate. The crystalline lens of the eye and a 2in. focus achromatic meniscus formed one composite optical system for projecting the image, and owing to the non-actinic colour of the retina an exposure of twenty minutes by gaslight was required—no small strain on the sitter, who, of course, had to look steadily at a dot during this time. The negative, although small, shows the bifurcation of the blood-vessels, and also the edge of the blind spot. Since the photograph was taken, some progress has been made as regards arrangements for future work.

Mrs. Elizabeth Thompson, of Stamford, Connecticut, not long ago gave 5,000 dollars as the nucleus of a fund to be controlled by the International Scientific Society. She has recently increased the amount to 25,000 dollars, the income of which is to be devoted to the advancement and prosecution of scientific research in its broadest sense. At their first meeting, the trustees, Dr. H. P. Bowditch, W. Minot, jun., Prof. E. C. Pickering, Gen. F. A. Walker, and (secretary) Charles S. Minot, Boston, Mass., resolved to call their trust the "Elizabeth Thompson Science Fund." The first appropriation will be made next autumn; but when the International Association is organised, the income will presumably be placed under the control of the executive of that body.

An improved life-raft has been invented and patented by Dr. Mears and Mr. Linkleter, of Tynemouth, who have built one, in which they intend to make a trip southwards along the coast as far as Dover and then cross to Calais. The raft has twin keels and an open middle, and from tests already made is a fast sailer.

Messrs. Capello and Ivens have crossed the African continent from west to east, meeting and crossing the Lualaba, Luapula, and the Chambezi.

The American Association for the Advancement of Science holds its meeting this year at Ann Arbor, Michigan, commencing August 26.

The British Association meets at Aberdeen on Sept. 9. Dr. Armstrong, president of the chemical section, has arranged for two important discussions in his department—viz.. on the determination of the molecular weights of liquid and solid bodies, and on electrolysis. A series of critical papers will be read, and several well-known authorities have promised to contribute.

M. Henri Vivarez, writing in *Cosmos*, states that silicious bronze has a conductibility comparable to that of copper, and a greater strength than that of iron. The silicium may be introduced in various proportions, the mechanical resistance varying inversely as the conductibility. In telegraphy galvanised iron wire, which weighs 155 kilogrammes per kilomètre, can be replaced by wires of silicious bronze, which weigh only 28 kilogrammes; and in telephony iron wires of 25 kilogrammes can be replaced by wires of silicious bronze, which weigh only 8·45 kilogrammes.

# LETTERS TO THE EDITOR.

[*We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.*]

*All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

*All Cheques and Post-office Orders to be made payable to* J. Passmore Edwards.

*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original." —*Montaigne's Essays.*

## TELESCOPES USED AS NIGHT GLASSES.

[24564.] — In response to "F.R.A.S.'s" invitation on page 473, I send you Prof. Holden's article for reproduction in your columns.

**H. Sadler.**

### Observations on the Light of Telescopes used as Night Glasses.

By Edward S. Holden.

(From the *American Journal of Science and Arts*, 3rd Series, Vol. XXII. p. 129.)

In the *Philosophical Transactions* for 1800, Vol. XC. p. 67, Sir William Herschel says:—"In the year 1776, when I had erected a telescope of 20ft. focal length, of the Newtonian construction, one of its effects by trial was that when towards evening, on account of darkness, the natural eye could not penetrate far into space, the telescope possessed that power sufficiently to show, by the dial of a distant church steeple, what o'clock it was, notwithstanding the naked eye could no longer see the steeple itself. Here I only speak of the penetrating power; for though it might require magnifying power to see the figures on the dial, it could require none to see the steeple."

I had long been desirous of trying this experiment with a large aperture, and made several attempts in 1874 to have the dome of the 26in. Clark refractor at Washington so arranged that a terrestrial object could be seen, but without success. I therefore took the first opportunity to try the effect of a telescope under these conditions at the Washburn Observatory, where the large equatorial commands the horizon. The most suitable object for examination was the tower of the Hospital for the Insane, which is 20,798ft. distant from the centre of the Dome.* 1" at this distance is 1·3in.; 1' is 78in.

The whole tower has an elevation of about 9' above the horizon line. In the observations which follow, the highest part (10ft. high) is spoken of as "the spire," the next (9ft.) as "the base of the spire," the next section (13ft. high) as "the cupola" or "the dome," and the remaining portion as "the tower."

The finder has an aperture of 3·50in., a field of 1° 20', and a magnifying power of 26 diameters. The refractor has an aperture of 15·56in., a field of 11·6', and a power of 195 diameters.

The following observations were made 1881, April 18, by Mr. S. W. Burnham and myself.

The whole sky was perfectly clear except a very faint bank of clouds to the west of the tower looked at. The observations were as follows (*Hn.* standing for observations made by Holden; $\beta$ for those made by Burnham):—

7h. 35m. The tower disappears to the naked eye. In the finder the spire is still plainly seen. In the 15in. the whole of the spire, ribs, dome, and many details well seen.—*Hn.*

7h. 42m.: The tower disappears to the naked eye. In the finder and telescope everything still seen.—$\beta$.

8h. 0m. 15in.: The ribs on the cupola are gone.—*Hn.* and $\beta$.

8h. 7m. Finder: The shape of the cupola is confused and uncertain.—*Hn.* and $\beta$.

8h. 14m. Finder: Pretty much the same. 15in.: The spire on top of the cupola is still plain. No one looking with the telescope would miss it.—*Hn.* and $\beta$.

8h. 17m. 15in.: The spire on top of the cupola gone.—*Hn.* I still see it.—$\beta$.

8h. 17m. Finder: All shape to the cupola is gone.—*Hn.*

8h. 21m. 15in.: Spire still seen by averted vision, not well by direct.—$\beta$.

8h. 22m. Finder: The tower is a mere black spot. 15in.: Spire is much fainter.—$\beta$.

8h. 23m. 15in.: The spire is gone, except that I can see that the outline of the cupola is not round. —$\beta$.

8h. 25m. 15in.: Spire gone.—$\beta$.

8h. 26m. Finder: Tower gone.—*Hn.*

8h. 27m. Finder: Tower and cupola gone.—$\beta$.

8h. 27m. 15in.: Tower and cupola gone.—*Hn.*

8h. 29m. 15in.: Tower has lost all shape.—$\beta$.

8h. 30m. 15in.: Tower gone.—$\beta$.

About this time the sky was dark and the horizon became clearer, as was shown by small stars becoming visible in the finder. Probably the light cloud above spoken of was dissipated.

8h. 35m. 15in.: The cupola and tower can be plainly seen as a dusky cloud with a certain shape, when the telescope is vibrated to and fro.—*Hn.* and $\beta$.

8h. 37m. 15in.: Same.—*Hn.* and $\beta$.

8h. 43m. 15in.: The cupola and tower are seen even better than before. The horizon is clearer. There is no difficulty in seeing them when the telescope is moved, and they can just be seen by direct vision.—$\beta$.

8h. 44m. Same.—*Hn.* and $\beta$.

8h. 45m. Stopped examination, as there seemed to be no prospect of losing the tower as long as the horizon remained clear. If we had lost it we should have attributed the loss to haze at the horizon. Small stars 8-9 magnitude seen in finder. They must have had an altitude of not more than 30'.

It appears to me that this confirmation of Herschel's experiments is important and worth the attention of physicists. So far as I know, there is no satisfactory explanation of the action of the ordinary Night-glass, nor of the similar effect when large apertures are used.

Washburn Observatory, Madison, May 1, 1881.

## 100 TO THE INCH OF APERTURE.

[24565.]—I think that Mr. W. P. Dodge (letter 24545, p. 475) has taken in too serious a sense a phrase that was used by me in a half-jocose manner —that of "setting optical theories at defiance." Certainly, I am satisfied with the general theories of optics, and have not the slightest intention of attacking such; but when I find statements in certain textbooks — generally copied one from another—that do not accord with my personal experience of a particular optical instrument—well, I must then express dissent from such views. In the particular case quoted, I can give no reason why a 26in. would not bear a power of 1300 on a planet as well as a 12in. would 600, save that the atmosphere prevents the use of these powers; and, further, that I suppose it is not possible to make large object-glasses so perfectly corrected as smaller ones. I believe that the power generally used on a well-known 26in. o.g. is about 400 for planetary observations; and I have had superlative views of Mars and Saturn with similar powers on comparatively small instruments. My contention was that the atmosphere had almost as much to do with magnifying power as the aperture of the telescope —within certain limits, of course—and this opinion I see no reason to abandon until I have had ocular demonstration to the contrary. But, at the same time, I do not wish to convey an impression that large apertures are therefore useless—far from it; because with equal powers the larger instrument will show the most, as we should expect. With regard to the magnification of star images Mr. D. is right, and I am wrong, the letter having been written when much pressed for time, and therefore not read over again before posting.

**W. S. Franks.**

[24566.]—My experience of high powers on telescopes, which may interest, is as follows. Several years ago, having a very good 2½in. Wray o.g., which performed very well with powers of 80 and 125, I obtained a pair of lenses from good makers to construct a more powerful eyepiece. The field lens was ¼in. diameter, and ⅜in. focus, and eyelens $\frac{1}{10}$in. diameter, and $\frac{5}{32}$in. focus, the thickness of both lenses being included in the focal length. These, when mounted ¼in. apart, formed an eyepiece but little inferior in power to a single lens of ⅛in. focus. I tried this on the 2½in. o.g., and afterwards on an equally good 2¾in., and also 3¼in., by the same maker, the result being that it was easily seen, by the softened outline of the planets and the disc of stars, that any higher power would be useless. I am now using it on my 6¼in. mirror, which certainly stands it the best, though it is but at rare intervals that the atmosphere is good enough for it to be used to any advantage. This shows bad for the 100 to the inch theory, as on all these, o.g.'s and mirror, it is but about 70 to the inch, both as measured by the spot at the eyepiece, or calculated by the old rule of dividing twice the product of the focal length of the lenses by their sum. Focal length of o.g.'s, 2½in., 35in.; 2¾in., 40in.; 3¼in., 46in. Calver mirror, 67in., all, certainly, of the best quality.

**F. T.**

## THE DAYLIGHT OCCULTATION OF ALDEBARAN.

[24567.]—Referring to Mr. Peek's remarks on the above subject, which appear in your last issue, I beg to remind him that it is of little use to have a sidereal chronometer rated by star transits so as to give the times of immersion and emersion within the decimal of a second, unless the times of immersion and emersion have been separately computed for the particular latitude and longitude of the place where the observation of the occultation is made, because the times, as calculated for places not very remote from each other, or from Greenwich, vary *very perceptibly.*

The "partially-graphic method" of computing occultations and solar eclipses is something more than a modification of "the well-known graphic method of Mr. Penrose": for, whereas by the latter method the times can seldom be calculated to within five minutes, by the former method the like results can be obtained to within thirty seconds.

But let anyone make the attempt of working out an occultation or a solar eclipse on the "partially-graphic method," and compare the time occupied in obtaining the same results by Woolhouse's or Shadwell's method, and he will be able to decide the question for himself.

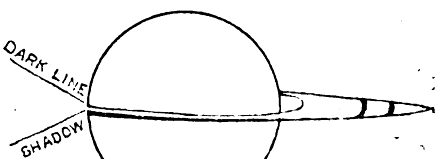
**James Pearson, M.A., F.R.A.S.**

Fleetwood Vicarage, Aug. 1.

## THE SYDNEY REFRACTOR.

[24568.]—I read in your "E. M." No. 1061, page 457, some remarks from Mr. H. Sadler about the Sydney refractor I made, and I am able to give some more particulars from the letters of Mr. H. C. Russell, Government Astronomer, Sydney, which I inclose and beg you to print them in your esteemed paper, as I think they will be of some interest.

The Sydney objective I supplied has 11⅜in. clear aperture and only 12ft. 6in. focal length. The focal length was limited by the size of the revolving dome of the Observatory. It is made of the Herschelian formula, and I supplied to Mr. H. C. Russell for this refractor the orthoscopic eyepieces for 100, 200, 400, 800 times power. According to the letters of Mr. Russell, he utilised for the most part the 400 times power; but Mr. Russell communicated in a letter of the 20th Sept., 1876, to me as follows: "I will mention one thing, and that is that I recently got a microscopic objective by Gundlach, of Berlin, ⅛in., and I tried it as an eyepiece, and though the power was 1,200 the definition was all that could be wished. Many times, in using the 800 power, I have felt that I could use a higher one." Then I supplied Mr. Russell with another set of eyepieces up to 1,500 times, and he was very pleased with that set. Mr. Russell mentioned in another letter that the 7¼in. is a Merz objective. Then Mr. Russell mentioned in the letter of 18th October, 1877, the following, about his testing the objective, that he could resolve a fine grating (which is still in my possession), at 400ft. distance with his power of 200. This very fine grating is the same as my pupil, Mr. Mellor, at Wedel, utilised for sifting the diatoms.



In the same letter of 18th October, Mr. Russell said:

"In 1874 I discovered a very fine black line along the edge of the white equatorial belt of Saturn. When I was in England I asked and no one had seen it; when I got to Washington I asked and they had not seen it. I looked myself through the 26in. and I could not see it. Now this very fine line almost exactly touches the shadow of the ring on Saturn, and a few nights ago I and another person saw both dark lines and shadow clearly, and the friend, whose eyes are sharper than mine, saw both divisions in the ring, as I have shown above; this, on the 10th of this month, when the plane of the ring almost passes through the earth."

"There is one simple test that I have often used with the glass, that may be mentioned, with a power of about 90 in the eyepiece, it will show the companion of Antares clearly *separate* from the large star."

**Dr. Hugo Schroeder.**

## PYROLOGY.

[24569.]—It is a pleasure to reason with Mr. Allen, because his arguments, independently of the gentlemanlike tone and good English in which they are expressed, are apparently directed towards the elucidation of the truth, and not, as is too often the case, towards mere controversial success. He complains (in letter 24555) that I have misquoted from his former letter the expression, "You have not proved that some of the lime was not dispersed about the bead" (of boric acid), and says "he never used any words of the kind," and that such words "are a serious perversion of his meaning." Those of your readers who have favoured us with a perusal of this discussion will remember that the words in question were quoted by me in my first letter from a private chemical communication, with the objections of which Mr. Allen says in his first letter "I fully agree"; and I therefore not unnaturally considered that, having adopted these chemical waifs so "fully," he had no intention of discarding the clothes in which they were dressed. But I am sorry to observe that the suit Mr. Allen has now put on them fits worse than before, and looks as though it had been got in a hurry from Moses and Co.; for if it be true that "chemists suspect lime to exist in a condition of solution in the clear portion of the bead" (of boric acid, which has been treated before the blowpipe), they are suspecting a chimera, for the simple reason that lime is insoluble under such conditions, both in the bead itself, B. B., and in boiling water.

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* I have to express my thanks to Prof. J. E. Davies for the communication of the Coast Survey data from which these figures are derived.

Mr. Allen contends that all arguments derived from a pyrological view of the subject are of a circular description and an effeminate character. To obtain a fine, square, masculine basis of logic we must, according to him, consult "wet" methods of analysis alone. Now, I am sure your readers, if they are to be the umpires in this matter, will consider this *ex parte* judgment as unfair to the ladies as to myself, although I have no objection to, and on the contrary should feel flattered by, being classed mentally with some of them. For it is obvious that the reproach of "arguing in a circle" can be at least as easily and justly applied to the "wet" methods of analysis as to the "dry." The "wet" reagent for lime is, I believe, a solution of oxalic acid, and Mr. Allen apparently wishes me to test the watered solution of the bead with oxalic acid after the calcium pyroborate ball has been removed, in order to see (I write, of course, under chemical correction) if I can thus obtain a precipitate of calcium oxalate from the residual bead. If I do not, then—and then only—will Mr. Allen believe that no lime exists "in a condition of solution in the clear bead." But suppose I were, in that case, to say I was not satisfied with that proof. Suppose I were to insist on evaporating the water solution of boron trioxide to dryness; to apply the residue to a fresh bead of pure boric acid before the blowpipe; to vesiculate it, and wave the hot vesicle in the dusty air of an ordinary room. I would then show Mr. Allen, with a lens, a considerable number of calcium borate balls (derived probably from the plaster of the ceiling) contained in the very bead which he had chemically decided to be free from lime. Of course I would not thus deceive him or any one else, but merely cite an instance to show that the reliance of the pyrologist on the delicacy of his anhydrous methods is as little to be described "arguing in a circle," and as much "on the square," as the reliance of the chemist upon his "wet" methods.

I certainly "appeal to chemists," as Mr. Allen states, but it is to give my new methods a fair practical trial, which their knowledge of chemistry enables them to do better than others, and not to test anhydrous results only by those of water solutions of acids, &c., with which they have as little to do as the attraction of gravitation has with "the man in the moon."

Far from asking Mr. Allen to "abandon his processes" for these, or to "replace" with the latter "the accepted wet methods of the chemist," I am sure your readers are aware, if he is not, that all I ask him to do is to study also anhydrous analysis (not the old blowpipe methods of testing minerals with borax, &c.) as a newly-discovered branch of that beautiful and glorious science of which he is, since the publication of his classical work on "Organic Analysis," one of the most distinguished professors. I would, in fact, call his attention to some far-sighted remarks on the subject in the *Chemical Review* for July, 1884, written (as I believe) by one of the best analysts in England, Mr. J. A. Wanklyn, in a review of my last published work on the blowpipe:—"Has it ever struck any of our readers that chemistry as at present understood, with all its far reaching speculations and its splendid practical results, is after all a mere fragment? . . . Yet this bold assertion is not entirely devoid of truth. We know, to a great extent, the properties and the mutual behaviour of bodies as they exist dissolved in water. If we could find a solvent which, instead of, like water, boiling in an open vessel at 212° Fahr., required to be heated, say to 600° or 1000° Fahr. before boiling, and could we dissolve bodies in it before letting them act upon each other, it is possible, or rather probable, that we might have much, very much, both to learn and to unlearn. Still more, did we take the pains to study the mutual reactions of bodies when liquefied, not by water but by intense heat, we should find ourselves introduced into a new world. . . . The purification and extraction of metals from their ores is a very different thing from the systematic examination of the reactions of all inorganic bodies upon each other at red, yellow, or white heats. The nearest approach to such a study is made in the use of the blowpipe in chemical *analysis*." (I have italicised the last word, because the received method of blowpipe *testing* is not analysis at all, inasmuch as it does not *separate* constituents of mineral or chemical compounds one from the other):

Mr. Allen says the anhydrous system cannot claim to detect as little as 0·5 per cent. of lime in a compound. That seems rather a vague illustration; but I will tell him what he can do for himself with it in a very short space of time. He can obtain in a bead of boric acid B.B. white opaque balls of (apparently) calcium phospho-borate from the head of a fly or quarter of a grain of wheat, accompanied by a (comparatively) large quantity of combined water. He can treat in this way an ordinary healthy housefly, and then (on another bead) one which has been poisoned on arsenical paper, and observe the immense difference in results of the two flattened beads under a microscope.

Mr. Allen's logic (which would astonish the late Archbishop Whateley if it could be communicated to him through a spiritualistic medium) may be happily illustrated by another of his objections. I state that, if any one properly performs a simple operation with pure boric acid, quicklime, a blowpipe, and an assay balance, he will ascertain the *fact* that lime combines anhydrously with boron trioxide to form calcium pyroborate in the ratio of 1 : 3. Any ordinary logician would suppose that the simplest and best way to refute this statement, if it can be refuted, would be for the doubter to perform carefully several times this simple operation himself, and then to state conscientiously his average result. But Mr. Allen thinks it would be a safer, if more roundabout, way to disprove my alleged fact by means of the atomic theory (!), without having recourse to anything so hazardous as practical experimental proof. He (virtually) says that, assuming the atomic weight of Ca to be 40· of B 11· and of O 16·, the weight of molecule CaO would be 56·, and of $B_2O_3$ 70. Therefore, the number of molecules of CaO in given weight of compound divided by the number of molecules of $B_2O_3$ in the same weight $= \frac{25}{56}$ divided by $\frac{75}{70} = \frac{5}{12}$; hence, the formula of the pyrological compound is $5CaO, 12B_2O_3$—"a very improbable constitution for a definite compound." This is "fitting the foot to the shoe" with a vengeance!—a chemical "torture of the boot" worthy of the worst days of the Vatican. Considering nothing more is claimed for the atomic theory than that it is "a convenient hypothesis" assumed for the purpose of explaining the undoubted facts of the combining proportions of hydrates and of gases, which (as Prof. Dewar explained the other night at the Royal Institution) can never be kept absolutely free from hydrogen; that there is no proof whatever of the existence of indivisible atoms, but very much the other way; no absolute proof of the elementary nature of metals, but only (as almost every trustworthy work on chemistry commences by stating) that chemists have hitherto, with the means at their disposal, been unable to decompose metals into any simpler forms—considering all this, I leave it to your scientific readers to decide whether alleged physical facts, capable of such facile experimental determination, can be logically proved or disproved by the application to them of hypothetical "theories" established upon undoubted phenomena of matter under almost entirely different conditions of existence.

Perhaps, as Mr. Allen is so solicitous to show your readers the extreme delicacy of his "wet" methods of analysis, he will explain how it happened that the thousands of previous chemical analyses of cigar-ashes never detected lithia in them until the spectroscope exhibited it there in considerable quantity.

When Mr. Allen accuses me of "persisting" in only using small quantities of material for pyrological analysis, it is evident he has of late given up reading as well as contributing to the English Mechanic, otherwise he would have seen by some late articles and illustrations of apparatus in that paper that I have devised "the aluminium open furnace" to be worked with the oxyhydrogen blowpipe for this very purpose, and there is a specimen of it (made by Johnson and Matthey) among my exhibits at the "Inventions." His suggestion of "a platinum crucible" only shows that he is not yet thoroughly acquainted with the matter, for these reactions cannot be produced in that.

The last unanswered objection of Mr. Allen to the anhydrous system of analysis now left is that the results of the reactions of 5 to 8 milligrammes (weighing 20 and 32 milligrammes in this case) only are placed in the assay balance, and really, considering he "claims" in this very letter to show us 0·5 per cent. of result in his "wet" analysis, I fail to see that there is very much difference in his use of the balance and in mine, especially when we remember that the pans of an assay balance by a reputable maker are guaranteed to turn with 0·1mgr. Why, then, should there be any greater danger to delicacy of analysis in using 5·0mgr. than in using 50mgr.? It would rather appear that the constant use of large weights would, if anything, increase the friction on the fulcrum, and, therefore, any source of error. Besides, as I have before stated, you can repeat the rapid results of blowpipe analysis over and over again, and have then, at least, as reasonable grounds for taking the average result as the correct one as you would have in adopting the result of *one* long operation (perhaps occupying several days) of solution, precipitation, filtering, washing, drying, &c., in the wet way.

On the other hand, consider the immense advantage of anhydrous analysis in the hundreds of cases where the operator can only obtain a minute crystal or very small fragment, or a few filings of the mineral, or jewel, or alloy to be analysed.

**W. A. Ross.**

## EXAMINATION OF MINERALS BEFORE THE BLOWPIPE.

[24570.]—No. 11. "An alkaline aluminous silicate, with large proportion of silica and alumina, very small ditto soda, and a little lithia: greyish white, compact, very hard; "prismatic crystalline structure" (?) This description seems to tally with that of the "bisilicate" of Dana, and the "silicate" of Des Cloizeaux and Brooke and Miller—called by the first and last "spodumene"; by the French mineralogist "triphane," and by Mohs "prismatischer triphan - spath." $SiO_2$ 65·02 $Al_2O_3$ 29·14, CaO 0·50, $Li_2O$ 5·47, $Na_2O$ 0·46, $K_2O$ 0·14 (Rammelsberg).

No. 12. Like the above but not so hard, and "semitransparent" (? translucent), with less alumina than the first. Probably "petalite" $SiO_2$ 79·212, $Al_2O_3$ 17·225, $Li_2O$ 5·761 = 102·198 (Arfvedson).

No. 13. "Lepidolite," of course: from λεπις a scale, called also "Lithionglimmer" (C. Gmelin.) $SiO_2$ 46·23, $Al_2O_3$ 14·14, $Fe_2O_3$ 17·97, MgO 4·57, $Li_2O$ 4·21, $K_2O$ 4·90, F 8·10 = 100 (Gmelin).

No. 14, stated by the analyst to be "barite" or "heavyspar"; but I can only say as regards the blowpipe reactions given, that I have found "celestine" (or Strontium sulphate) to behave in much the same way with these reagents, i.e., to "hold by its sulphuric acid with great tenacity"; fragments, effervescing considerably at first—more with greater heat, but eventually declining to decompose into "transparent balls and bubbles of $SO_3$"; but Col. Ross says "this important reaction is afforded by no other mineral than barite"?

No. 15. Barium carbonate, generally called "witherite." **Mineralogist.**

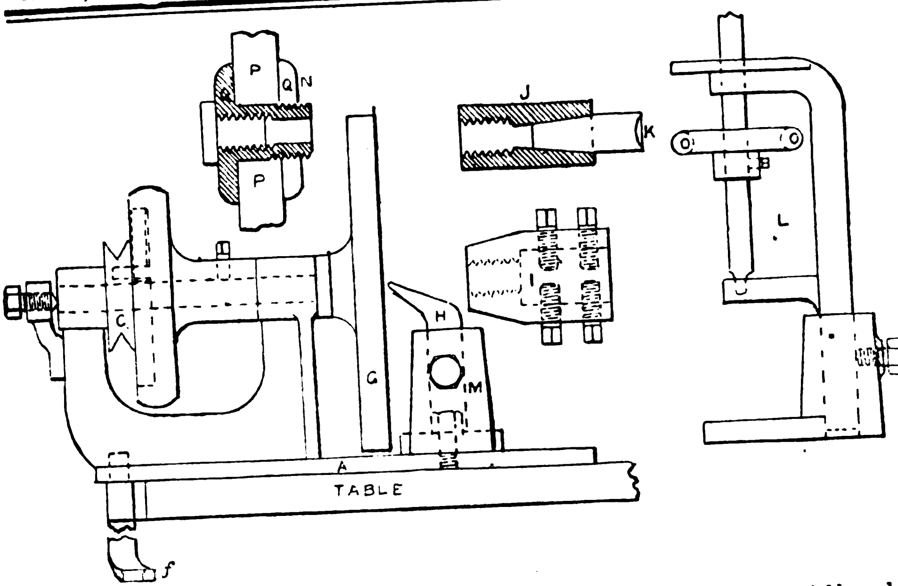
## THE OTTO BICYCLE—TO MR. BOYS, "ANTARES," AND OTHERS.

[24571.]—Happening to look over last year's "E.M.'s" a few days ago, I came on several letters on the Otto Bicycle, and am seriously thinking of getting one; but as there is no chance of seeing one out here before buying, I should like some advice from riders of the machine. What opinion has "Antares" now got of the Otto after a year's riding? At present I ride a 50in. ordinary bicycle, but the roads here are mostly too rough for it to be a pleasure to take long rides on it. Has the suggestion of having central gearing on the Otto, with chain instead of band, been carried out, and is it any improvement? I am afraid the rubber on bands would not last very long in this climate. Would it be necessary to have a stock of spare bands for this part of the world? Any advice would be very welcome to

**A South Australian Bicyclist,**

## AMATEUR LENS GRINDING.

[24572.]—I was much interested in the article which appeared in "Ours" of July 17 on lens making, and as it seemed very *nice* work, and not too difficult—in fact, just the thing for a "hobby"—I decided to "have a try," and, at the same time, it struck me that there were many besides lathe-owners who might like to do the same. I at once began to scheme a machine that should, 1st, do all the work necessary, 2nd, that could be fixed on an ordinary table, 3rd, that should not be expensive, and I now send the result. The base A is about 11in. long, and can be cramped to the corner of any table—of course, a stiff, strong table is preferable; but any one may be made stiff enough by means of a prop or two. Now, suppose the machine cramped, and we wish to start work. The end of a cord is made fast to a spring attached to eye F (spring not shown), the other end is brought up on far side of machine over wheel C, and down on the near side to within about 15in. from the floor; a stirrup or arrangement somewhat like a lathe-treadle being provided for foot to rest on, then, on treading downwards, the spindle will



revolve, and continue revolving till stopped by friction; but before it stops another tread may be given, and so the spindle kept revolving (this is effected by a noiseless friction arrangement). The speed may be altered by removing wheel C and putting a larger in its place, which can be done in half a minute. This arrangement is better than a crank motion, as the length and frequency of treads may be varied, and the foot need not follow the treadle, as when the foot is removed the stirrup or treadle will remain still, and yet the spindle keep running.

To cut the gauges, screw a piece of board on to faceplate G, face it true, screw on some sheet brass, and turn out to required radius, using rest H to support the tool. Next remove H, take off face-plate, and screw on chuck I; then, having some pieces of brass cut off, fix them one by one on chuck I by means of the screws, and turn ends to fit chuck J. (This is done to save time afterwards, as when once fitted in J they will run true without trouble.) Next take off I, screw it on J, and turn ends to gauge as at K, then proceed as in description given July 17. For large lenses the apparatus L can be fixed in M and run off faceplate by means of rubber ring O, the tool inclosed in wooden box being fixed on top of spindle.

For grinding edges of lenses a grindstone can be fixed on spindle, as shown in section at N, where P is grindstone, fixed by screwing between cheeks Q.

Mareham-le-Fen, Boston. **S. Beeching.**

## THE HISTORY OF THE TIDAL PROBLEM.—II.

(*Continued*).

[24573.]—Wallis, in A.D. 1666, in his letters to Mr. Boyle, derives the phenomena of the tides from the consideration that it is the common centre of gravity of the moon and earth, which describes an orbit round the sun while they revolve about this common centre. He, however, appears to have conjectured the principle of gravitation, though it is scarcely clear that he understood how the tides were caused by its action. These letters are published in his works, and in the "Philosophical Transactions," Volume I. page 263. He was Savilian Professor of Geometry at Oxford, and one of the first members of the scientific association which gave birth to the Royal Society. In answer to an objection which was made to him in the form of a query, "How two bodies, which have no tie, can have a common centre of gravity?" Wallis says, "It is harder to show how they have, than that they have it. That the loadstone and iron have somewhat equivalent to a tie, though we see it not yet by the effects we know. . . . . As to the present case, how the earth and moon are connected I will not undertake to show, nor is it necessary to my purpose; but that there is somewhat which does connect them, as much as what connects the loadstone and iron which it draws, is past doubt to those who allow them to be carried about the sun as one aggregate or body."

Francis Bacon, Baron of Verulam, Viscount of St. Albans, and in the reign of James I. Lord High Chancellor of England, was the most illustrious ornament of his age, and the reformer of philosophy. He was the author of a treatise "On the Flow and Ebb of the Sea"; but it must be admitted that his views on this branch of science were not characterised by the accuracy which marked his other investigations, for he conceives the phenomena of the tides to have been attributed to the moon "by common but unsupported conjecture."

To John Flamstead, who was the first Astronomer Royal at Greenwich Observatory, must be ascribed the merit of having constructed tide-tables, which professed to show the true times of high water at London Bridge for every day in the year A.D. 1683. His attention had been turned to the subject from his having frequently occasion to go to Greenwich by water.

To Sir Isaac Newton, however, belongs the glory of discovering and expounding the true theory of the tides. His theory explained with singular felicity all the prominent circumstances attending them—the difference of spring and neap tides with the effect of the moon's and sun's declination and parallax. It was about this time, also, that the Royal Society of England and the Academy of France made attempts to collect practical observations, and in A.D. 1740 prizes were offered for the best treatises on the whole subject. The treatises selected were those contributed by Euler, D'Alembert, and Bernoulli, and that of Bernoulli contained a table for computing the times of high water, which, with proper modifications, can still be used for the port of London. The modern editions of Newton's "Principia" contain a treatise by Bernoulli in Latin.

In A.D. 1774 Laplace took up the subject. Availing himself of the discoveries of D'Alembert in the theory of hydro-dynamics, he attempted to deduce from the equations of motion of fluids, the principal phenomena of the tides. The integration of these equations, however, presents great difficulties, even in the case in which the depth of the ocean is assumed to be constant, and the solid nucleus but little different from a sphere.

Finally, Laplace had recourse to the following indirect consideration—viz.: "That the state of any system in which the primitive conditions have disappeared, through the resistance which its motion encounters, is periodical with the forces which act upon it." Hence he concludes that if the system is disturbed by a periodic force, expressed by *a series of cosines of variable angles*, the height of the tide is represented by a similar series, in which the *periods* and arguments are the same, but the epochs and *coefficients* are different: This amounts to expressing the height of the tide by a series in which everything is arbitrary, except the periods of the arguments. The attention of Laplace, however, does not appear to have been directed to the construction of tide tables, for predicting the time and height of high water at any port, which is the truest test of the value of any theory.

The labours of Dr. Whewell and Sir John Lubbock furnish a large contribution to our stock of intelligence concerning the tides. By the former, an attempt was made to trace the progress of the tide into all the seas of the globe by drawing upon maps of the ocean what he calls *co-tidal lines*—*i.e.*, lines marking the co-temporaneous position of the summits of the great wave which carries high water from shore to shore. By Sir John Lubbock careful comparison was made between theory and observation, and tables were obtained for the effect of the moon's declination, parallax, and transit, as obtained from the most correct principles in the *Nautical Almanac*. By this means the *times* of high water were computed with remarkable precision; but the calculated *heights* showed discordances which this philosopher did not attempt to account for.

The tide tables first put into circulation for the port of Liverpool were those originated by the Rev. George Holden, a clergyman of Maghull, near that town, of which the theory, he tells us, was supplied by his brother, the arithmetical calculations by himself. These tables were first issued in A.D. 1770, and contained the times of high water, but not the *heights*. Subsequently, however, the heights were inserted; but the principles of the method have never been published.

Tide tables for Liverpool are also published annually in the Isle of Man, and as the calculations are performed independently, the results at times vary considerably from these of Holden.

In the *Encyclopædia Metropolitana* there is a treatise on tides and waves, which is most valuable as showing the theoretical basis on which the problem of the tides must rest. The author is Sir George Airy, the late Astronomer Royal. It discovers a ready means of disentangling some of the complicacy presented by the distribution of the times of high water in different places, and forming a sure foundation for the practical estimate of a definite part of the whole amount of retardation, when the times of spring and neap tides are better known, for all parts of the sea.

**James Pearson, M.A., F.R.A.S.**

Fleetwood, July 30th.

(*To be continued.*)

## GRINDING TOOLS FOR HAYDON'S CUTTER-BAR.

[24574.]—With regard to the letter No. 24492, published in "E. M." 17th ult., the part which deals with the division of the angles, and also the section where Mr. Atkinson speaks about advancing the tool, is not very explicit; so if he kindly takes the trouble to explain them more fully, then I shall be highly obliged.

In his letter he advises to get a sheet of paper, on which to make a semicircle exactly equal to half the size of the grindstone, and then to draw a line through the centre, and to call it a starting line. He then advises to set out certain angles, and to draw some parallel lines. He then goes on to say that the intersection of the lines which bound the angles with the parallel lines will give the heights at which the tools must be ground. My difficulty lies here. In the first place, Mr. Atkinson does not mention the points through which the parallel lines must be drawn. Secondly, he has omitted to mention the principle he has followed in dividing the grindstone into certain angles, and also in getting the heights at which the tool must be held to have a certain cutting edge. I mean to say this, Why the intersection of the boundary line of the angle—say, 25½°—with the corresponding parallel line give you the edge 80° to the tool?

Again, further down, the practical example he has taken to show the application of his instructions is, I am afraid to say, not very clear. In the drawing I could not find any "x," so I could not understand that part. Moreover, where he speaks of advancing the tool he does not say whether to advance it laterally or vertically, for advancing it in either way we shall get certain angles. About reversing the tool the part is not very clear. It will be a pity if these points are left unexplained; so if Mr. Atkinson kindly takes the trouble to take another example, and explain the details of his instructions more fully, then I shall be highly obliged.

**J. D.**

## THE NEW ZEALAND RAILWAYS 3ft. 6in. GAUGE—THEIR PROGRESS AND RESULTS FOR 1884—THEIR LOCOMOTIVE PRACTICE, AND NEW DEPARTURES IN THAT DEPARTMENT.

[24575.]—I regret that illness in the first instance, and subsequently my recent visit to England, should have compelled me to suspend my contributions on the subject of the New Zealand railways. I hope to be more regular in future.

The year 1884 has been of a somewhat mixed character as regards its results in connection with the railways of New Zealand. The gross receipts were larger than those of any previous year—viz., £961,304 as compared with £953,347 for 1882-3 and £892,026 for 1881-2. But in the first place, as this was the yield of 1,395 working miles, as against 1,358 and 1,319 respectively, it does not represent so good a result proportionately to mileage, and, secondly, the working expenses absorbed 68·2 per cent. of these gross receipts, as against 52·1 and 58·6 respectively. So the net profit showed a material diminution as compared with that of preceding years. The falling off was due to imprudent reductions in the tariff of freights made in compliance with outside political pressure, and in flat defiance of the earnest warnings of all capable counsellors. The consequence has been that although the traffic has increased, so much more work has been done for so much less pay, and the revenue has suffered to such a formidable extent that the Government have been forced to reverse their injudicious policy, and it is hoped the railways will do better this year. But it is easier to do a wrong thing than to undo it. The increase in rates was resented, and ministers have paid, in extrusion from office, the penalty of their former too easy concession to improper outside pressure.

During the year 3,272,644 passengers were conveyed, also 1,700,040 tons of cargo, 686,287 cattle, sheep, &c., and 359,896 parcels, &c. The work done comprised 66,316,931 "ton-miles," at rate of working equivalent to 2·15d. per ton-mile. The rolling-stock for 1884 stood as follows:—Locomotives 218 (viz., 45 tender engines and 173 tank-engines, the latter including 4 "Fell" and 30 "Fairlie" engines, "double" and "single-boiler"), 450 passenger coaches, and 7,076 goods waggons. The employés numbered 4,839 persons.

The new engines added during the year have been mostly of the "J" class, described in former articles. They have six coupled wheels 3ft. 6in. in diameter, cylinders 14 by 20, and a leading two-wheel bogie. These engines now run most of the main-line traffic, passenger as well as goods. Indeed, the majority of trains are "mixed," and travel at a slow rate of speed. The "through" (or so-called "express") trains between Christchurch and Dunedin, which I have before described, and which may be said to be slow expresses for 140 miles, and fast stopping-trains for 90 miles, are occasionally taken by these engines. In fact, I quoted in one of my last letters, instances of their doing very good work on this duty. As a more recent illustration I might name the run from Studholme Junction to Oamaru over many gradients from 1 in 100, both ways being done at an average speed of 30 miles an hour by the express with a "J" engine. The express service is ordinarily assigned to the regular express-engines (American) of the "K" class, with cylinders 12 by 20, four-coupled wheels 4ft. diameter, and leading and trailing two-wheel bogies; but these, while doing admirably with light trains on the more level portions of the road, are not equal to heavy loads on the steeper gradients of 1 in 50 for many miles, which prevail near Dunedin, so as additional engines were needed, it was determined to take a new departure, and this was rendered the more desirable by the fact that an important line undertaken by a private company, but really an essential portion of the North Island Trunk line—no other than the first 80 miles northward from Wellington, the capital of the colony—was about to be equipped with locomotive stock of a more powerful type than any yet in use on the Government lines with which it will connect. It was deemed advisable if possible to agree upon one type of new engine, and so a consultation took place between the company's engineer (Mr. H. P. Higginson, M.I.C.E.), on the one hand, and the chief Government officials on the other, including Mr. J. Blacket, M.I.C.E., engineer-in-chief; Mr. J. P. Maxwell, A.M.I.C.E.; and the locomotive superintendent, Mr. Allison Smith, M.I.M.E., with the result that a new class of engine was agreed upon, and twelve were ordered forthwith.

The new engines will be, in point of fact, a more powerful combination of the "J" and "K" classes; or, perhaps, it would be more convenient to consider them as a development of the latter. That is to say, if we take the latter with their leading and trailing two-wheel bogies, their four coupled 4ft. driving-wheels, and their 12 × 20 cylinder, and if we insert between the two pairs of 4ft. drivers a third pair of like diameter, but unflanged, and if we add 3in. to the cylinder diameter, making it 15in., still keeping a 20in. stroke, and if further we give it proportionately increased boiler power, and a general English construction as to material and exterior, retaining the eight-wheeled double bogie tender, then we shall practically have the new type of New Zealand passenger engine. To sum up its characteristics it will be a ten-wheeled engine, six wheels coupled with leading and trailing Bissell bogies, and the following principal dimensions: Cylinders—diameter 15in., stroke, 20in.; coupled wheels, 4ft.; bogie wheels, 2ft.; heating surface about 950 sq. ft.; weight on six coupled wheels, about 24 tons; on bogies, about 10 or 11 tons; total weight, 34 to 35 tons; tender about 15 tons. These engines are expected to take heavy loads on moderate gradients easily at a speed of 45 miles an hour, and to pull the through expresses, in the long banks of 1 in 50 near Dunedin, without needing pilots.

Orders have also been sent to England for the construction of ten goods engines of the "Consolidation" class, with eight-coupled wheels, 3ft. diameter (the second and third pairs unflanged), leading Bissell bogie and cylinders 15 by 18. The six American-built engines of this description received some years ago from the Baldwin works have shown very satisfactory results so far; but while this type will be adhered to for heavy goods traffic, the English construction will be preferred, owing to its superiority, chiefly as regards the materials used for the tubes, fireboxes, and wheels.

I am still unconvinced that Mr. Fairlie's double-boiler engines have had a full and fair trial in N.Z. His single-boilers have, and are valued accordingly as among the most useful of all the numerous types now at work on N.Z. lines. But the poor double-boilers have had to contend against strong adverse prejudices, and against the still stronger adverse influences created by their having been employed under conditions never contemplated by their inventor, and eminently unfavourable to the development of their full power. That is to say, they were worked on train services which only offered light and inadequate loads, and they were not worked expansively enough. So, naturally, they did not show to advantage in the comparison of tabulated results; and when heavier loads were available, these were handed over to other engines. Therefore it is that I deem the double Fairlies rather hardly used in N.Z., and I should very much like to see some of the twelve-wheeled class (double six-coupled) tried on some of the heavy goods train services on the southern railways of this colony. But I fear that is not very probable.

The latest return of locomotive work seems to me to strengthen my contention that the double Fairlies are capable of giving much better results than many suppose. On the Hurunui-Oamaru section of the Southern Trunk Line, thirteen engines of the "J." class (above described) took an average tonnage of 125·63 per train mile: four of the "M." class (cylinders 13 by 20, six-coupled wheels, 3ft. 6in. diameter, 28 tons adhesion weight) took 104·87 tons per train mile, at a respective cost per ton mile of 0·082d for Class J, and of 0·083d for Class M. The one double Fairlie running on that section (having cylinders 9 by 16; eight wheels 3ft. 3in., double four-coupled; adhesion weight 24 tons) took 124·10 tons per train mile at a cost of only 0·075d per ton mile. These figures speak for themselves.

I may mention, before concluding this rather long letter, that another fresh type of locomotive has been introduced by the Wellington and Manawatu Railway Company, already referred to. It is a ten-wheeled tank engine, having leading and trailing Bissell bogies, six coupled 3ft. wheels (the middle pair unflanged), and cylinders 12ft. × 18ft. This engine was designed by Mr. Higginson, engineer of the line. Five of these, built by Messrs. Manning and Wardle, have already been imported, and are now employed in construction work. They are doing exceedingly well, and are likely to prove one of the most useful classes we have out here. I had a run with one a few days ago, and found it showing excellent results.

**C. Rous Marten, F.R.G.S.**

Wellington, N.Z., June 19th.

## RAILWAY-SIGNAL RETURNS.

[24576.]—MR. C. E. STRETTON, or any one who knows, would render a service by explaining or by inducing the Board of Trade to explain, through the medium of the ENGLISH MECHANIC, what is the scope and meaning of the formula at the head of the returns the companies are required to fill up. At present each company is left to interpret the directions in any way it likes, and, doubtless, each prefers to make its statements look as favourable as possible.

First, as to the heading, "Number of cases in which any passenger line is connected with or crossed on the level by 'any passenger line.'" This would be much clearer if it read "any passenger line or passenger siding' so as to make the figures include the numerous passenger sidings at the great terminal stations and the crossovers and engine sidings leading therefrom, also the passenger sidings at the larger intermediate stations. This would, no doubt, increase the number of cases immensely, and in doing so would afford a means of ascertaining to what extent interlocking had been adopted at these large stations.

Directions ought to be given as to whether a passenger "loop" line should be computed as one or two cases (I should say *two* cases); also, whether an ordinary double junction should be reckoned as one, two, or three cases.

Probably a great proportion of the "sidings" mentioned in the return are passenger sidings; and as "catches" are generally inadmissible on passenger sidings, it is misleading (as Mr. Stretton's letter, No. 24498, in your last issue shows) to include these among those sidings for which safety points are "requisite."

Goods lines and goods sidings should be included in one column, and the column for number of safety points should refer to these only.

Are "runaway" catches to be included in the return? If so, where?

There are several other points which require elucidation, but my letter is getting too lengthy.

**Coral.**

## THE PENISTONE ACCIDENT.

[24577.]—I HAVE read with surprise and regret in the Manchester papers that the action, Woodhead *v.* the M. S. and L. Ry. Co. *re* Penistone Accident, has failed. Here was a case where persons were killed in consequence of the "neglect" of the company to provide proper brakes, yet the jury do not give a verdict for plaintiff. It is a very serious matter for all railway passengers, because it proves that companies can run their trains just as they like, and when persons are killed no damages can be obtained.

I should like to ask the opinions of your railway correspondents on the matter—what do they think of the verdict? Perhaps they will go further and tell us what is "negligence," because to my mind if such a case as this does not come under that head, there never was one that does.

Here we have twenty-four persons killed and sixty-two injured through neglect to have a proper brake, and the company gets off without paying a penny! Justice, where art thou?

**Traveller.**

## RAILWAY BRAKES.

[24578.]—WOULD "Meteor," or any of your other able railway correspondents, explain the working of the Act of June, 1878, so far as it relates to brake failures? The Act says the companies are liable to a fine of £50 if they make a false return. Now, it seems the last returns come under this head. The secretary of the Railway Society has pointed this out to the Board of Trade, but they don't put the Act in action. What I want to know is what steps are necessary to be taken to put the Act in force?

**Anxious to Know.**

## FAILURES OF BRAKES.

[24579.]—LATELY there have been a large number of these failures of brakes, but I notice they have not been mentioned in your journal.

On 23rd June, the 12.55 Midland express from Bradford to London was delayed at Manningham in consequence of a vacuum-brake failure. The brake in question was not the old "leak off," but the new "ball valve" system.

On Monday, 6th July, the Midland train from London at 6.10 a.m. broke couplings in no less than three places when stopping; the vacuum brake was of two kinds, the "ball valve" and the "leak-away," and as the two don't work well in one train, there were fearful jerks, and the break-loose followed.

On 7th July, the 6.10 a.m. train from St. Pancras was fitted with "leak off" and "ball valve" brakes; the ball valve would not come off, and there were delays at Mill Hill, St. Alban's, and Harpenden.

Another serious delay was caused by the vacuum brake last week, and the cause is clearly put forward in the letter of a passenger to a newspaper as follows:—

"SIR,—I think I have a right to complain of a long delay to a Midland Scotch express on Friday last, July 24th. I left London by the 9.15 p.m. (as a rule, this train is worked with an air brake), but by great neglect on the night in question, a wrong engine, 1,328, with vacuum brake, was provided. Two or three miles after we got past Leicester we came to a stop, the vacuum brake was 'sticking' on the wheels of the front van, and the wheels were red hot; all the luggage had to be got out and put in another van they got from Leicester. This bothering vacuum brake caused the train and myself to be delayed actually *one hour and twelve minutes*. They surely ought not to use a vacuum brake on trains like the 9.15, the most important on the line. A DISGUSTED PASSENGER."

I see last week that the *Engineer*, with reference to failures, remarks that they are recorded in its columns, as they find no place in the Board of Trade Returns. Surely this shows in a very true light the incorrect way in which the returns are made out.

**Midland.**

## COMPOUND LOCOMOTIVES.

[24580.]—I WAS glad to observe the letter of "Kappa" (24549) calling attention to the very unsatisfactory performances of the above engines. More particularly would I corroborate your correspondent as to their deficiency in speed power. It will, I think, be readily admitted that engines which have such great difficulty in running at high speeds are not suitable for express passenger traffic, especially wheh the rate of speed is so high as on the L. and N.W. I will endeavour to obtain some details of the fuel burnt by these engines shortly; but I have good reason for believing that, taken as a whole, the compounds consume as much as the Precedents, if not slightly more. Considering the high pressure at which the compounds work, this result is the more disappointing.

**G. D. [illegible]**

## SPEED OF AMERICAN TRAINS.

[24581.]—WHILE the speed of English trains is being discussed in your paper, may I bring before your notice a very remarkable run made on July 9th last, on the New York West Shore and Buffalo Railway from East Buffalo Junction to Frankfort, N.Y.?

The train in question was a special, consisting of a West Shore baggage car, the W.S. General Manager's car, and a Baltimore and Ohio car, the total weight, including engine, being 292,500lb. The distance from E. Buffalo to Frankfort is 201·7 miles, and this distance, including stops, was run in exactly four hours. Deducting the 39 minutes occupied by stops, and partial stops, we get a running time of 201 minutes for the 201·7 miles, or an average speed of 60·2 miles per hour. The worst grade encountered was 30ft. to the mile, from Oneida Castle east for seven miles. Two engines were employed in this run—Engine 45, Charles Smith, engineer, from East Buffalo to Newark, 93 4 miles; and Engine 50, Martin Pearce, engineer, from Newark to Frankfort, 108 3 miles. Both these engines are of the West Shore class "B," having outside cylinders, four coupled wheels, and a leading four-wheeled truck. They were built by Rogers, of Paterson, N.Y., from the designs of the late Mr. Howard Fry. The leading dimensions are:—

Cylinders, 18in. × 24in.; drivers, 5ft. 8in. dia.; truck wheels, 2ft. 9in. dia.; crs. of cyls. apart, 6ft. 5in.; mean diam. of boiler (straight top), 4ft. 8in.; length of barrel, 10ft. 7in.; thickness of sheets (Otis steel), $\frac{7}{16}$in.; height of c.l. of boiler from rail, 7ft. 5¾in.; inside firebox, length, 5ft. 10⅜in.; inside firebox, width at bottom, 2ft. 10¼in.; mean height, 6ft. 1¼in.; number of flues, 188; diam. ext., 2in.; h.s. of flues, 1,084 sq. ft.; h.s. of firebox, 128 sq. ft.; total, 1,212 sq. ft. Smoke box (extended), 4ft. 11in. diam.; smoke box, length, 6ft. 2in. Fuel, bituminous coal; weight in w.o. on drivers, 62,500lb.; weight in w.o. on truck, 32,000lb.; total, 94,500lb. Weight of tender loaded, ⅔ max. capacity, 54,000lb. Engine fitted with Westinghouse brakes on drivers and tender truck wheels.

Referring to letter 24526, p. 455, it may perhaps put "L. N. W.'s" mind at rest to know that 444 miles without stop was actually made on the P.R.R. from Jersey City to Pittsburgh.

**Yankee Loco.**

## LIST OF TRAINS—CORRECTIONS AND ADDITIONS.

[24582.]—G.N.R.—

No. 2 should be 29¼, not 29½ miles. The rest is correct.

5. Stations omitted should be Retford and Doncaster.

6. Finsbury and Peterboro .. 73¾, 84, $52\frac{57}{84}$

8. Huntingdon and Finsbury 56¼, 63, $53\frac{4}{7}$

14. Finsbury and Peterboro .. 73¾, 86, $51\frac{39}{86}$

20. Finsbury and Peterboro .. 73¾, 87, $50\frac{75}{87}$

Additions.—

King's-cross—Grantham.. 105½, 126, $50\frac{5}{21}$
1 Man. and Sheff. ex.

Peterboro—Finsbury .... 73¾, 87, $50\frac{75}{87}$
1 Scotch ex.

Peterboro—Finsbury .... 73¾, 88, $50\frac{25}{88}$
2 (1 Scotch, 1 Man. express).

Express mileage over 50, not including trains running on Sundays or special days—

| | |
|---|---|
| Great Northern Railway.......... | 2,472 |
| London & North-Western Railway. | 883½ |
| Midland Railway ................ | 527¾ |
| Great Western Railway .......... | 499¼ |
| Manchester, Sheffield and L. Ry. .. | 360 |
| North-Eastern .................. | 44¼ |
| | 4,786¾ |

L.N.W.R.—

Willesden—Leighton, 35, 42, 50, 1 Birmingham express. No. 2 runs on Sundays only.

**D. A. P.**

## NEW REMEDIES FOR CORNS.

[24583.]—Corns are not exactly a scientific subject; but probably the man who could provide us with an easy and efficient remedy would earn the thanks of the multitude, just as much as some of the inventors have done, especially if he gave his discovery freely to the world and omitted the royalty.

According to the *Chemist and Druggist*, salicylic plaster has recently been put upon the market as a cure for corns, bunions, and thickened skins generally. The price is reasonable enough, but some may prefer to make it for themselves. Dissolve two drachms each of salicylic acid and common yellow resin in six drachms of sulphuric ether, and paint the solution over belladonna or opium plaster spread on swan's-down. The mixture dries almost instantaneously, and the plaster is then ready for cutting up into suitable sizes for corns. Considering that the whole does not cost more than three or four shillings per yard, and that several thousand plasters may be made out of that quantity, it is cheap.

Some corns are so painful that neither paint nor plaster can be endured, something of the nature of a shield alone giving relief. For such cases as these, the following wrinkle may be appreciated: Take a corn-shield, enlarge the diameter of the hole to a small extent by means of a knife or scissors, and apply in the usual way. Then place in the hollow thus formed over the corn, a small quantity of any of the following solutions: Salicylic acid and extract cannabis indica dissolved in ether; or, extract cannabis indica, one-half drachm, dissolved in two drachms of liquor potassæ; or, a saturated solution of iodine, or iodide of potash, in strong alcohol. The shield does the double service of taking the pressure of the boot off the corn, and at the same time preventing the liquid being rubbed off by the sock; while all these solutions penetrate the skin much more rapidly than the usual collodion preparation, and are consequently much more effective in their operation. The saturated solution of iodine often succeeds in removing corns and indurated epidermis when other remedies have failed, and the well-known solvent action of liquor potassæ is a sufficient credential to induce for it at least a trial.

Many corns can be removed by a persevering application of the ordinary shields, which, relieving the pressure of the boot, enable nature to throw off the old skin. Acetic acid, too, is an excellent remedy for corroding the indurated epidermis; but it is necessary to protect the surrounding parts by means of a paper shield.

**Pharmakeutikos.**

## HIGH CHIMNEYS.

[24584.]—In the English Mechanic of July 31st, under the head of "Useful and Scientific Notes," the paragraph on "High Chimneys" gives the height of the huge one at Messrs. Townsend's Chemical Works, Glasgow (468ft. from the foundation), and goes on to say that it is "the loftiest building in the world excepting the Great Pyramid of Ghizeh, the spire of Strasburg Cathedral, and that of St. Stephen's, Vienna." This is a mistake, for there are at least three buildings, each of which is of greater height than any of the above-mentioned—viz., the Washington Monument, at Washington; the City Hall, Philadelphia (both of which I had the pleasure of viewing recently); and Cologne Cathedral. The height of the Washington Monument from the floor is 555ft. 4in.; the City Hall, Philadelphia, 537ft. 4in.; and Cologne Cathedral, 524ft 11in. The height of the Great Pyramid of Ghizeh has been variously stated at 460ft. and 480ft., and the same remark applies to St. Stephen's, Vienna, which has been given at 441ft. and 452ft. Strasburg Cathedral and Townsend's chimney stand equal at 468ft. From foundation to top the Washington Monument measures 592ft., or 124ft. more than Townsend's chimney. It is without doubt the highest building in the world, and to some of the readers of the English Mechanic the following may not be without interest:—

"The building of the Washington National Monument at Washington was completed on Saturday, December 6, 1884, by the setting of its marble copestone and metal finial of aluminium. The idea of this national monument took definite shape in 1833, when citizens of Washington formed an association to build it by popular subscriptions of individual sums not to exceed one dollar each. Chief Justice Marshall was the first president of the association. In 1847 the collections footed up only 87,000 dollars. With this sum it was determined to begin the work. On the 4th July, 1848, the corner stone of the monument was laid; in 1854 the funds of the National Monument Society, amounting to 230,000 dollars, were exhausted. The monument had then reached a height of 170ft., including the foundation, and during the succeeding 24 years only 4ft. were added. On August 22, 1876, Congress passed an Act creating a joint commission for the continuance and completion of the monument, and made the necessary appropriation, which was continued annually. Before resuming work on the old shaft, it was deemed best to strengthen the foundation by placing under it an additional mass of cement concrete to a depth of 12ft. 4in. This mass was extended 23ft. 3in. beyond the old foundation, or 126ft. 6in. square. The weight of the mass then worked under was 32,176 tons. The total pressure of the foundation, obelisk, and earth on top of and within the foundation as it stands is 80,378 tons, or a mean pressure of over five tons to the square foot. A slight deflection of the axis of the shaft of the old structure was corrected, and the total settlement of the completed shaft has been but 4in., of which 2½in. occurred during the underpinning. The monument is a marble obelisk. The shaft from the floor is 555ft. 4in. high, being 30ft. 5in. higher than the spire of the great cathedral at Cologne, Germany. The present foundations are 36ft. 8in. deep, making an aggregate height from the foundation bed of 592ft. The base of the obelisk is 55ft. 1½in. square, the walls 15ft. ¼in. thick, and at the 500ft. mark, where the pyramidal top begins, 34ft. 5½in. square, and 18in. thick. The amounts expended for the monument to the date of December 6th, 1884, were as follows: By the Monument Society, 230,000dols.; appropriated by Congress, 900,000dols., making a total of 1,130,000 dols. Within the obelisk (the walls being vertical) is an elevator and stairway, both of which will be fitted up for visitors after the workmen finish. From the top of the wall of the obelisk to the bottom are 900 steps, about twenty minutes being required to make the descent. On the four faces of the metal point forming the apex of the monument, the following inscriptions are engraved: 'Chief engineer and architect, Thomas Lincoln Casey, Colonel Corps of Engineers; assistants, George W. Davis, 14th United States Infantry; Bernard R. Green, civil engineer; master mechanic, P. H. McLaughlin. Corner-stone laid upon bed of foundation, July 4th, 1848. First stone at height of 153ft., laid August 7th, 1880. Cap-stone set December 6th, 1884. Joint Commission at setting of capstone: Chester A. Arthur, W. W. Corcoran (chairman), M. E. Bell, Edward Clark, John Newton; Act of August 2nd, 1876'; and upon the last one 'Laus Deo.' The monument was built from the height of 150ft. to 555ft. of marble, from the quaraies of the Beaver Dam Marble Company, Baltimore County, Md., Hugh Sisson, president, between the dates of August 21st, 1880, and November 14th, 1884."

**John Wood, D.D.S., L.D.S., Ed. & I.**

Dumfries, Aug. 3.

## CAN ALUMINIUM BE EXTRACTED CHEAPLY?

[24585.]—I see this question is again cropping up in your pages, and one contributor actually says that he easily obtains calcium. I send you particulars of a process invented in the United States by Mr. F. J. Seymour. His formula is substantially as follows: Zinc ore 100 parts, kaolin 50 parts, carbon either as anthracite coal or its equivalent in hydrocarbon gas 125 parts, pearlash or its equivalent 15 parts, chloride sodium or its equivalent 10 parts, and may be varied somewhat, all these parts (except hydrocarbon gas when used) to be intimately mixed together by grinding under heavy rollers. It has been found that the earths or ores peculiar to America carrying aluminium are mainly composed of silica and alumina in about equal proportion—viz., on average 50 per cent. alumina and 45 per cent. silica, the balance of parts being moisture and impurities. The union of the alumina and silica as found in the natural earths is a mechanical, not a chemical one, and it has also been found that all attempts to cast down the metal from the natural earths directly or by any process analogous to the general method of metallurgic operation, or to the method generally in use for the distillation of zinc ores, have failed for the reason that alumina in its natural condition as found in the various earths is so very highly sublimated, also so very light in its specific gravity when reduced into a metallic condition, that all the common methods of treating by heat either in an open crucible or by distillation will fail to cast down in any way analogous to the common methods of treating ores. The method herein described consists mainly in the use of zinc ore of the calamine or carbonate order with kaolin or earths carrying alumina, for the reason that the one metal has such chemical affinity for the other, and the one such greater specific gravity than the other, that when mixed in proper proportion and subjected to heat under conditions as hereinafter explained, the one will act as a flux, and assist in liberating the oxides to be taken down together either as the oxides of the two metals or in a metallic condition. The deposit of alumina in all the rocks and earths is found in such sublimated condition as to approach more closely than most other deposits of mineral to what may be stated as condensed or congealed atmosphere, and under a moderate degree of heat is expelled in such rarefied vapour as to escape observation.

A quantity of kaolin placed under heat in open crucible (showing 40 per cent. alumina by critical analysis) will before the silica is calcined have entirely disappeared, so that no trace is found by the same analysis as the one preceding its being placed under heat.

Many inquiries have been made attempting to determine from what source the great deposit of alumina projected. Geologists determine that one-eighth per cent. of the entire crust of the earth is an aluminous deposit. There are certain localities and special formations of the earth's surface that show in excess the deposit of this mineral, notably the drift clays in America. The process described proposes to treat kaolin in its natural condition direct by heat, and includes making use of such fluxes as may be used to advantage in its reduction and concentration and delivering it either in the condition of oxide or metal.

Distillation under heat carried up to that degree which will liberate the mineral contained in the kaolin or other ores in vapours, conducting the vapours into a condensing chamber, from thence taking the condensation automatically down and out into settlers, easy of access for subsequent treatment and reduction into metallic aluminium. The analogous chemical properties of zinc and aluminum, also the similar character of their natural depositions, including the low and uniform degree of heat at which they are fused, and from the fact that the same agents or acids will act upon both metals equally, and hold in solution, also that the same reagents will precipitate, furnish the basis of Mr. Seymour's method of treatment.

The furnace may be constructed so as to carry in number from one to several hundred retorts, each of which will receive for one charge about 100lb. of the above mixture. The retorts may be of plumbago, preferably of steel of such temper as will not fuse under 4,000 deg. F. These retorts are coated on their inner surface with a refractory material, preferably quicklime and borax in equal proportion held in solution of that degree of plasticity that the coating may be uniformly laid upon the inner surface. The retorts are, inside dimensions 36in. long, 12in. diameter, with sides, $\frac{7}{8}$in. thick. They are set vertical in a furnace chamber separated by about 4in. from contact with any other of the same series; the chamber to be heated preferably by gas to insure great uniformity of heat, which should be carried continuously at about 2,500 deg. F. The degree of heat applied and the uniformity with which it is conducted will determine the length of time needed to effect complete reduction of the ores. Properly handled, the furnace should make two charges in 24 to 30 hours. The retorts are so arranged that access may be had to the contents at the bottom for a two-fold purpose—one to reach and remove the ashes and cinders occasioned by the reduction, and also to obtain any metallic deposit resulting from the action of the heat and fluxes; the other purpose, to be enabled at any time to project hydrocarbon gas into the retorts and through the contents, thereby giving direction to the vapours liberated into the condensing chamber, making one of the essential conditions of having under control the amount of heat within the retorts, also determining to a great extent the character of and rapidity with which work may be accomplished. The retorts are also provided at their upper end with an adjustable cap or cover, fitted so as to be centrally placed thereon, also fitted centrally with an outlet pipe connecting with a main pipe leading into a condensing chamber. Each retort is also so arranged as to be operated singly or in connection with a series of retorts placed in the same furnace. They are also so arranged as to be charged with fresh material without disturbing the proper working of any other one of the same series. The condensing chamber to which the vapours are conducted should be, for a furnace of 10 retorts, about 8ft. diameter and 8ft. long, of thin copper fitted with proper connection to the pipe to which each retort has access, also provided at its outer end with an outlet pipe provided with a valve. The condenser should also be provided with an inlet pipe at its uppermost surface, projecting into the condensing cylinder for sufficient distance to allow space for a perforated cap through which is to be projected into the condensing surface water or other fluid in a finely diffused spray. The condensing cylinder is also provided with an outlet pipe at its extreme lower surface. This pipe is also provided with a valve to regulate the flow from the condensing cylinder, through the outlet pipe, into a series of settlers as fast as condensation has taken place.

Mr. Seymour says: "I have found it advantageous to use zinc ore in excess over that of aluminium ore, and for the reason that actually the zinc begins vaporisation first, and at about 200deg. F. below the point at which the alumina commences vaporisation from the kaolin, and hence the advantage of having and using appliances by which complete control may be had over the contents of the retorts, and by observation and regulation, or adjustment, of the valve on the outlet-pipe of the condenser, one can determine at all times the character of the condensed oxides."

I have said enough, however, to give an idea of this improved process; but it appears to me that, like most other discoveries, it wants a deal of proving, while so far as I can see it results only in the production of alumina. **Metallurg.**

### A POCKET FIELD MICROSCOPE.

[24586.]—A POCKET field microscope, magnifying 100 diameters, useful in the search for infusoria, &c., and which may be constructed, lens and all, in a few minutes.

Bend a slip of thin metal 5in. or 6in. long and $\frac{3}{8}$in. wide into the form of the letter V, make two circular holes $\frac{1}{10}$in. in diameter, one in each arm, opposite each other, so that when the arms are sprung together by pressure the holes shall meet exactly. Place a drop of water in one hole, taking care not to wet more than its interior circumference. The water will assume the form of a perfect double convex lens, of focal length varying from $\frac{1}{8}$ to $\frac{1}{10}$ of an inch according to the quantity of water introduced. Such lens, though by evaporation its focal length is gradually increased, maintains its efficiency for a time quite sufficient for the examination of a drop of water, or other substance in the opposite hole. The end of one arm of the V is bent inward so as to form a "stop," which when they are pressed towards each other to effect the focal adjustment, prevents a contact which would destroy the lenticular form. The flame of a candle gives the best illumination of the field. In the open air the diffused light of the sky gives an unsatisfactory illumination; but if it is modified by passing through the nearly-closed hand, placed in front as a diaphragm, a favourable definition is obtained. The definition of these water-lenses is excellent, and their magnifying power is from 80 to 100 diameters according to the quantity of water in the lenticular drop. I inclose specimen.

Stoneaston, Aug. 2. **J. Hippisley.**

### RIFLE SHOOTING.

[24587.]—IT is hardly possible that amongst the large number of readers of the "E. M." there are none who are interested in the use and practice of the rifle. Having myself been for many years associated with the burning of powder, I still have a liking for it that induces me to investigate any matters connected with it; and for the benefit of those who take a delight in being an efficient marksman, I now write this. That every volunteer rifleman, for instance, to possess a rifle range of his own on his private premises would be impossible; but practice with the regulation weapon is now made safe, easy, and cheap, by several appliances introduced of late. I am not aware who the individual was who devised the plan of utilising the service rifle; but he deserves well of his country at any rate. The practical outcome of this is an apparatus, in one instance, fitting into the breech of the service rifle so that a diminutive cartridge instead of the full size one is used, No. 1 bulleted caps being the ammunition. A target, of suitable size, of paper being affixed to a piece of stout wood, we may fire away in one's own garden, or in a room of sufficient length. Such practice has a most beneficial result on the shooting of recruits, whilst good shots can keep up and improve their shooting. The most recent form coming under my notice is that of a tube fitting for its whole length into the barrel, the cartridge being minute, as I mentioned before. The practice obtainable at a range of 100 yards from the target giving the marksman the practice of firing at the regulation target at distances of from 200 to 800 yards. Where space is more scarce, another form of instructor I have can be utilised with a range of 10 to 50ft., giving all the equivalents of longer ranges.

I should consider that amongst your readers there must be many who would desire to get home practice with the regulation weapon; and a choice of the two instructors I have would give every facility so long as the range of from 5 to 100 yards be available. These small cartridges produce but little noise—not sufficient to be an objection. Should my remarks attract the notice of anyone else interested in the matter, I shall be very pleased to have something further to say on the practical use and experience of such aids to good shooting.

**Invicta.**

### WHAT IS "CREATION"?

[24588.]—To make a new thing that also has a connection with the universe. To make a thing that has a beginning and an end, which the universe has not—viz., derived from the universe, yet is self-existent in itself. Creation has only relation to the individual, because the individual is distinct from all others, yet bears a likeness to all things. To explain. Take a leaf from any plant or tree, compare it with the other leaves on the same parent stem, or any other same or different species, and a variety in likeness is certain; compare the two halves of the same leaf, they are different in their likeness; quarter it, cut it into a thousand pieces, they are all alike yet different. 'Tis the same leaf that is different to itself, and to all other leaves. A leaf is a world in itself, so is a grain of sand.

No human hand, foot, or other member is exactly like mine, yet I am related to all men, animals, and plants, for we are all alike yet diverse; hence comes the variation of men, animals, and plants (without domestication, begging Darwin's pardon). There is no need to observe the various yet connected forms in a natural history museum, only remark the variation in one's own body. Everything is created in pairs, which are alike yet different, and is caused by an original or primal centre, which physiology attributes to the brain in the propagation and continuance of its kind from beginning to the end of its creation, in the individual. All are agreed that each individual (creation) is from a centre, which without fail divides in two, which two divides over and over again into almost infinite ultimates or functions, and always in pairs, as cells, glands, nerves, muscles, flesh, and bones. It seems a contradictory business, for the bones are interior yet recent, while the nerves and flesh are external yet first in the advent. We shall find this rule paramount in all; a sort of agreement to differ.

What! You shall ask five hundred children a question, and they will all answer differently. Do you say that creation is a finished fact? Of what use, then, is this wealth of imagination often conveyed in erroneous answers, and is everything cut and dried? Per contra, "there are sermons in stones and good in everything." Then we have monstrosities in nature, albinos', anthropoid apes, poisonous and vicious animals, &c., all wrong answers to man's call for higher intelligence and the human form divine; yet these all form a part of man, he alone contains them all, a contradiction in himself, and yet like all the others. A fox is always a fox, but a man can be fox, sloth, and lion in one. Pope says that Homer had the greatest invention of all poets; but what shall we say to that greatest of all inventions, the vertebrate form, agreeing yet differing in all its species, from 300ft. long down to a microscopic arrangement.

Seeing, then, that the universal law is opposition in unity, or likeness in unlikeness, we perceive that creation is an individual fact, same as heat and cold are only different degrees of the same temperature.

**Fiddler.**

### MYSTIFICATION.

[24589.]—PRAY, sir, what is a person to understand from M. de Fromelin's hypothesis (page 473) of the floating of the particles of which clouds and dust are composed? "That a special atmosphere surrounds each particle—that the attraction which retains it is within the domain of molecular forces"! Query, is "it" the atmosphere or the particle? And then as to the floating in the "vesicle or particle surrounded by its atmosphere (special, of course), the thermal absorption of the water is much greater than that of the surrounding diathermanous air; the atmosphere (special, again) of the vesicle is consequently expanded, and so it floats in the circumambient air"! This, surely, is science mystified with a vengeance!

Any person who has carefully studied clouds, fogs, or even the waste steam blown off from a locomotive, knows that these particles are continually sinking in the atmosphere, but that this sinking is lessened in velocity by their friction through the air, their surface being so enormously increased by subdivision in proportion to the relative weights of equal bulks of water and air—e.g., a cube foot has 864 sup. inches: divide it into cube inches, and the surface is increased to 10,368, and so ad infinitum. This, I fancy, is the simple explanation devoid of mystery.

The above leads me to the remark that those who have the pleasure of attending our different scientific meetings have sometimes this pleasure considerably interfered with by mystification in one form or other, notably so by the inordinate use of abstruse formulæ on the "Black Board," which not one in a thousand can either follow or care to understand, when the result, in plain terms, would be both interesting and instructive. Again, in writing the use of chemical algebra and nomenclature is well enough for chemists, but there are people well instructed in other branches who would much prefer "sulphate of copper," or even, if the learned person preferred it, "cuprous sulphate," to "$CuSO_4$. Uncharitably profane people say that mystification is a modus operandi in the "capital market," but this must not be believed.

**Rho.**

**Green Peas and French Beans** are preserved for winter use in France by the following course of treatment: They must be mature and fresh and dry to begin with. If old they are not worth keeping; if very young they will not keep well, being too watery. Take a middle-sized stewpan and nearly fill it with peas or beans, over which sprinkle, very lightly, pounded loaf-sugar. To a quart of peas there should be added two tablespoonfuls of sugar. Put the pan over a slow fire, and carefully stir two or three times. As they become heated a little water will flow from them, which is the sign that they are heated enough. Turn them out on a soft cloth to drain, and when rendered as dry as possible remove them to sheets of paper spread out in an airy room. In doing this look for any that are bruised or discoloured, and remove them. When quite dry pack them in smallish earthen jars, and tie down and store in a cool dry place. If they are not quite dry mildew will soon appear and render them worthless. But if the work is well done they will be coated with a thin glaze of sugar, which is peculiarly preservative in its nature. French beans preserved in this way are of a good colour and flavour when used in the winter, and will require only the ordinary process of cooking. Green peas fully grown, but still tender, may be preserved for soups by spreading them on trays or papers and drying them in a cool oven—say, not hotter than the hand can bear without inconvenience. They will be much shrivelled, but will be excellent for soups and ragouts.—*Amateur Gardening.*

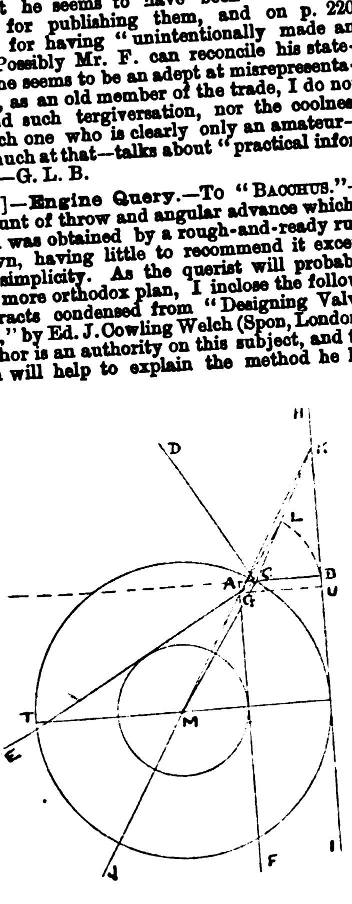
**Razor Paste.**—Mix fine emery intimately with fat and wax until the proper consistency is obtained in the paste, and then rub it well into the leather strop. Prepare the emery by pounding thoroughly in a mortar the coarse kind, throwing it into a large jug of water, and stirring well. Immediately the large particles have sunk, pour off into a shallow plate or basin, and let the water evaporate. Another recipe is, levigated oxide of tin, prepared putty powder, 1oz., powdered oxalic acid $\frac{1}{4}$oz., powdered gum 20gr.; make into a stiff paste with water, and evenly and thinly spread it over the strop. With very little friction this paste gives a fine edge to the razor, and its efficiency is still further increased by moistening it.

# REPLIES TO QUERIES.

**** In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[56676.]—**Free Reeds.**—It is not impossible that I fail to comprehend the "exact requirements" of this querist, as Mr. Fryer (p. 481) says; but as Mr. F. thinks it necessary to "remind" me that the querist requires to know how to tune reeds, I can only point to the query which appears on p. 268, and remind Mr. F. that it says nothing about the actual methods of tuning reeds, but asks how to "make a tuning apparatus." I have already recommended the querist to use the exhaust principle, and told him that three holes will be sufficient for all practical purposes; the question obviously has no reference to the tuning of reeds in an instrument, because that is known as fine-tuning and is always spoken of—even by novices—as "tuning the instrument." I have always understood that queries were inserted for the benefit of all, and as I knew nothing of Mr. Fryer's private correspondence, it seemed to me that his reply to this query was wide of the mark, for it did not give the slightest idea of the "tuning apparatus" asked for by the querist. Now as to the price of reeds, it is not a question of what local dealers charge. On p. 199 Mr. Fryer said that a set (5 octaves) costs 6s. 6d., but on p. 220 he said he had made a mistake, and that the price of a set should be 10s. 6d., but in spite of his own statements he retained an "unalterable opinion" that 18s. is a "very moderate charge for a set of reeds of good quality." There are no better harmonium reeds made than those sold by Esteve, of Paris; he has two agents in London, and the average price asked is 10s. 6d. I say "average" because the price varies according to the "style" of the reed. Thus, the price of the small set for Bassoon is 9s. 6d.; the broad bent 11s. 6d. Why Mr. Fryer, in view of this simple fact, which is well known to, or can be readily ascertained by, anyone interested, should retain an "unalterable opinion," and imply that 18s., 20s., and even 25s. are fair prices, is best known to himself; but I think what he has written on this matter from first to last is a splendid example of that "theoretical humbug and misconception" (p. 437) which he appears to deprecate. The prices he gave for fittings on p. 199 are the wholesale prices for the cheaper kinds; but he seems to have been "called to account" for publishing them, and on p. 220 apologises for having "unintentionally made an error." Possibly Mr. F. can reconcile his statements, as he seems to be an adept at misrepresentation; but, as an old member of the trade, I do not understand such tergiversation, nor the coolness with which one who is clearly only an amateur—and not much at that—talks about "practical information."—G. L. B.

[56798.]—**Engine Query.**—To "BACCHUS."—The amount of throw and angular advance which I gave you was obtained by a rough-and-ready rule of my own, having little to recommend it except extreme simplicity. As the querist will probably prefer a more orthodox plan, I inclose the following extracts condensed from "Designing Valve-Gearing," by Ed. J. Cowling Welch (Spon, London). The author is an authority on this subject, and the diagram will help to explain the method he has adopted.



**Greatest port opening, lead and cut off point being given, to find lap, throw, and angular advance.** Draw A B = maximum port opening, and let A C = lead, and B C D the angle travelled by the crank before cut off. Draw C E ⊥ C D, and A F ⊥ A B intersecting at G. Through B draw H I parallel to A F. Bisect E G F at J and produce J G to K. Join K C, mark off G L = G U = A B. Join L G, and from C draw C M parallel to L G, intersecting J G at M. Draw T M parallel to A B, then C M T is the angular advance, and M C is the half-travel of valve. The radius of the small circle gives the amount of lap.—BACCHUS.

[56804.]—**Fifteen-Lighter Dynamo.**—See answer to "Electra" query 57050.—W. H. EAVES, Coventry.

[56809.]—**Dynamo for Arc Lights.**—To W. H. EAVES.—I am sorry I cannot comply with your request for details of 12in. armature and magnets, because to have every proportion right each detail has to be separately worked out. It would take a day and a half of hard work to do your query justice, so I think you had better employ a professional electrician, whose fee for drawings and specification would not come to much. The 8in. armature, if wound for arc lighting, would give two lights of over 2,000 c.p. each. If this would suit you, I shall be happy to give you all information.—W. H. EAVES, Coventry.

[56888.]—**Bicycle Turning.**—I am not sure that I understand "J. R. T.'s" difficulty; but I think he will find it removed if he reflects that the wheels at any instant touch the ground only in points, and that the small wheel must follow the large one, or be wrecked.—ESSAR.

[56889.]—**Protosulphide of Iron.**—"C. D." may prepare ferrous sulphide by bringing white-hot iron into contact with sulphur, or by throwing borings of iron and sulphur in powder into a red-hot earthen crucible. The proportions are seven parts iron, four parts sulphur.—F. R. J.

[56890.]—**Filtering.**—If "C. D." wants to filter by the aid of a vacuum, he had better try the pump, unless he has steam to spare, and uses an ejector.—H. R. T.

[56892.]—**Tricycle Chain.**—It wants tightening up a bit, that is all; but you will have to get a smith to do it.—ESSAR.

[56894.]—**Oils.**—Filter through canvas, then felt, and after that animal charcoal. If not clean enough, you must treat them with acid by the methods often given for bleaching oils.—ESSAR.

[56896.]—**Loco. Slide Valves.**—See p. 343, Vol. XXXVIII., and for indicator diagrams, pp. 130, 244, 272, Vol. XXXVII. You will find all you want to know in back volumes, but the pages given have diagrams which will help you.—T. J. M.

[56898.]—**Naphtha.**—It is a hydrocarbon gas, but what, it is impossible to say, especially as "F. S. Sc." does not state whether it is wood or mineral naphtha he means.—A. S. Sc.

[56901.]—**Irish Degrees.**—There is Dublin University, the Royal University of Ireland, and the Catholic University of Ireland; but as to the arrangements "Student" should inquire direct of the registrar in the first case, and of the secretary in the others.—CLONMEL.

[56908.]—**Caloric Engine.**—"Invicta," on p. 395, says "asbestos is not, as a rule, a good packing at all for glands or parts in motion. But I can show 'Romeo' how to get over that." Would it be too much to ask "Invicta" to kindly explain "how to get over that" in these columns? The information might be useful to many readers besides "Romeo." Perhaps Mr. J. Boyd (p. 368) would give some information on this point, and possibly show "how to do it" at the stand in the Exhibition. There is little enough there now; but as the noisy machine is making packing, no doubt Mr. Boyd can tell us how to utilise it to the best advantage.—H. MAUDSLAY.

[56912.]—**Jablochkoff Battery.**—"J. H. G." had better leave this battery alone until it has been successfully tried in a practical manner. Newspaper reports of effects produced by electrical appliances are not always accurate.—NUN. DOR.

[56920.]—**Locomotive.**—Surely "S. S." must see that how often a loco. boiler requires washing out must depend on the character of the feed-water: it might be once a week, or once a month, or even once a twelvemonth when pure water is used; but where will that be found along the whole length of a line? New tubes will be wanted, say, once in five years; but really "years" have nothing to do with it—the life of a loco. is reckoned by miles run; so say new tubes after 120,000 miles.—NUN. DOR.

[56923.]—**Bleaching Shellac.**—Permit me to suggest to "J. L." that he would learn much more by just trying a few experiments himself than by reading any number of columns of replies. The "cement" is, no doubt, any ordinary luting; Glycerol is glycerine. But if the querist wants to bleach shellac, he will find several recipes in back volumes, and if he will say for what purposes he uses it, I will direct him to a recipe, or give a process. Perhaps the easiest is to dissolve the lac in spirit, mix it with animal charcoal, and expose to the light for some days in closed bottles; but if the lac is required in the solid form, perhaps the acid process is best.—NUN. DOR.

[56926.]—**Leaky Tank.**—Empty tank, let it dry, and coat it with solid paraffin, using hot flat-irons to drive the wax in.—C. M.

[56929.]—**Cork-Cutting Machine.**—One illustrated on p. 181, Vol. XXXVIII.—T. G.

[56950.]—**Lead Burning.**—There is something wanting still to make this matter clear, the present net result of the "Replies" received amounting really to a gratuitous advertisement of Messrs. Briggs and Co.'s patent machines; without, however, the slightest scrap of information as to what such machines really are, how they are worked, or what liquid is used in them. Surely, Sir, this is contrary to your rules, and as some recompense, I ask that they shall give us a full specification and description of them and their use; and also the number of their specification. I may add that on a recent visit to the "village" I went two days in succession to the "Inventions" to see this machine; but no one was in attendance to explain its merits. The attendant at the next stall could not say when anyone would be there, and the machine, although marked "patent," did not bear the patent number; and the "leaflets" left on the stall "pro bono publico," while fully describing the benefits (which any practical man will at once concede) of avoiding the use of the "fire-pot," gives no information at all; in fact, like Messrs. Briggs's first letter in "Ours," they carefully *conceal* all that is desirable to know before anyone is inclined to purchase. It is quite possible that I might have been a purchaser had all information been forthcoming in an open, straightforward manner.—FINEM RESPICE.

[56956.]—**Ball Bearings.**—If Chas. Hosken will take one of his gunmetal bearings and a ball bearing and fill both with road dust, he will soon find a difference, I think. Give each a certain number of turns, after which it will be found that the balls have suffered little, if at all; while the gunmetal will be torn and scratched to pieces. A spindle borne on balls certainly runs lighter than one on an ordinary bearing—why, I don't know; I only go in for facts, and have *no* belief in theory.—F. SHAKESPEAR, Dresden.

[56956.]—**Ball Bearings.**—In a bicycle a wide bearing is impossible on the driving-wheel; about 1in. or $1\frac{1}{4}$in. is as much as can be had. In a steam-engine the bearing can be made any length; but it is not exposed to the grit of dusty roads. A locomotive does not run through such dust as a bicycle, and while the locomotive is constantly being cleaned, the bicycle not often gets a wipe. The box of the ball bearing may become full of so much macadam, but less power is required to grind up substances by means of balls than is required to grind by means of two surfaces rubbing together. As the balls grind by rolling round, and being of hardened steel, the grit does not become imbedded in them. With gunmetal it is otherwise; being soft, it is soon imbedded with grit, which wears away the steel axle. This latter becomes scratched and grooved, and these get filled with smaller grit, and in their turn grind away the gunmetal. To say that several first-rate riders are thoroughly opposed to ball-bearings is no better than saying one has driven a tricycle 5,000 miles and it carries less weight.—F. SHAKESPEARE, Dresden.

[56961.]—**Boating.**—To "INVICTA."—I am glad you have made the whole theory clear to yourself, and hope "Aqua" has also. I shall, as soon as I get time, make the machine, and if more power should be required I can easily add it; but I should not think there would be much power required for a small boat that will not carry more than two persons, as "Aqua" speaks of in No. 1059. Mr. J. Adams speaks of one he has seen that will go eight miles an hour with half the labour of rowing. If Mr. J. Adams could favour us with the sketch it would no doubt benefit our readers. I daresay particulars and sketch of "Invicta's" plan would be favourably received.—T. HANDEL.

[56969.]—**Hydraulic Ram.**—I am sorry "Invicta" should think that I have misquoted him. If he will look back he will see that I have faithfully given his very words; they are, p. 439, "No doubt the valve is made in itself heavy enough to more than balance the permanent head of water," and just before he had said, "the pressure of the head of water itself would not support the escape valve." It is the truth of these statements taken in their plain and obvious sense that I dispute. With regard to "Invicta's" remarks, p. 481, about a light valve not waiting for the water to attain its proper velocity, I would say that there is practically no fear of a valve being made so light as this, seeing that it must have substance enough to stand the repeated shocks of impact. When extra weight is given or added, it is usually with the idea of assisting the fall of the valve, which it does to a small extent, though at the expense of efficiency. The whole weight of the heavy valve, however, would not equal one-twentieth part of the permanent pressure.—W. A. S.

[56977.]—**Strength of Beams.**—The relative strength of beams of rectangular section among themselves, and of circular section among themselves, is represented by the formula $\frac{BD^2}{L}$; but it does not apply to the comparison of rectangular with circular sections. Beams of square section vary in strength as the cubes of the depths, and beams of circular section as the cubes of the diameters. Taking the strength of a square section as unity, the strength of a circular section of the same depth is $\cdot 7854 \times \frac{3}{4} = \cdot 589$. When the areas are equal the strengths are as 1 to ·75. I hope "Dubliniensis" will show how his results are arrived at.—J. S. C.

[56988.]—**Siphon.**—It is usually supposed that to insure the action of a siphon, one leg must be longer than the other; but it is not so. It may be convenient to lengthen the outer leg to conduct the liquid into another vessel, but it is not requisite otherwise. The legs may be of equal length, yet a flow would take place. It is caused by the pressure of the column of liquid above the end of the inner leg of the siphon. As the height of the column decreases, so does the rate of the current. Any increased velocity through or below a lengthened leg must be ascribed to the well-known law relating to falling bodies.—W. B. P.

[56997.]—**Hydropathy.**—A valuable medical paper just issued says:—"The sufferer from *ennui*, which is a condition of nervousness and debility combined, must get his blood purified; he must eat but little, especially if weak. The mistake weakly people constantly make is forcing into their systems food which cannot be digested, and continues to poison the blood; or they drench themselves with tonics, in doing which they are but breeding heat and fever; or they take stimulants. This last is almost a fatal mistake, for the brain of one suffering from *ennui* is far too weak to bear stimulation. By-and-by, when the sufferer feels lighter, happier, and more hopeful, then tonics may be begun most cautiously—mild vegetable tonics first, with cod-liver oil." The momentary stimulus given by alcohol is at the cost of after-depression and wakefulness; sleep being the greatest nerve strengthener, as I find. "Quixote" for this should be as much as possible in the open air, avoiding exhausting exercise. This, with tea and coffee left off, and milk or cocoatina substituted, must greatly benefit. Rubbing with a rough towel after ablutions is very good.—C. M. Y.

[57005.]—**New Steam Motor.**—To "Invicta."—Can you give me the following information—viz., the weight, cost, and space occupied by the motor; also the power, and name of maker?—F. Shakespear, Lüttichaustrasse 14, Dresden.

[57026.]—**Problem.**—If $x$ and $y$ be the numbers of gallons of whisky,

$$16x \times 19y = 512$$
$$\text{whence } x = 43 - 19v$$
$$y = 16v - 4$$
$$\therefore v \ngtr \tfrac{43}{19} \text{ or } 2\tfrac{5}{19} \text{ and } \nless \tfrac{1}{4}.$$

"Bogie" probably intended that only integral numbers of gallons should be used; if so, $v$ has two possible values, 2 and 1.

$$\therefore \left.\begin{aligned} x &= 24 \text{ or } 5 \\ y &= 12 \text{ or } 28 \\ \text{Water} &= 15 \text{ or } 18 \end{aligned}\right\}$$

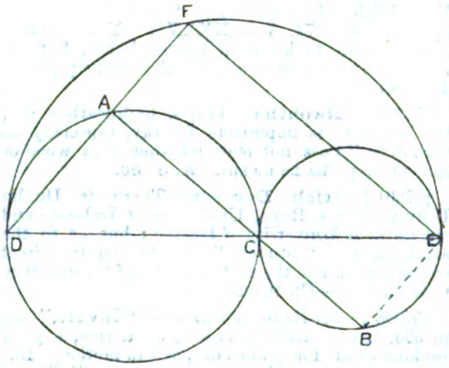
If $x$ and $y$ are equal, $v = \frac{47}{35}$, giving the result obtained by W. Hardie.—X, Y. Z.

[57028.]—**Stamping in Relief.**—I don't know that I am able to give much more information on this subject. I think I should advise him to buy the counterpart: it is most likely made of copper. He will get the brass sheet at a metal-shop; it is sold in sheets 2ft. by 4ft., that is, eight square feet, that is the regular trade size both for brass and copper, and if he wants to know where to get it he will have to advertise his address. By all means get a press, and see that it is in good order; the counter-die is fixed to the bed of the press, and the die to the plunger; whether the tickets will be cut out and stamped at one operation depends upon whether the dies are made to do that work: if not, the metal must be ruled off and cut with shears. The cost of the press I don't know; but a sixpenny advertisement will probably bring replies. The counter-die is stamped in much the same way as the tickets; but I expect it requires a much heavier press, such as would be used for coining and that class of work. Soft brass should be obtained, and the vendors should be told what it is required for. The thinner the brass is the more it will cost per pound; but per sheet it will be less. Thin metal is, of course, conducive to longevity in the dies. The metal must be clean and bright before being stamped; the lacquer is applied with a camel hair or other soft brush, the tickets having been previously heated just hot enough to hold. I don't think the dies would be suitable for stamping stationery, as I should imagine the relief would be rather too high. I don't wish the querist to be under the impression that I am practically acquainted with this work; but in the absence of other information, the foregoing may be of service.—Os.

[57042.]—**Spark Coil.**—"Spark" might try the following experiments with this coil. Pass the spark through the flame of a wax taper, holding the flame (1) under the spark, (2) near the spark, and (3) so that the spark passes over the top of the wick, and observe the modification of the spark under each condition. Attach a metal ball to one pole, and as the spark passes it is divided into a number of branches. Substitute a hollow plate of metal, and a similar division takes place, accompanied by a report. Pass the spark on to a moistened piece of guttapercha, and it will be greatly increased in length in a zigzag shape. Obtain the ordinary spark by approximating the poles, and while it passes blow upon it through a glass or paper tube (a metal one on no account), and the air passing through the spark appears ignited. Bring the poles to opposite edges of a drop of water on a plate of glass, and the spark is increased in length, passing round the edge of the water. Place one pole in a glass of water, bringing the other pole towards the surface of the water; vivid sparks pass from the water. Dip the ends of the wires in oil, the colour of the spark is green. Put a drop of oil upon tin-foil, to which one pole is attached, and bring the other to the edge of the oil. The oil appears to be boiling. Bring the other pole to the opposite side of the oil, and the boiling is intensified, and flashes of light are observed. A small quantity of gun-cotton may be ignited if held with forceps in the stream of sparks, the ignition being accompanied by a feeble explosion. All these effects would be intensified if a larger coil were employed, and stronger battery power might be necessary.—Bobadil.

[57052.]—**Weight and Stress of Beam.**—The question itself is puzzling, and the answer (page 483) is so too. Will the writers explain them?—J. S. C.

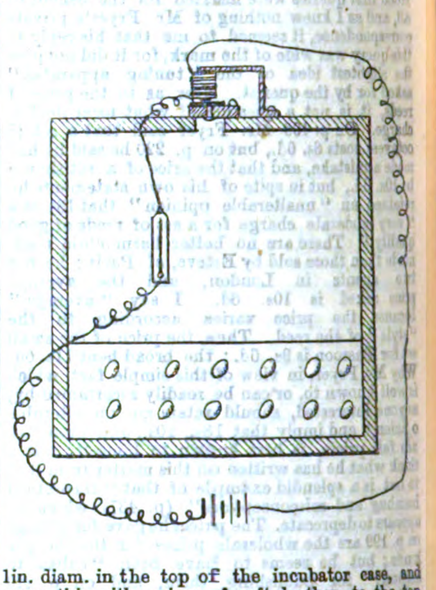
[57058.]—**Science Examination.**—C. Planck's solution of the above is scarcely suitable, as it requires a knowledge of Book VI. of "Euclid's Elements," which is beyond the requirements of Stage 2. The following is a simple solution:—



Draw D E C the common diameter of the two circles. On D E describe a semicircle, in which place E F equal to the given line. Join D F, cutting the circle on C D as diameter in A. Join A C, and produce to meet the other circle in B. A C B shall be the line required. For it is evident that E F A B is a rectangle. (III. 31). Therefore, A C, being equal to E F, is equal to the given line.—T. Watt.

[57055.]—**Electric Bells in Series.**—I think it would have been much better if Messrs. P. Jolin and Co. had given the querist the information asked for. The Editor of the "E. M." has, I think, a strong objection to replies being sent by post privately. Certain I am of this: however long the explanation referred to might have been, it would have been found room for if worth reading at all. I thought (with the querist) that the secondary coil, as it is termed, was wound in a reverse direction to the main coils, so probably it was the current passing in the opposite direction when the armature made contact, that the correspondent calls "a counter current." I think I have heard the advantage claimed for this "Jolin" bell in its non-sparking properties through the circuit never being broken. This is not any advantage over the short-circuit system spoken of. The circuit is never broken in that case, yet all depends upon a clean contact for the other bells working properly in circuit. If the two wires are wound on at once in the same direction, I agree with your correspondent, they are in the way; in fact, as he says, only introduce complications in the way of extra resistances; and if wound in a reverse direction to the main coils, it must mean an extra process, because it is quite impossible (even with the improved machinery Jolin and Co. have) to get the iron core to revolve away from you and towards you at the same time. Are we to understand the current passes through the cores when the armature makes contact in a reverse direction, thus demagnetises the cores? If so, the cores would really need to be of very soft iron to get a good result. Instead of giving evasive replies, if the inventor will give the details of construction and the advantages over other bells, he will probably find the criticisms rather an advantage to him than otherwise, the readers of the "E. M." being very keen, and they will soon suggest an improvement if this is necessary. For those interested, I would say that an engraving of the "Jolin" bell is to be found (without at all a clear description) in the *Electrical Review* for May 30th; but before answering the query, I would ask them to refer to the *Electrician*, Vol. XI. 1883, pp. 113 to 189, and the "E. M." for 1875, Vol. XXI., p. 646, and if they can see any improvement on the bells there described, to please point it out.—An A.S.T.E.

[57078.]—**Incubator.**—Obtain an ordinary electrical thermometer and connect it up with, say, three moderate-sized Daniell cells. Bore a hole



1in. diam. in the top of the incubator case, and cover this with a piece of soft leather, to the top side of which is fastened a light strip of soft iron. Directly over the strip of soft iron is suspended an electro-magnet, the coils of which are included in the circuit. Set the thermometer to required temperature; when this is exceeded the electro-magnet will open the valve, but will allow it to close when the temperature falls.—F. M. Rogers.

[57080.]—**Siphon.**—The cause of the stoppage mentioned by "Surveyor," is doubtless an accumulation of air in the highest part of the pipe.—W. B. P.

[57080.]—**Siphon.**—I cannot think that a small quantity of air—enough, say, to fill a foot or two of pipe, would stop the siphon, for, suppose the ball-cock open, what happens? The water in the long leg must descend, for it is not balanced; also the well-water must rise in the short leg, or there will be a partial vacuum. So the siphon begins to act, and the air which, when at rest, occupied the top of the bend, is carried into the long leg and hangs about in the pipe, sometimes rising and again being swept down, until the ball-clock closes, when it returns to the summit. In time, however, air accumulates in such quantity that its presence in the long leg makes that leg no heavier than the short one; then the siphon ceases to act.—W. A. S.

[57081.]—**Watchmaker's Bow.**—For strong work, use a cane bow and either thread or gut. For small work, whalebone and horsehair. The bows should be tapered towards the top to give them a good shape.—C. A. N.

[57086.]—**Colliery Warnings.**—For obvious reasons I must respectfully decline to give "Ralph" the information he requires.—T. J. Murday, Felton, R.S.O., Northumberland.

[57098.]—**Watchwork.**—To "C. A. N."—Mix diamantine the same as red stuff, using as little oil as possible, and taking care to have the stake and oil quite clean.—C. A. N.

[57100.]—**Spectroscope.**—In reply to "E. B. F.," I may tell him that I have succeeded in seeing the forms of solar prominences by the aid of a 5-prism direct-vision spectroscope by Browning, on 3¼in. Wray telescope, a short account of which he will find in the "E. M." for March, 1885. "E. B. F." should get a small box of metal chlorides (from Browning, or any good chemist), many of which are available for use with a common spirit lamp. All he has to do is to fit a bit of platinum wire about 3in. long, moisten the end, and stick a little of the chloride on it and put in the flame, and he will get lots of beautiful spectra; the other end of the wire should be held in any simple kind of clip stand. Get a drop of blood and colour a little water in a test-tube with it, and he will have two absorption bands. If he wants a simple way of seeing the sodium line reversed, get a little saltpetre and salt well mixed, roll up in a bit of paper and put on to the red embers of a fire: he will soon see a yellow band and the sodium line black in the centre of it.—T. R. Clapham.

[57107.]—**Developing Formulæ.**—A correct exposure for any one developer is correct for all others. An ounce of water must be "measured." Nawt.

[57112.]—**Wet-Plate Photography.**—The best book for all processes is "Instruction in Photography," by Capt. Abney, R.E., price about 3s. 6d. A very good shilling book is by Hughes, sold by Werge, Berners-street, W. Dry plate is easiest, but most expensive.—Nawt.

[57113.]—**Photography.**—Fry's plates are as good as any. Probably your chemicals have gone wrong, which cause the defect, or they may be too strong during this hot weather.—Nawt.

[57124.]—**Lifting Bar.**—The work done in lifting the bar is the same in both cases; but in lifting it by one end, the muscles of the hand and forearm have also to counteract the weight, acting with a leverage equal to the distance from the centre of the bar to centre of the hand.—J. S. C.

[57124.]—**Lifting Bar.**—The reason why you require more force to lift the bar at the end than in the middle, is because you raise not only the weight of the bar but also its moment, or tendency of the bar to twist round its middle point. Thus, suppose the bar was 6ft. long and 4lb. weight, the power you would have to exert at one end would be three times as much as its weight, and if you meant to raise it 4ft., this would have to be added to the work done. This being the case, you can't expect to gain time, space, or leverage.—Nester.

[57125.]—**Photo. Scrap Book.**—Since "F. A. R." objects to an album, I should certainly think cards would suit him best: they are very convenient for writing descriptions and particulars of the photos. on the backs. I cannot even suggest what size cards to use till I know what size the photos. are; and then it would be a matter of taste. The only thing is not to have them very thin. For mounting, starch or dextrine will be best.—A.R.F.

[57126.]—**Obach's Galvanometer.**—This is an ordinary tangent galvanometer, but the coil is movable, and can be inclined from its usual upright position. Thus, instead of the current being proportional to the tangent of the angle of deflection, it is proportional to the tangent of the angle of deflection of the needle, multiplied by the secant of the angle of inclination of the coil. If, by moving the coil for the different current strengths the deflection of the needle is kept constant, the instrument will then act as a secant galvanometer, and the current will be proportional to the secant of the angle of the inclination of the coil. To obtain absolute measures these values must be multiplied by the constant of the instrument.—Eugene Brown.

[57128.]—**Storage Battery.**—The best form of storage battery is as follows:—Lead plates 4in. by 6in. are bored with very small holes about $\frac{1}{8}$in. in diameter all over, and a flap of lead is left projecting at one end for connections. The holes are filled with a paste of red lead mixed with water, and they are dipped in dilute sulphuric acid (1 to 10) two or three times, and allowed to dry. When dry they are placed in jars containing dilute sulphuric mixed as before. They are then "formed" by passing a current from a dynamo through them, discharging through some resistance, and then charged the reverse way. This is done for several days, sometimes a week. After formation they are always charged the same way. If "Werdna" will give E.M.F. of his lamp, and the current it takes, I will tell him how many plates he will want.—Bunsen.

[57129.]—**Steam-Engine for Farm Work.**—In the absence of more precise information relative to the work absorbed by gearing, shafting, &c., I should recommend you to use a steam-engine with a cylinder 6in. bore and 12in. stroke, the engine to run at 160 a minute. You mention a boiler pressure of 35lb.; but the steam pressure should be at least 50lb. to 60lb., the boiler being, of course, correctly designed to be safe at such a working pressure and having a liberal margin of safety. The boiler should be 6ft. 6in. high, and 2ft. 9in. diam.; height of firebox, 4ft.; diam. of same, 2ft.; diam. of uptake, 8in.; thickness of shell plate, $\frac{5}{16}$in.; firebox, $\frac{3}{8}$in.; uptake,, $\frac{3}{8}$in. also: the firebox to have either two crosswater tubes, each tube being 8in. diam. of $\frac{3}{8}$in. plate, or, far better still, three 6in. siphon water tubes. Such a boiler may be tested to 120lb. water pressure, so that the margin of safety is very large; the total weight comes out at about 18cwt. only. Your next portion of this question comes to a different and more difficult matter for me to deal with. If coals be dear, then the gas-engine working at a cost of about one penny per horse per hour would be best, whilst the steam-engine would be independent of gas supply. If coal can be got very cheaply, then the steam-engine would run as cheap nearly as gas, but would not be always ready to start as a gas-engine is. There is also a third choice, that of the new motor advertised in the pages of this journal—the vacuum engine. After myself using one for some time to drive my electric-light dynamo and other small matters, I prefer it to both the ordinary steam or gas-engines. My reasons being that it is perfectly safe, and requires no attention for two or three hours at a time at least. If you think of making your own motor I could, I think, help you very considerably.—Invicta.

[57131.]—**Electro-Motor.**—Reversing the current through a shunt or a series motor would not reverse the direction of rotation. A shunt motor will run with its brushes, and a series motor against its brushes, no matter in which direction the current flows. In order to reverse the motor the lead of the brushes must be altered.—Eugene Brown.

[57132.]—**Electro-Motor.**—The reversal of the direction of the current would not reverse the direction of motion, nor would it injure the machine in any way.—S. Bottone.

[57133.]—**Removing Tin from Scrap.**—Numberless methods have been proposed for effecting this; but, for the most part, with but indifferent success. The following are probably the most promising: 1. Beck's system. The sheet scraps are placed in a stout sheet-iron tank. To each cwt. scrap are added 6lb. flowers of sulphur, 10lb. caustic soda, and a sufficient quantity of water. Steam is introduced by means of a suitable pipe into the tank, and in this way the whole is boiled for 30 minutes. The liquor is then filtered, evaporated to dryness, and the mass, ignited with excess of air, is lixiviated with water. Stannate of soda and sulphate of soda are crystallised, and their different degrees of solubility permitting of their separation. 2. Largue's method. The scraps are mixed with finely powdered charcoal and half per cent. of salt, and placed in a kettle that can be closed, supplied with a horizontal perforated diaphragm in the middle. The upper portion is then heated red-hot, while the lower is cooled with water, when the tin melts and runs through. I fancy this latter method is patented, but I am not certain. A very simple method was suggested by a correspondent of ours some years ago which had succeeded with him on a small scale (see letter 16929, p. 605, Vol. XXX., from Mr. Fahrig, Electrician, of Southampton). He washed the scraps in dilute sulphuric acid (1 acid to 30 water) and then placed them in an earthenware vessel (a cylinder to revolve), covered them with mercury, agitated them well for one hour, and then collected the united mercury and tin, which of course could be easily separated. I shall be glad to hear if any of "ours" have tried this, and how they succeeded.—Percy W. Stanley, 119, Manchester-road, Poplar.

[57133.]—**Removing Tin from Scrap.**—"M. F. K." wants "full particulars." He will find them in back volumes, but any commercially successful process is patented.—Video.

[57134.]—**Easton's Syrup.**—This is the "syrup of phosphate of iron, with quinia and strychnia." The dose is one drachm. It is a fine brain and nerve tonic. Recipe (gratis) by post, if desired.—Percy W. Stanley, 119, Manchester-road, Poplar, E.

[57135.]—**Varnishing Fancy Woods.**—Rub the work over with some patent knotting on a piece of rag two or three times; when this is hard, varnish again, and you will find it all right.—W. Stanyer.

[57136.]—**Problem.**—Since area × height = volume, and $a = \frac{7}{288}$ sq. ft., and $v = \frac{252}{62 \cdot 5} = 4 \cdot 032$ c. ft., $\therefore \frac{7}{288} h = 4 \cdot 032$, $7 h = 1161 \cdot 216$, $h = 165 \cdot 888$. Rate of flow per hour $= 165 \cdot 888 \times 60 = 9953 \cdot 28$ft. per hour.—Bunsen.

[57136.]—**Problem.**—252lb. = (252 × 16) 4,032 ounces = 4·032 cube feet per minute. $\frac{3 \cdot 5}{144} = 0 \cdot 0243$ sq. ft. = sectional area of pipe. Let $x$ = velocity of water per minute, then $0 \cdot 0243\, x = 4 \cdot 032$. Hence $x$ = 166ft. nearly = velocity per minute. ∴ velocity per hour = 166 × 60 = 9,960ft. = 1·886 miles.—J. E. G.

[57136.]—**Problem.**—As I cannot say whether "Judy" means a pipe 3½in. bore or 3½in. area, I have worked the two out for him. A gallon of water weighs 10lb., hence $\frac{252}{10} = 25 \cdot 2$ galls. discharged per minute. A foot length of a pipe 3½in. dia. or bore contains $3 \cdot 5^2 \times \cdot 034 = \cdot 416$ galls., then $\frac{25 \cdot 2}{\cdot 416} = 60 \cdot 57$ft. velocity per minute, and $60 \cdot 57 \times 60 = 3634 \cdot 2$ft. velocity per hour. A pipe 3½in. area:—$3 \cdot 5 \times 12 = 42$ cubic inches in a foot length. Therefore, the 25·2 galls. delivered per minute, multiplied by 277·274, the number of cubic inches in a gallon, and divided by 42 cubic inches $\frac{25 \cdot 2 \times 277 \cdot 274}{42} = 166 \cdot 36$ft. velocity per minute, and $166 \cdot 36 \times 60 = 9981 \cdot 6$ft. velocity per hour.—D. T. W.

[57136.]—**Problem.**—252lb. per minute would equal 252lb. × 60 per hour = 151,20lb. 1 cubic foot of water weighs 1,000oz.

$$= \frac{1000}{16} \text{ lb.} = 62\tfrac{1}{2}\text{lb.}$$

$$3\tfrac{1}{2}\text{sq. inches} = \frac{7}{2} \times \frac{1}{144} \text{ sq. feet.}$$

$$\therefore \text{velocity per hour of water}$$

$$= 15{,}120 \times \frac{2}{225} \times \frac{2 \times 144}{7}$$

$$= 5530 \cdot 6. \text{ Ans.}$$

—Nester.

[57136.]—**Problem.**—252lb. pass per min.; 151,20lb. pass per hour; 241,920oz. pass per hour; 241·920 cub. ft. pass. per hour. There are $\frac{7}{288}$ sq. ft. in 3½ sq. in. $241 \cdot 92 \div \frac{7}{288} = \frac{24912}{100} \times \frac{288}{7} = 9953 \cdot 28$ft. per hour.—Ernst Siemens.

[57138.]—**Removing Tin from Scrap.**—No subject has perhaps been so thoroughly exhausted as this one, upon which "M. F. K." desires information. I would strongly advise him to procure and peruse an article on the subject in the *Journal* of the Society of Chemical Industry, for May, 1885, and to note carefully the criticism at the end of it. As a supplement to that paper, and as a matter of general interest, I subjoin a note of most of the processes that have been proposed and patented during the last twenty years.

English Patent List.

1866. Newton, 1,207. Converts the tin scrap into steel.
1871. Becks, 286. Employs it for precipitating copper.
1872. Morton, 1,739. Removes the tin by dissolving in hydrochloric acid.
* 1872. Morton, 3,676. Removes the tin by dissolving in hydrochloric acid.
* 1873. Gutensohn, 258. Removes the tin by dissolving in hydrochloric acid.
1873. Robinson, 1,708. Removes tin by amalgamating it with mercury.
1873. Hanberg, 2,775. Removes tin by amalgamating it with mercury.
* 1873. Zenger, 3,384. Removes it in a bath of caustic nitrate and chloride of sodium.
1873 Haseltine, 4,070. Dissolves the tin in hydrochloric acid and the iron in aqua regia.
1874. Stuart, 1,276. Treats it with acid and air to yield tin and ammonium salts.
* 1874. Browne, 1,692. Heats in retorts with salammoniac.
* 1874. Morton, 4,285. Liquates out the tin by heating in a chamber with a grating.
* 1875. Clark, 927. Heats the scrap with salt in closed retorts.
* 1875. Morton, 1,471. Heats to liquate the tin in a reverberatory furnace.
1876. Madge, 3,160. Amalgamates with mercury in revolving barrels with gravel.
1876. Parnell, 3,183. Dissolves the tin by sulphide solutions.
1877. Wallbridge, 1,346. Moves the scrap progressively through a hot electrolysing bath.
* 1877. Gutensohn, 1,901. Dissolves in hydrochloric acid, adding ammonia and cupric sulphate.
* 1878. Edmunds, 1,348. Blisters the tin by heat, and separated by a hydro-extractor.
1878. Siegler, 2,851. Dissolves in hydrochloric acid, and removes iron by prussiate of potash.
1879. Reid, 4,700. Oxidises by calcination, and separates the tin by grinding.
1879. Gutensohn, 4,879. Dissolves in hydrochloric acid, and precipitates by electrolysis.
1880. Biggs, 321. Dissolves by acids, and precipitates the tin by sulphuretted hydrogen.
1880. Gutensohn, 4,259. Heats to redness with phosphate of alumina.
1881. Gutensohn, 3,772. Heats in a revolving cylinder with sand to scour off the tin.
1882. Schultze, 777. Dissolves the tin by plumbate of soda.
1882. Barlow, 1,576. Dissolves by hydrochloric acid in revolving cylinders.
1882. Beeks, 3,731. Dissolves in acid and precipitates with chalk.
1882. Abel, 4,400. Employs plumbate of soda and granulated iron to scour it.
* 1883. Laird, 3,952. Employs caustic soda and an electric current.
1883. Cleaver, 5,033. Immerses the scrap in acid or soda with an electric current.
1883. Price, 5,849. Employs caustic soda with an electric current.

1884. Price, 2,119. Employs caustic soda with an electric current.
1884. Poensgen, 4,684. Dissolves in solutions of alkali with nitre.

Those marked with an asterisk received provisional protection only.—H. B. F.

[57139.]—**Amateur Modeller.**—You ought to be the best judge of your own capabilities, and needs. Of course, a planing-machine is not an easy thing to make; but why not tackle a lathe, or an engine, a bench, a tool-box, a dynamo, or some one out of the hundreds of things which have been described in the "E. M." Other things besides planing-machines will be described in the "Amateur Workshop," drills, and a shaper, possibly a metal-turning lathe, and some minor tools, and out of these you may find something which will suit your requirements.—J. H.

[57139.]—**Amateur Modeller.**—Is this querist a dabbler with clay or wax, or is he a mechanical modeller? In the latter case I would gladly help him in any way I can. If he amuses himself with clay or wax I fear my education, being only elementary on those subjects, would not admit of my being of much use to him. My services would be quite at his service; but I am not a "dab hand" at clay.—Invicta.

[57139.]—**Amateur Modeller.**—If "Simpleton" will make known what his inclinations and tastes are mostly disposed for in manipulation, possibly I may be able to suggest something in the way of model-making both pleasing and useful. In fact, I am disposed to lend something to make a copy from. Meantime, I certainly recommend him to make an effort to join the Amateur Mechanical Society, feeling sure some of its members would gladly acquiesce likewise.—E. F. Baker.

[57140.]—**Safe Load.**—In what position is this structure to be fixed? If it is a girder, what is the span, which way up, and what is the thickness of the plates 6ft. long? Or is it a column, and what its height?—J. S. C.

[57141.]—**Gas-Engines.**—I think Mr. W. Bundy is right in saying his drawings would interest a good many readers. I, for one, should very much like to see them.—G. G.

[57141.]—**Gas-Engine.**—To "Invicta," "J.H.," and Others.—Whilst I have not sufficient evidence before me to pass a positive opinion, yet several points named by you are so clear that they are dealable with. I have heard of this Rogerson engine; but, not having the particulars at hand, I cannot give more than a passing opinion. I would, however, ask you the practical question whether you have seen the engine at work, and satisfied yourself that it does do its work on a reasonable gas consumption. I mention this because the heating of the new charge by the old hot products has been tried and put in actual practice by several patentees — notably by Butcher. The theory is right, if it were possible. But no practical arrangement has yet come to my notice, nor do I expect to see such; because the only right way of doing it is by absorbing heat from the waste gas after the gas and air have left the air-pump cylinder. The effect of heating the feeder or air-pump cylinder is most decidedly bad, so much so that one well-known patentee actually jackets his air-pump with water; whilst another makes it of such proportions that the heat due to compression can be thrown off. If the other arrangements be right, the abolition of the hot jacket to the air pump would considerably increase the efficiency of the engine as a whole. Admitting, and releasing, and firing the charge by slots passed over by the piston are not new, although the arrangement you speak of may be. Of that, until I saw it, I could not give an opinion. Bessel's patents cover the system of forcing in air to cool the cylinder from the front part or air-pump, a gland being used. My own suggestion is that, if the drawing can be either published, or if you like at any time to take my private opinion—the address column will give you the necessary channel. Either the patentee must be *very* modest, or he has not satisfied himself on certain points, if he wants only 20s. per engine. And this does not incline me to think that it is a practicable engine. There are also several other points on which I could pass opinions; but in the absence of drawings it would not be fair to hazard what one may think. Can you tell me the number, date, and year of this patent, as it would save me searching back for it?—Invicta.

[57142.]—**Planing Machine.**—With the exception of lathe planers, I have only seen one treadle machine, and that is at the Inventions, next to Evans's and Holtzapffel's stands. I did not examine it sufficiently to be able to tell you how it is worked, neither could you make it, because the machine is patented. It is sold by Selig, Sonnenthal, and Co., and is advertised in the English Mechanic for July 24th.—J. H.

[57143.]—**Dr. Eder's New Sulphite of Ammonia Developer.**—Answered last number, page 453.—A. R. F.

[57144.]—**Bright Silver Plating.**—The articles should first be plated in the ordinary way and then finished in a bath, to which a little bisulphide of carbon is added. The bisulphide should be mixed with a little of the cyanide of silver solution before adding to the bath. The solution is liable to spoil by keeping.—Eugene Brown.

[57145.]—**Gas-Engine.**—It seems strange that this number of the "E. M." should be so prolific of "gas-engine" queries. In reply, the Hutchinson patent, under which the engine you have was made, is No. 5471, 29th December, 1880; it comes under claims 1, 3, 4, and 6. You will find that the light is drawn into the cylinder to ignite the charge through a small aperture. Covering this aperture, and also an auxiliary gas supply, should be a little flap valve. This is either gone altogether, or is stuck fast, and hence allows the flame to be blown out. After standing so long, you should have had the parts cleaned and replaced by a competent man before starting, as the valves throughout are no doubt out of order. It is possible they were never right, as some buyers have told me. Be that as it may, I have myself seen and had running Hutchinson's engines, and the only fault I found with them was that a water jacket was wanted and was not there. If I were near you I would get it going, I feel sure, as the system is right enough, and those I have had to do with for intermittent work ran well enough, because time to cool was then given.—Invicta.

[57149.] — **Brightening Small Goods.** — Bisulphide (not bisulphate) of carbon is the modern name for what used to be called, after Lavoisier's plan, "bisulphuret." The strict scientific name, as adopted by the Publication Committee of the Chemical Society, the highest authority in existence on chemical nomenclature, is "carbon disulphide." We still speak familiarly of carburetted, phosphuretted, and sulphuretted, hydrogen; but these terms are gradually being replaced by the more scientific appellations of "hydrogen sulphide," &c. The carbon disulphide is an extremely volatile liquid, highly inflammable, and usually possessing a most disagreeable odour, somewhat suggestive of stale cabbage water. If this is what your chemist has given you, have the article recommended.—Percy W. Stanley, 119, Manchester-road, Poplar, E.

[57149.]—**Brightening Small Goods.**—It is the bisulphide of carbon you require; bisulphuret is the same thing. It is easily recognised by its smell resembling rotten eggs.—Eugene Brown.

[57150.]—**To Mr. Bottone.**—Your connections are wrong. You should couple from one brush to one coil of field magnets, round the other field magnet to the lamp, back from lamp to other brush. If all were well, you might light seven or eight 10's, or four or five 20's, with such a machine. Provided the insulation and connections be right, the other little points mentioned would not vitiate the machine.—S. Bottone.

[57151.]—**Problem.**—Let £$a$ = interest now accumulated; £$b$ = weekly interest of the sum; £$c$ = a workman's weekly wages; $x$ = time required (in weeks). Then—

$$a + 11\,b = 165\,c$$
$$a + 5\,b = 155\,c$$
$$a + x\,b = 9\,x\,c$$

Subtracting the second equation from each of the others we get $6\,b = 10\,c$, and $(x - 5)\,b = (9\,x - 155)\,c$. Therefore—

$$\frac{3}{x - 5} = \frac{5}{9\,x - 155}$$

$$\text{Therefore}\quad 27\,x - 465 = 5\,x - 25$$
$$\text{whence}\quad 22\,x = 440$$
$$\text{and}\quad x = 20 \text{ weeks.}$$

—T. Watt.

[57151.]—**Problem.**—Let weekly wages = $x$.

$$15 \times 11 \times x = 165\,x = \text{sum paid}$$
$$31 \times 5 \times x = 155\,x = \text{sum paid.}$$

Let A = number of weeks elapsed
R = rate per cent.
P = principal.

$$165\,x = \frac{P\,R}{100} \times \frac{A + 11}{52} \quad (1)$$
$$155\,x = \frac{P\,R}{100} \times \frac{A + 5}{52} \quad (2)$$

equate values of $x$:

$$31\,(A + 11) = 33\,(A + 5)$$
$$2\,A = 176$$
$$A = 88 \text{ weeks.} \quad (3)$$

let $y$ = number of weeks required, then

$$9\,x\,y = \frac{P\,R}{100} \times \frac{88 + y}{52} \quad (4)$$
$$165\,x = \frac{P\,R}{100} \times \frac{99}{52} \quad (1 \text{ and } 3)$$

equate values of $\overline{P\,R}$:

$$165\,(88 + y) = 99 \times 9\,y$$
$$165\,y + 14520 = 891\,y$$
$$726\,y = 14520$$
$$y = 20 \text{ weeks.}$$

—Ernst Siemens.

[57153.]—**Problem.**—Let $x$ = original amount of grass per acre, let $m\,x$ = daily growth per acre. If 15 oxen consume 5¼ acres in $4\,y$ days, then 1 ox consumes $\frac{7}{20}$ of an acre in $4\,y$ days, and 1 ox consumes $\frac{35}{124}$ of an acre in $3\,y$ days—

$$\therefore \frac{7\,x}{20} + \frac{7\,m\,x\,y}{5} : \frac{35\,x}{142} + \frac{105\,m\,x\,y}{124} :: 4\,y : 3\,y.$$

$$\text{Hence}\qquad m\,y = \frac{7}{72}$$

If 20 oxen consume 6¼ acres in $z$ days, then 1 ox consumes $\frac{5}{16}$ of an acre in $z$ days.

$$\therefore \frac{7\,x}{20} + \frac{7\,m\,x\,y}{5} : \frac{5\,x}{16} + \frac{5\,m\,x\,z}{16} :: 4\,y : z.$$

Hence, substituting for $m\,y$—

$$z = \frac{24\,y}{7}$$

Similarly we find—

$$z + 3 = \frac{27\,y}{7}$$
$$\therefore \quad \frac{3\,y}{7} = 3$$

$\therefore 3\,y = 21$ days, which is the time required.—T. Watt.

[57153.]—**Problem.**—The time varies as the number of acres, and inversely as the number of oxen. Let $x$ = number of days in which one ox eats one acre—

$$\text{Then time for } 20 = \tfrac{25}{4} \times \frac{x}{20} = \frac{5\,x}{16} \quad \ldots\ldots\ldots\ldots(1)$$
$$\text{,,}\qquad \text{,,}\qquad 22 = \frac{15\,x}{44} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$
$$\frac{15\,x}{44} - 3 = \frac{5\,x}{16}$$
$$\frac{15\,x}{44} - \frac{5\,x}{16} = 3$$
$$x = 105{\cdot}6 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Therefore the time for $15 = \tfrac{21}{4} \times \frac{x}{15} = \frac{7\,x}{20}$, and by hypothesis the 31 oxen take ¾ of this. $\tfrac{3}{4} \times \tfrac{7}{20} \times 105{\cdot}6 = 27{\cdot}72$ days.—Ernst Siemens.

[57154.]—**Horse Taming or Breaking.**—It is evident that in your case the horse is at present master of the situation; now you must reverse the order of things—you must be master. If you are nervous, dispose of the animal, and purchase something warranted quiet. If not, stick to him, and try by kindness and persuasion to get him quiet. There are plenty of men used to horses employed in cabyards, 'bus, and tramyards, that for a small consideration would go out with you and help to keep him quiet, and after a few lessons you would be able to drive him by yourself. Of course, there are lots of horses that are incurable. In your case perhaps he does not have sufficient work; but there are so many reasons for a horse kicking besides viciousness, that unless I saw him in harness I could not advise. About the year 1858 a Mr. Rarey, an American, visited this country, and was very successful with vicious horses. He published a book explaining his system, which, I think, is to be had from Routledge and Co., Broadway, E.C. However, I know that it is worth trying; so purchase the book and tame your horse.—J. H. F.

[57154.]—**Horse Taming or Breaking.**—You cannot have this query answered after the manner of a recipe. It is quite evident that the horse is exactly what you have made him to be by your improper treatment, and it is not likely that with the best advice you will be able to improve him. What is required to be master of a horse is kindness, firmness, fearlessness, a perfect mastery of one's own temper, and no unfair play. This, with a moderate amount of perseverance, will insure success, but very few can practise it thoroughly. I do not consider any man a good horseman unless he can go into a great park and take up his turned-loose horses as easily as if they were tied. Should be happy to give you a lesson gratis if I lived near. I would never allow a circus man to take a horse of mine out of my sight, and I know something of their practice.—Old Ploughman.

[57154.]—**Horse Taming or Breaking.**—In reply to the latter part of this query, I may inform "M. H. J." that there is a full description (illustrated) of Rarey's method of horsebreaking in "Stonehenge's" book on the Horse. I should be happy to lend my copy of the book to "M. H. J." if he will take care of it and return it in a reasonable time, and will advertise his address.—Eques.

[57158.]—**Bird Taming.**—Having been successful in taming wild birds, I send my mode of treatment for the benefit of "W. P." and others who may be interested. First, treat your bird kindly, avoid frightening it, and do not speak in an angry tone. Secondly, take it into a dark place every day; put your hand into the cage and place the forefinger against its breast. The bird will step on to the finger. Now bring it gently out of the cage and place the forefinger of your other hand against its breast as before, when you will find it will step on to the other finger. Keep on repeating this, first one finger and then the other, for at least five minutes, and keep on with this treatment once a day, or oftener, if convenient, speaking kindly as you proceed. After a time you will find that the bird may be let out of the cage and will perch on your head, hands, or anywhere without the slightest fear.—W. Potter.

[57159.]—**Watch Query.**—The verge escapement is a most unreliable one at the best, and one which is governed most of all by the pendulum (or hair) spring. "Caribbean," no doubt, has his spring too stout—too strong for the watch, or it may be caused by the escapement being too shallow. If the spring has not been all let out from the stud, put it out, and if it still gains, it will be necessary to have a weaker one. This can be judged from the weight of the balance on the spring—take one which is stretched a trifle further out when the balance is suspended from it. Of course it must be put on to coil the right way, so that the first coil passes through the regulator. If this is not sufficiently explicit, shall be happy to further explain. —Escapement.

[57159.]—**Watch Query.**—The number of beats per hour must first be ascertained; say, for instance, it 's 16,200: that would be nine beats or vibrations of balance in two seconds. Find the right size spring shall be, lay it on balance arms, balance lying verge upwards, and gently press collet down on it sufficient to hold spring. Take hold of spring so many turns from outside coil as is right size, and hold by the tweezers, balance suspended. With a touch set it vibrating, and count. Thus you can try any number of springs without troubling to pin them in, shorten them, or damage in any way. Of course, the beat may be any other number than above quoted. Whatever it is, you must reckon the number of beats it would be in any given number of seconds most convenient.—Peganredstuff.

[57163.]—**Employment at the Arsenal.**—Only by applying to the superintendent or manager of the department, unless you can obtain a letter of recommendation from somebody who is a somebody.—E. G. M.

## UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

56688. Rifle, p. 289.
56692. Carbon in Cast Iron, 289.
56693. Silos, 289.
56694. Butter Kegs, 289.
56707. Electro-plating, 289.
56712. Shutter, 289.
56723. Chaster's Electro-motor, 290.
56731. Midland Engines, 290.
56735. Water Gauge, 290.

56887. Drying under Pressure, p. 375.
56897. Organic Chemistry Examination, 375.
56905. Mal de Mer, 375.
56906. Deed of Gift, 375.
56916. Telescope Eye Tube, 375.
56922. Twine, 375.
56927. Co-ordinate Geometry, 376.
56934. File-cutting Machines, 376.

**Unreported Brake Failures.**—At the meeting of the Executive Committee of the Amalgamated Society of Railway Servants held in London last week, the general secretary stated in his report that, having drawn the attention of the Board of Trade to brake failures which had not been reported by the companies to the Board, the reply he received was a very unsatisfactory one, and from which it would appear that the Board of Trade have no intention of putting the law in force against those companies. The executive committee passed the following resolution thereon:—"That this committee strongly urge the Board of Trade to put in force the provisions of the Railway Returns (Continuous Brakes) Act, 1878, in all cases wherein default has been made by companies omitting to make the returns, or where same, when made, are inaccurate, or, to use the words of the Act, 'false in any particular.'" It was resolved that the committee recommend to the annual general meeting that Clement E. Stretton, Esq., C.E., become vice-president of the society.

From W. Wesley and Sons, of Essex-street, we have No. 66 of the Natural History and Scientific Book Circular, which gives the titles of works they have for sale connected with entomology, botany, ornithology, fishes, &c.

## QUERIES.

[57164.]—**Trigonometrical.**—From the summit of a tower, whose height is 108ft., the angles of depression of the top and bottom of a vertical column, stand on a level with the base of the tower, are found to be 30° and 60°. Find the height of the column. Will some mathematician kindly give me a simple trigonometrical solution of the above?—Chas. A. Whatmore.

[57165.]—**Course of the Wind.**—Within the last 24 hours, the wind has backed from E. through N. W. and S., returning again to E., with a barometer absolutely stationary, and without any atmospheric disturbance whatever, save some fog at daybreak, the sky throughout the day being mostly cloudless. Meteorologists say that a complete revolution round the compass, if the wind is in the same direction as the sun, occurs but a very few times in the course of the year. Will some correspondent who is conversant with the subject, say how often a complete revolution in the opposite direction (backing against the sun) as in this case, occurs? I have observed the weather and course of the wind for many years, and have never observed such an occurrence within anything like the same space of time?—M. A., Gloucester.

[57166.]—**Model Well.**—Will any of your correspondents kindly explain the following? A friend has a model ebbing and flowing well in his garden; the water supply is from a large fountain tank, out of which projects a tap to regulate the flow into a cylindrical leaden cistern from near the bottom of which projects the siphon. The bore of the supply pipe being much smaller than that of the siphon, how is the latter completely filled with water at the bend, and thus siphon action made commence?—lead cistern about 2ft. deep, by 12in. diameter.—H. A.

[57167.]—**Wood Planer.**—Can any correspondent give me a detailed account or description of the Daniels wood planer, with a diagram if possible?—Improvement.

[57168.]—**Separating Oil from Tallow.**—Will any kind reader please inform me how I might obtain the oil from beef tallow?—Improver.

[57169.]—**Boiler Construction.**—I should feel obliged for any information as to the correct dimensions of vertical, from one horse-power up to six horse-power, and the best way to construct the same. I should be glad to know the number of tubes, and the best way to put them in, and the sizes of tubes for each boiler, and the thickness of plates. Are there any works on the subject?—T. M. S.

[57170.]—**To Mr. Bottone.**—Will you give particulars "how pure P is prepared in an atmosphere of $CO_2$." A diagram of apparatus would greatly please.—Magi.

[57171.]—**Hardening Punches.**—What is the best way of hardening punches for punching the nail-holes in horseshoes? I am a smith by trade, therefore I happen to know a little about the working of steel, and have tried various ways for hardening them, but cannot get them to stand. I think the difficulty lies in the shape of the punch, it being taper, therefore there is no clearance at the back of the punch, which causes it to jam in the holes, so you will see by that that there is a great strain on the punch: if they are too hard they break, and if they are not, they shove up. I must tell you they are steel shoes, and the punches work in a machine, and the shoes are punched cold. The size of the punch is 3-16th to ¼th, at point tapering up to ⅜th.—H. F.

[57172.]—**Dynamite for Quarrying.**—Could any reader tell me if dynamite would be better than rock powder for getting out stone, and how used? Also if there is a quicker way for a man with means limited to get water out of quarry, than by a common stand pump about 15ft. lift?—Quarryman.

[57173.]—**Easing Force Pump.**—My force pump, with a lift about 30ft., goes tremendously hard. Could I make it easier by having an air vessel put to it?—Rector.

[57174.]—**Steam Canoe.**—To "Invicta" or Others. —Being about to build a canoe, 12ft. or 15ft. long, and 3ft. wide, I am desirous of fitting a screw engine into it. Could the new steam motor, about which you have spoken, drive it?—if not, can you advise me as to a boiler and engine that will work at a pressure beneath the atmospheric? Any information will be thankfully received.—K.

[57175.]—**Sand-Blast.**—Could any of your correspondents give me a description of a sand-blast apparatus for working against a vertical surface? Also of a suitable blower for the above to be worked by manual labour.—A. Frankish.

[57176.]—**Microscope Lamp.**—I have a student's monocular, which I intend to fit with a small incandescent lamp. Will some reader kindly give a description, with a sketch, if possible, of a stand suitable for the purpose, and also name the best kind of lamp to use? I shall employ a bichromate battery.—J. B.

[57177.]—**Soldering.**—I have a deal of soldering to do, but do as I will, I can't keep the solder on the iron. Will someone kindly tell me how to proceed, so as to make a good job of it?—New Beginner.

[57178.]—**Clutch.**—Will some reader kindly give sketch and description of clutch, suitable for treadle of foot-lathe?—Clutch.

[57179.]—**Leather Scrap.**—If this lies exposed to the weather, say for a year or so, I shall be glad to know whether it will have lost any of its nitrogen?—Scrap.

[57180.]—**To Mr. Bottone.**—Would you be good enough to explain, either in words or by diagram, how the wire is wound on a Siemens H laminated armature? Do not the projecting ends of the central shaft interfere with the lapping of the wire over the ends of armature?—Perplexed.

[57181.]—**Heating Greenhouse.**—Will any of "ours" kindly enlighten me on the following?—I desire to put heating apparatus into small greenhouse 10ft. by 6. I am told the slow-combustion stoves do not answer the purpose, and that I shall require the hot-water pipe affair. Is there any real practical advantage in these pipes over the combustion stoves? Should be glad to have the opinion of anyone who has had experience in this matter.—Thermo.

[57182.]—**G.N. Locomotives.**—(1) What are the chief dimensions of the "single drivers" of the G.N.Ry.? I should particularly like to know the diameters of the wheels, the wheel base, the length of the boiler, and the length of the connecting-rods. (2) Have these engines the largest driving-wheels in England? If not, where are they to be found?—V. J. B.

[57183.]—**Planing Machine.**—Some time ago I had a planer made to plane 20in. by 10in. square; it was fitted with a pair of clamps 2in. high, and a pair of angle plates 3in. high. I find that the latter tilt up and are forced apart by their screws when any work is placed between them, the screws being placed ½in. from top of plates. I complained about this, and am given to understand that I must not expect to plane more than 4in. high on so small a machine. Can "J. H.," or some other, tell me how to make suitable clamps, &c., that will not tilt up or let the work slip away? I may say I have planed the full height of the machine without its trembling in the least degree, but the work always slips away after three or four cuts.—F. Shakespear, Dresden.

[57184.]—**Headstock.**—Can I make a back-geared headstock with only one arm for back-gearing? All the wheels would be behind the pulley. I propose to make a boss on arm 2in. long for eccentric to work in, the wheels to be carried on a short stud. Can this be done, and what alteration needs the pattern?—F. Shakespear, Dresden.

[57185.]—**Dynamo.**—To Mr. W. H. Eaves, Coventry.—Kindly permit me to tender you my warmest and most sincere thanks for your prompt and courteous reply to my inquiries respecting construction of dynamo; but, being a little disappointed with the prospective capability of such machine when finished—viz., four 20-c.p. lamps—I suspected that there must have been an error somewhere, and consequently I referred back to my query (No. 57068), wherein I found I had blundered very much by stating that my armature was "two-thirds less," &c., whereas I should have stated it to be "three-fourths of the size given by you for a 30 lighter." Therefore, to avoid further mistake, I beg to give you exact size of my armature, which is 5 13-16in. in length by 5 13-16in. external diameter by 3¾in. internal diameter. Will you kindly give me the needful information asked in my previous letter with this correction? Also, please say about what h.p. will it require to run it? Hope you will pardon me for thus giving you further trouble.—Cymro Gwledig.

[57186.]—**Astronomical.**—Will "F.R.A.S.," Mr. Franks, or Mr. Sadler, kindly give me the exact places for 1885 of the following objects in the late Mr. Webb's book, fourth edition, as I cannot find them from his descriptions? I think it a great drawback that in the last edition the places are only given to the nearest minute of time. T Coronæ. B.A.C. 6624, 7001, 7219. Σ Neb. 6 Tauri Poniatowski. H 5112 Sagittarii. Bu. 142 Aquilæ. H 1470 Cygni. B 658 Cassiop.—J. W. Ruthven.

[57187.]—**Repairing Marble Ornament.**—Will anyone inform me how to dissolve plaster of Paris so that I can move a portion of a marble ornament joined together with it? Of course, it must be something that will not injure or discolour the marble, which is white. I have tried soaking in cold water for over four hours, which had not the slightest effect, the plaster being thick, and in so doing the gloss on the ornament came off up to the water-line. Could anyone inform me also what this gloss is composed of, or how to put it on?—W. E.

[57188.]—**American Popcorn.**—Can any reader give the recipe for colouring and flavouring above?—W. L.

[57189.]—**Income Tax.**—A firm consisting of two partners makes £280 in one year. Is the firm liable for income tax, although the income of each partner is under £150?—Glasgow.

[57190.]—**L.B. and S.C.R. Engines.**—Can any of your readers give me full dimensions of the "Gladstone," L B. and S.C.R.; No. 605, G.E.R.; and the "Lord of the Isles," G.W.R?—Piston Rod.

[57191.]—**Tuning Clock Bells.**—To "Clerkenwell Clockmaker," or Others.—Will someone give me a few hints as to tuning bells for a Westminster chime, or on tuning bells generally? How much is a bell capable of being altered in pitch—say a 8in. ordinary clock bell? Would the wire coils, the so-called "cathedral-toned gongs," be of use for this purpose?—Roi ne Puis, Souza je Suis.

[57192.]—**Drills and Taps.**—Will any of our readers give me a scale or table of sizes of drills for drilling holes for tapping, say, from ¼in. up to 1½in. in bolts, and from ¼in. up to 1in. in piping?—Drills.

[57193.]—**Balance Staff.**—Would anyone give me instructions for working watch turns—say the whole process of fitting balance staff or cylinder? How is the staff fixed in turns, &c.? Should watch or clock pinions be oiled?—British Workman.

[57194.]—**Punch.**—To "Invicta."—Will you kindly tell me how I can make a punch to work by lever to punch holes up to 5-16in. diam., through ¼in. copper and brass?—F. Shakespear, Dresden.

[57195.]—**Iron Rusting.**—What kind of paint can I use to prevent the bright parts of a machine becoming rusty? The paint must be easy to remove; the white lead and oil sets on the iron too hard.—F. Shakespear, Dresden.

[57196.]—**Preparation for Hair.**—With reference to letter 24530, can any correspondent say whether Dr. Rohe's preparation for the hair can be obtained in England, or the German soft soap used in it?—Emu.

[57197.]—**Watch Springing.**—Can any of the watchmaking correspondents of the "E.M." kindly give me directions how to order a new mainspring, the size and strength of the broken one? I have a mainspring gauge with strength gauge. Can anyone tell me when I take out the broken mainspring how to take the proper size and strength of it by the gauges, so that when I send to the material dealers that the sizes I give will be intelligible?—Amateur Watch Repairer.

[57198.]—**Valves in Compound Engines.**—To "Invicta."—Will you kindly let me see the sketch of the valves of a compound engine that you willingly offered "Boolie" if requested by him ?—F. Hawkins.

[57199.]—**Gas Engine.**—Would "Invicta," or anyone interested in gas-engines, kindly give a table in these columns to get the horse-power of a gas-engine ? I have a 2 man-power gas-engine which will not maintain the power of a boy at nine years of age, and I wish to reckon it up.—G. G.

[57200.]—**Indicator Diagrams.**—Will any of your readers kindly inform me how to calculate the indicator diagram of three cylinder engines ? What I want to know is, when I get the mean pressure of each cylinder, do I add the three means together and work them out in one sum, or do I work the mean pressure of each cylinder out by itself ? Stroke of engine, 44in. ; 50 strokes per minute ; bore of two low-pressure cylinders, 19in. ; high-pressure, 13¾in. ; boiler pressure, 78lb. Average pressure on each side of pistons—

| | | lb. |
|---|---|---|
| Low-pressure | Left back | 28·6 |
| Low-pressure | Left front | 25·2 |
| Low-pressure | Right back | 27·0 |
| Low-pressure | Right front | 24·2 |
| High-pressure | Right front | 47·4 |
| High-pressure | Right back | 66·2 |

—Young Beginner.

[57201.]—**Violin Strings.**—Could any reader of the "E.M." kindly tell me what is the relative thickness of each string upon an English 3-string double-bass to bring out the finest tone, and the probable cost of the same ? Also, the distance of sound peg from the foot of the bridge ? I wish to re-string my instrument as the present one makes my fingers sore, and I am informed they are too thick. Will someone oblige ?—Contra.

[57202.] — **Driving Cotton Machines by Electricity.** — I am intending turning two cotton machines by electricity. The machines will require about 1-h.p., and are situate about 100 yards from the motive power. The information I want is (1) What will the cost of running by electricity be compared with steam per hour ? (2) What will a 1-h.p. dynamo cost ? (3) What will the wire cost to transmit the power per yard ? (4) How is the power to be applied to the machine ?—will it require copper pulleys ? Any other information relative to electricity used as a motive power I shall be glad of.—Cotton.

[57203.]—**Numbers of Locomotives.**—Could any of your readers inform me by what rule the numbers of locomotives are determined, and why they should be changed, as I hear will be done with the "Marchioness of Stafford" ?—V. J. B.

[57204.]—**Sea-Water Aquarium.**—I am thinking of constructing an average-sized sea-water aquarium. Would any reader give me any hints about this ? (1) The kind of fish and plants most suitable ? (2) How long can the water be kept without being changed ?—(I heard of one being kept five years without change of water.) (3) Would the aquarium require any zinc top ? (4) What sort of place it should be kept in, and any other useful hints ?—Nester.

[57205.]—**Over-dry Leather.**—Owing to the use of a gas stove, the backs of my bound books have become dry, and are apt to crack. Will someone kindly tell me how to remedy the mischief ?—B. A.

[57206.]—**Land.**—What is the legal remedy, if any, in the following case ? I bought a plot of land, paid nearly the whole purchase money on account, and took a receipt for the money (bearing a penny stamp) with a rough plan of the ground thereon. The seller now refuses to give me a title, because he has learnt that I intend to put up a house of about half the accommodation of one that he has since built (and let) on a neighbouring plot. The value has increased ; he would return the money, mine being at the back of his, that is to say, his back door is towards my plot. I don't want to quarrel with him if I can avoid it, and would be thankful for any advice.—Ignorant.

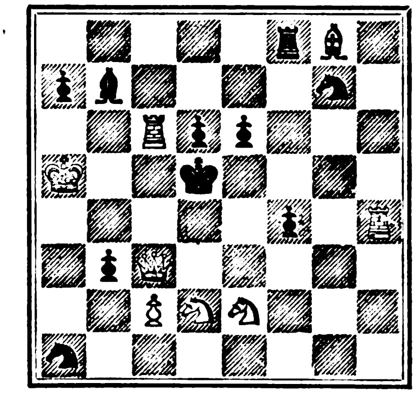
**Colouring Matter of Leaves.**—M. Arnaud, in a note read at the Paris Academy of Sciences, has called attention to the identity established by his researches between the orange-red matter extracted from leaves and carotine. He has found the same solubility in various disolvents, the same crystalline form and the same point of fusion (335° Fahr.) The two substances have likewise the same appearance and the same chemical reactions. They are not nitrogenised, and give birth under the influence of chlorine water to a chlorated composition, which is white and insoluble in water. Husemann has prepared this composition by starting from carotine, and assigns to it the formula $C_{18}H_{20}Cl_{14}O$. M. Arnaud has reproduced it by the assistance of the orange-red substance in spinage leaves, having satisfied himself on this subject by ascertaining the point of fusion (248° Fahr.) Carotine has been studied with great care by Zeise and Husemann, who has established for it the formula $C_{18}H_{24}O$. Carotine is found in the different organs of vegetables. It appears to constantly accompany the chlorophylle. He discovered it to exist in the leaves of spinach (*Spinacia glabra* and *oleracea*), of mulberry (*Morus alba*), of peach (*Persica vulgaris*), of sycamore (*Acer pseudoplatanus*), of ivy (*Hedera helix*), in carrot root (*Daucus carota*), and in large gourds (*Cucurbita pepo*). The simultaneous and constant presence of carotine and chlorophylle in these leaves is doubtless not entirely fortuitous, and it is considered that there must be certain chemical relations between the two substances, of which the details are not known.

## CHESS.

All Communications for this department must be addressed to J. Pierce, Langley House, Dorking.

### PROBLEM DCCCCLI—"The Way the Wind Blows."

*Black.*



*White.* [8 + 10

**White to play and mate in two moves.**

### Solution to 949.

| *White.* | *Black.* |
|---|---|
| 1. Q-K B 2 | 1. Anything |
| 2. Q, R or Kt mates | |

(Six variations.)

### NOTICES TO CORRESPONDENTS.

Correct solutions to 948 by F. A. Vincent (very interesting, but variation 1 B-B 5 omitted—Ed.), E. S., R. A. Bennett, J. A. Miles (a very fine and difficult problem, but if in your main play 1 $\frac{\quad}{\text{K takes B}}$ 2 $\frac{\text{Kt takes P (ch)}}{\text{B takes Kt}}$. — Ed.

To 919 by J. A. Miles (weak), E. S. (but variations not given), F. O'N. H., R. A. Bennett, and Pathologist.

C. C.—Very good for a first attempt. You will soon be able to manage three-movers.

English Mechanic Tourney.—Game between Rev. J. T. Chatto (White) and J. H. Blake (Black).

(King's Knight's Defence).

1. P-K 4, P-K 4 / 2. B-B 4, Kt-K B 3 / 3. Kt-Q B 3, B-B 4 / 4. P-Q 3, P-Q B 3 / 5. Kt-B 3, P-Q 3 / 6. P-K R 3 (*a*), B-K 3 / 7. B-Kt 3, Q Kt-Q 2 / 8. Castles, P-K R 3 (*b*) 9. Kt-K 2, Kt-B sq / 10. P-Q B 3, B-Kt 3 / 11. Kt-Kt 3, Q-B 2 / 12. Kt-R 4, Castles / 13. K Kt-B 5, P-Q 4 / 14. Kt takes Kt P, P takes P / 15. Kt takes B, Kt takes Kt (*c*) / 16. B takes Kt (ch), P takes B / 17. Q-Kt 3 P takes P / 18. Q takes P (ch), Kt-Q 2 / 19. Kt-B 5, Q R-B sq / 20. Kt-Q 6 (ch), K-Kt sq / 21. Kt-K 4, Kt-B 4 / 22. Kt takes Kt, B takes Kt / 23. Q-Kt 6, Q-Q 2 (*d*) / 24. B-K 3, B takes B / 25. P takes B, Q-Q 4 / 26. R takes R (ch), R takes R / 27. P-B 4, R-Kt sq (*e*) / 28. K-B 2, Q takes B P / 29. Q-Q 6 (ch), K-R sq (*f*) / 30. P-K Kt 4, Q-B 7 (ch) / 31. K-Kt sq, Q-K 7 / 32. R-K B sq (*g*), Q takes K P (ch) / 33. K-Kt 2, P-Q R 3 / 34. R-B 8 (ch), R takes R / 35. Q takes R (ch), K-R 2 / 36. Q-B 2, Q-Kt 3 (*h*) / 37. Q takes Q (ch), K takes Q / 38. K-B 2, K-B 4 / 39. resigns.

### Notes by J. H. Blake.

(*a*) As he intends castling K-side, and Black has not done so, this move is weak as being likely to facilitate an attack by Black's K-side pawns.

(*b*) To support the advance of K Kt-P whenever it may be thought desirable. In another game with the same opening moves, White continued 9 $\frac{\text{Kt-R 2}}{\quad}$ when Black was able to reply 9 $\frac{\quad}{\text{P-K Kt 4}}$ preventing the advance of K B P.

(*c*) Weak : he should retake with B P, when it is not easy to see how White can escape losing a P.

(*d*) If 23 $\frac{\quad}{\text{R takes P}}$ Black ultimately loses his valuable Q P in return for the one gained.

(*e*) Best : for if 28 P takes Q, R takes Q / 29. P takes P, R takes B P / and Black has a winning end game.

(*f*) Better than B sq, on account of the after play.

(*g*) If 32. Q takes K P, P-Q 7 / 33. Q-Q 4, R-K B 4, and wins.

(*h*) Much better than taking at once : e.g. — 36 . . . . . Q takes Q (ch) 37. K takes Q, K-Kt 3 / 38. P-K R 4, K-B 2 or 4 / 39. P-Kt 5, P takes P / 40. P-R 5, P-Kt 5 / 41. P-R 6, P-Kt 6 (ch) / 42. K takes P, P-Q 7 / 43. P-R 7, P Qs / 44. P Qs, and Black has by no means an easy win.

**Holloway's Ointment** is unrivalled for its healing qualities. Printed and very plain directions accompany each pot. It reduces local inflammation, heals ulcerations, and cleanses the surface of wounds. It is invaluable in cases of rheumatism and neuralgia, relieving mucular and nervous spasms, together with cramps in the limbs or bowels.

## ANSWERS TO CORRESPONDENTS.

⁂ *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

### HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

⁂ Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

### BACK NUMBERS.

We receive so many queries asking for directions how to make many instruments and appliances which have been fully described in back volumes that we have compiled a list, which we shall insert in this column at intervals, of those most frequently sent, and as the numbers are still in stock, new subscribers should consult the list before sending their questions.

Batteries: Nos. 741.
Bookbinding: Nos. 613.
Copying processes: Nos. 750, 753.
Electric machines: Nos. 628, 759, 840.
Electro-magnets: Nos. 756, 772.
Lacquers: No. 866.
Pattern Making: Nos, 938, 941, 943, 945, 948, 950, 952, 954, 955, 956, 958, 959, 962, 963, 965, 969, 973, 974, 975, 981, 986, 989, 993, 995, 998, 1,000, 1,001, 1,003 1,004, 1,005, 1,009, 1,010.
Silver-plating: No. 890.
Telephones: Nos. 695, 747, 865.
Varnishes: 478, 619, 675, 691, 723, 775.

The following are the initials, &c., of letters to hand up to Wednesday evening, Aug. 5th, and unacknowledged elsewhere :—

J. H. Porter.—Tha Ban.—J. T. M.—Kippo.—George Yarg.—S. Bottone.—Chas. Hosken.—G. Fryer.—J. S. C.—A Fellow of the Royal Astronomical Society.—W. Lane Sear.—W. P. W.—Asterisk.—Subscriber from No. 1.—Rev. J. Pearson.—Rev. T. H. Browne.—David Stephen. — Z. A. — Hiram. — E. S. L.—Manchester Plumber.—Carpenter.—A Constant Reader.—G. Worlands.—Plate Worker. — Busby.—Surveyor.—Western Youth.—Topic.—Dandie Dinmont.—Fred Loundes.—Orderic Vital.

Ar. (It would be alike useless to trouble "F.R.A.S." or to go to the cost of engraving your diagram, inasmuch as the most rudimentary acquaintance with the subject would show you that your idea is radically unsound.)—Tyro. (See Hints No. 4. 2. Nitric acid most likely. The metal is protected by soap or wax. 3. Remove a ring of the bark, clearing it out down to the wood. 4. Gum ; see answer to "Gum" below.)—A Fitter's Labourer. (The methods of cutting out have been described, as you appear to know ; but as to buying the music merely marked out, we suspect you must apply to the dealers in the instruments named. Why not mark it out yourself ?)—Gum. (You would have found the recipe if you had looked through No. 980. Take dextrine 2oz., acetic acid 1oz., water 5oz. and mix. When the dextrine is dissolved, add 1oz. alcohol.)—S. J. (Try the publishers of sporting books, such as Baily and Co., Cornhill.)—A. Horrocks. (Cannot you settle the question yourself by trying how long it will keep ? Surely it depends to a large extent on the weather.)—H. S. H. (You will find a good deal about it in back numbers, and we may possibly have an article about it before long.)—Armourer. (Ebonite is made of indiarubber and sulphur subjected to a temperature above 300° Fahr. It is not easily made "at home," but can be done in a dentist's vulcaniser. Asbestos is a silicate of magnesia ; it ranks as a non-conductor, and, mixed with a hydrocarbon, is known under the name of asbestite, a material sometimes used for cells and for stands of electrical machines.)—E. A. Thomas. (All objects within the cone of rays would be seen ; but only those on a level with the aperture if the range is short. See the indices.)—A Railway Signalman. (We do not know ; but about ten or twelve hours, according to the weather. Lodgings are cheap compared with the usual run of seaside places. Nothing special to be seen.)—Henry Taaffe. (Why not ask the chemical professor himself ? The process could, no doubt, be found in the *Transactions* of the Chemical Society.)—L. Lee. (The plan has its advantages, and has already been tried with partial success in towns where large furnaces are convenient.)—W. Mitchell. (We know nothing of them, and we strongly advise all readers to have nothing to do with "handsome offers" of any kind till they learn more about them. Some of these are, perhaps, genuine affairs, and when advertisements come to us through respectable agents we are unable very well to refuse them, and we have no time to inquire into their real character ; but readers must in all cases exercise discretion, and take no advertisement for granted because it appears in a respectable paper.)

## NOTICE TO SUBSCRIBERS.

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## USEFUL AND SCIENTIFIC NOTES.

**Estimation of Oil in Cattle Cake.**—Having had occasion to estimate the percentage of oil in some samples of linseed and cotton cake, a very simple and effective method of conducting the analysis suggested itself to me, and a description of it may be of some use to analytical chemists. It consists in placing the sample, together with about 50cc. of ether, in a small, well-stoppered bottle, tying the stopper, and leaving the bottle in a vessel of boiling water for fifteen to thirty minutes. The solution of oil is decanted into a small weighed flask, the residue in the bottle washed with ether, and the washings added to the contents of the flask; the ether may then be distilled off, and the residual oil dried at 100° C. A repetition of the process was found to give in no case more than 2mgm. of oil, thus appearing to be far more exhaustive than the method usually employed, which consists in either boiling the sample with ether in a flask fitted with an inverted condenser, or repeatedly drawing cold ether over the cake which is packed in a glass tube, while at the same time it is more expeditious and less troublesome.—*Chemist and Druggist*.

**Salted Runner Beans** are in favour in many parts of the country, and are acceptable in spring for a change. They are gathered when full grown, but not seedy, and are closely packed in earthen jars, and sprinkled with salt as the packing proceeds. Sometimes the precaution is taken to dry the salt in an oven previously to using it, and to spread the freshly-gathered beans out for an hour to render them extra dry before packing. The jars are tied down securely, and stored in any cool and dry place. When the beans are taken out they require to be soaked in cold water for a few hours; they are then cooked whole and served with a little butter. The colour is certainly not good, but the flavour is excellent.—*Amateur Gardening*.

**Regeneration of Nerves.**—"Fresh Researches on the Regeneration of Peripheral Nerves" was the subject of a paper communicated to the Académie des Sciences by M. Vanlair (*L'Union Médicale*, July 11th). If the process of regeneration be studied in the divided sciatic nerve of the dog, after the lapse of several years it will be found that the initial phases of the evolution are accomplished in a definite manner, whilst the final stages are by no means uniform. In all cases the lower extremity of the central portion of the nerve exhibits a proliferation of the marginal zone of nerve fibrils, a disappearance of the axial fibres, and a sprouting of new fibres, which project into a new formation of connective tissue. The whole forms at the central end of the divided nerve a "neuroma of regeneration." The further changes vary in different cases. Sometimes the neuromatous formation remains sterile; it stretches a little distance from the divided end, then becomes thinner, and disappears without giving rise to any nerve fibres. Sometimes genuine nerve fibrils are formed. This organisation, which is often achieved only after a series of fruitless attempts, results in the formation of a longitudinal and systematic arrangement of nerve fibres. The author insists on the importance of mechanical conditions in assisting the regenerative process; the chief mechanical condition is the accurate apposition of the divided ends.

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Wanted, 4in. back-geared **Lathe-Head**, also Vertical Boiler, for ½ horse-power engine. Exchange.—ED. FRANCIS, Bull Ring, St. Austell.

**Celestial Globe**, with brass ring and stand, globe 12in. dia., in perfect order. Offers.—W. HOGG, Oakwell-road, Castle Douglas.

"**English Mechanic**," Vols. XXXVII., XXXVIII., XL., complete, unbound; exchange 2in. stroke cylinder, or parts of Model Engine.—CHEMIST, 224, Roman-road, Bow, E.

**Hand Dynamo**, laminated armature, new, on polished baywood baseboard, complete with two 10-c.p lamps, lamp holders and wall-brackets, lights lamps well. What offers?—H. HADDOCK, Victoria-street, Radcliffe, Manchester.

Wanted, **Anvil**, about 2cwt. Will give Bench Drilling Stand and 12 drills up to 1¼in., will drill at any angle; well-made tool.—Address, 128, Barkerend-road, Bradford.

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A good six-keyed C **Clarionet**. Wanted, a good six-keyed E flat Piccolo, or offers.—W. HARTNUP, jun., Hurst Green, Sussex.

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*FRIDAY, AUGUST* 14, 1885.

## THE SOARING BIRD: A MECHANICAL PROBLEM.

THE problem of the soaring bird is one that has exercised some of the 'cutest intellects, and our own columns contain many contributions on the subject. Perhaps it is for that reason that Mr. I. Lancaster, of Chicago, has sent us his tractate, in which he attempts to solve the problem, "How does a soaring bird manage to sustain itself in the air on motionless wings?" It must be confessed that he has made a very good shot. He starts with the assumption—perhaps we should say proposition—that a body can do work by falling without losing its energy of position, and to reconcile that "seeming impossibility" with the laws of mechanics, he has written his tractate, in which, however, he offers no "experimental proof," as that would carry the question further than he is at present prepared to go. He contends, nevertheless, that if the Newtonian laws of motion are to be depended on, and there is no flaw in the mathematical treatment of the abstract forces, as used by writers on mechanical science, then the possibility of a device enabling gravity to become a continuous motive power is established. The soaring or hovering bird is an example of an imperfect character; but a rightly constructed plane surface is a perfect example, because such a surface can be so placed at an incline to the direction in which it meets the air that its gravitating force will do more work on the atmosphere than the rear-push can do. The total work done by both forces flows to the rear in the disturbed air, and there falls to the tension of the surrounding atmosphere; but a part of this otherwise wasted force is utilised, and takes the place of the rear-push, when the gravitating force will be the only one actuating the plane. The question then arises, Can a surface be constructed in which gravity will do more work on the air than is done by the rear-push? If that question is answered in the affirmative, it makes artificial control of the atmospheric spaces possible; in other words, it solves the problem of flight. Innumerable observers have testified to the fact that birds soar; that is, they rise and fall in the air without perceptible motion of the wings, and that is a mechanical problem which awaits solution. How is it done? Flight by motion of the wings can be understood; but how do birds support themselves in the air, with their wings outstretched it is true, but so far as we can see perfectly motionless. The carrion-eating vultures are a good example. They float for hours in the wind with extended wings, and without more than a suspected alteration of the inclination of the wings as regards the direction of the wind, they rise or fall steadily, and float with apparent ease, now at one height, now at another. We say a "suspected alteration," because from what we know of the mechanism of bird-soaring it is reasonable to suppose that there must be some alteration in the inclination of the wing surface; but so far as can be observed, the wings are perfectly quiescent. Mr. Lancaster offers the following explanation:—The bird weighs 8lb., say, and the wind is travelling at the rate of 20 miles an hour, or about 30ft. in a second; by an alteration in the inclination of the lower surface of the wings, the direction of the wind is changed from the horizontal to the vertical, and we have then a weight of 8lb., which should fall at the rate of 30ft. per second; but it does not, and we have 240 foot-pounds as the motive power. That raises the bird of 8lb. 10ft. per second against gravity, which absorbs 80 foot-pounds, and we have 160 foot-pounds left to hold the bird against the wind and to compensate for losses, which are the equivalent of friction in a machine. Mr. Lancaster supports this conclusion by arguments that certainly help to establish his position, which show that after making due allowance for friction and waste in lateral motion, there is still ample energy in the rear. He has consulted the tables of Smeaton and Hutton, showing the action of air on inclined planes, and refers particularly to the experiments made by the Aëronautical Society of Great Britain. In the latter, the results of which are confirmed by his experiments, it was found that where the angle was very oblique, the ratio of the perpendicular to the direct force increases faster than the angle diminishes, which serves to show that there is some uuexplained action of the wind, or of atmospheric air, which acts on planes with greater force at right angles to the direct than could be assumed to be the case with an abstract force estimated from a diagram in which the resolution of forces is plotted down.

Drawing two lines at right angles, the horizontal one representing the direction of the wind, the vertical the position of the plane, we have a quadrant in which the plane can be placed at various angles between 0° and 90°, and as the angle decreased, or the inclination of the plane varied, a less and less body of air would strike the surface; but as the weight to be supported remains the same, the velocity of the wind would have to be increased just as the quantity diminished. Hence, the rear support would remain precisely the same in each case—viz., just enough to hold the plane against a wind strong enough to support, say 10lb. If the air is supposed to be calm, and the plane is moved upon it, the same result comes out theoretically. Where the angle is 45°, or an inclination which would resolve the abstract force into 1 direct to 1 of perpendicular, the movement would be slow, but the push considerable. With an inclination of 1 to 5, the push would be only one-fifth as great, but five times faster, and the rule holds good with any angle; but the question here is, does the element of elasticity give to a flow of air powers different to those found in the case of a flow of water? Mr. Lancaster has satisfied himself that the mathematics of the matter go to destruction in the solvent of common sense, and in his attempt to produce harmony arrives at the conclusion that the usual methods of determining momentum must be modified to meet the peculiarities of the case. He finds in the statements of Clerk-Maxwell a key to the mystery, for that writer in "Matter and Motion" says: "It is true that when we say that a body is at rest we use a form of words which appears to assert something about that body considered in itself, and we might imagine that the velocity of another body, if reckoned with respect to a body at rest, would be its true and only absolute velocity. But the phrase 'at rest' means in ordinary language 'having no velocity with respect to that on which the body stands,' as, for instance, the surface of the earth or the deck of a ship. It cannot be made to mean more than this. It is, therefore, unscientific to distinguish between rest and motion as between two different states of a body in itself, since it is impossible to speak of a body being at rest or in motion except with reference expressed or implied to some other body." Mr. Lancaster also quotes from the well-known article Aëro-dynamics, in the old "Penny Cyclopædia," and suggests the following case as an example: Suppose a flat body weighing 10lb. to be placed high in the air in a horizontal position, the atmosphere being still and homogeneous throughout, and the body allowed to fall. At first it will be variable in its motion, until a velocity is reached at which its descent will be uniform, the change being caused by the disturbances produced in the air by the falling body exactly balancing the momentum of the body at the velocity at which its motion became uniform. Suppose, for instance, that velocity to be 10ft. per second, then the tensions set up in the atmosphere will be equal to 10lb. moving ten feet in one second, and they will constitute the reactive forces against the active forces of the falling body, and we have a case of a falling body doing work. On the other hand, if the body, uniformly moving, be arrested and held in place, and the air be supposed to move vertically upwards with a velocity of ten feet per second against it, the body would, if released, be at rest relatively to the earth, and would be supported on the moving air. Mr. Lancaster holds that the two cases are identical: the forces are the same, the processes and the effects are the same, the factors are alike, and the sum total is the same. So if a properly-constructed device meets the air in a horizontal instead of a vertical direction, with the same effect of reaction against gravity, the latter will become a continuous motive power operating the device indefinitely and doing work on the atmosphere sufficient to balance the gravitating force. It would seem that we have in these considerations an explanation of the soaring or hovering bird, which, as has been pointed out before, may be assumed to be continually sliding down an upward current of air, the air itself carrying it upwards as fast as it slides down, and thus producing a condition of absolute rest, so far as the observer on the earth is concerned. Darwin was one of the first to draw attention to the fact that birds can and do remain perfectly motionless, so far as the eye can detect, and Mr. Lancaster corroborates him. He observed off the south-west coast of Florida a number of pelicans which rose into the air, and facing the wind floated for several hours in his vicinity, passing many times over his head as they oscillated up and down the beach, on which he had erected his apparatus for determining any deflection from the horizontal in the flow of the air. That consisted of a radial arm balanced at the joint, and feathered with five square feet of surface horizontally, its outer end moving through a circle of twelve feet radius. An ounce weight would throw this arm through 30° of arc either up or down; but the indicator remained level during the whole time the performances of the birds were watched, and Mr. Lancaster says he has never detected any deflection from the horizontal in a coast wind twenty feet from the ground, or above tree tops. The entire movement of air is on level lines, and all hypotheses of upward flowing currents of air to sustain the bird may be abandoned, as they do not exist, while a dead calm is the very best state of the atmosphere for a soaring bird. The conclusion is, then, that the direction of the wind is changed by the inclination of the wings, and that the mere weight of the bird tending to fall through still air produces by the angle of the wings sufficient elevating or sustaining force to enable the bird to float without movement of its wings. Soaring pelicans are rather exceptional, and one Mr. Lancaster shot was found to weigh twenty-five pounds (twelve pounds being foreign matter, mainly fish in its gullet), to measure 9ft. from tip to tip of the wings, which presented about as many square feet of surface to the air. There is no publisher's address to the tractate we have thus noticed; but as the matter in-

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terests many, we may say that Mr. Lancaster's address is 335, Wabash-avenue, Chicago, U.S.A., and that the work contains several diagrams which help to elucidate the subject.

# THE INTERNATIONAL INVENTIONS EXHIBITION.—XV.

## Paper, Printing, Bookbinding, Stationery, &c.

ALTHOUGH the group which bears this title (26) is, from the public point of view, one of the most attractive, it must be confessed that it is rather "mixed," while no one of the trades can be said to be adequately represented. So far as paper is concerned, beyond samples of wood pulp and a rag engine or two, the manufacture of that invaluable article is not illustrated at all. The most interesting exhibits in connection with it are the samples showing the stages through which wood passes in becoming a pulp suitable for the papermaker. It is about 25 years ago since Voelter succeeded in perfecting a process of disintegrating wood, by grinding it in the green state with abundance of water; but recently great improvements have been introduced, and now wood pulp enters largely into the manufacture of the cheaper and coarser kinds of paper. Mechanical means have been supplemented or superseded by chemical methods, and by removing the lignine which binds the individual cells together the cellulose is obtained in an isolated form, and is nearly as good as the product obtained from esparto fibre, while it lends itself readily to the bleaching processes. The cellulose thus obtained is perhaps less suitable for papermaking than for other purposes, as it becomes more brittle and less tough; but the exhibits of samples of the cellulose and of paper made from it, with the addition of more or less rag pulp or other binding material, show conclusively to what a high degree of perfection the manufacture has attained in a quarter of a century. So far as printing is concerned, it is principally in connection with the machines for working off impressions from the type formes that the group can be said to be an exhibit of printing processes, and even in that case it is only certain special machines that are to be seen. It would have been highly interesting, for instance, to have had the machine at work which, according to the preface written by Dr. Hugo Müller, F.R.S., was made in 1859, for the *Standard*, and was capable of producing 20,000 copies per hour! It would also have been more interesting to have had at least one of those type-setting machines which have been "simplified and perfected," for so far as we have been able to discover only one of them has been placed in the East Gallery for public inspection and criticism. Entering this gallery by the south door we find an interesting and attractive exhibit by the proprietors of the *Graphic*. Around the walls are a number of pictures; but surrounding the machine, which is exhibited at work printing coloured plates for their paper, is a table on which are displayed the various processes of producing illustrations. The effect produced by ten workings of different colours is shown by means of a proof from each plate side by side with one exhibiting the state of the picture after each impression. Mr. E. Badoureau contributes cases of wood-engraving tools, a log of boxwood, pieces of the same cut up, and various sized woodblocks for the *Graphic*, showing the manner of piecing together (in two styles) to make up the large blocks required by our contemporary. Then there is a photograph on wood, an artist's drawing on wood, and a finished block, while alongside is a mould in wax, an electrotype shell, and a mounted electrotype. Altogether the *Graphic* exhibit is one of the most interesting in the whole group so far as the public are concerned. Mr. W. J. Ingram (*The Illustrated London News*) is entered in the second edition of the catalogue as exhibiting a four-colour rotary machine; but the exhibit is really a two-feeder Bremner machine at work printing portions of the forthcoming issues of the paper. It is probably as good a machine of the type for printing "cuts" as can be found, for the cylinder reverses its action with the movements of the table, and the arrangements for obtaining impression and for distributing the ink are practically perfect. Mr. F. R. Daldy, City-road, E.C., shows Smyth's thread sewing machine, and the same inventor's machine for sawing the grooves in the backs of books into which the tapes or cords enter. The sewing machine is said to be capable of working at the rate of 18,000 sheets per day. Bookbinders and others interested should compare this machine with those shown by A. Brehmer, of Moor-lane, E.C., at whose stand a wire staple machine is exhibited, though not at work. In these machines short bits of wire are driven through the backs of the sheets, and the ends are bent over. The method has been adopted by some publishers for binding their books, and it has the merit that there is no likelihood of the wire staple coming out. At Stand 1976 Messrs. Virtue and Co. exhibit the process of printing from copper plates, in the shape of etchings for the *Art Journal*. In this case the copper-plate is faced with iron by the aciertype process, to give greater durability, for in this method of printing great pressure is required. The engraved portions of the plate are smeared over with a thick ink, which is well worked into the etched lines, and every portion of it except that retained by the lines is carefully removed by sundry manipulations, the final operation leaving the plate with a highly-polished, almost chemically clean, surface. The plate with a sheet of paper over it is then drawn through the press, which consists of a couple of cylinders, and the paper being thus forced into contact with the ink, pulls the latter out of the lines in which it has been buried. The process is necessarily a slow one, about 80 prints being a good day's work. Henderson, Rait, and Spalding, of Marylebone-lane, have an interesting historical exhibit in the shape of the methods adopted for printing music, including the punches, matrices, and rules used in the Scheurman process, and the blocks and rules of the Cowper process, in which the notes were printed from raised types on ruled paper. They also show the modern method, in which the music is punched into a pewter plate, and an impression is taken and transferred to stone, the printing being accomplished by the ordinary lithographic process. It is impossible in the space at our disposal to notice the various printing machines, both letterpress and lithographic, and it would be useless to attempt to point out their chief features and differences without illustrations; but printers will certainly be interested in the self-delivering, self-registering, gripper platen machine of Mr. A. Godfrey, North Reddish, No. 1981. In this machine the platen and the forme or type surface are both perpendicular to the base of the machine throughout the movement, the platen sliding backwards and forwards in horizontal guides. The ink-table is semicircular, with a run of 32in., and a rocking "doctor" delivers the ink at the fore edge just as the distributing and inking rollers come up from the face of the forme, whence they run over the table, underneath, and pass between the forme and the platen as soon as the latter has receded far enough. No skill is needed in feeding, as the sheets are laid on a fixed sloping board, are adjusted by automatic lays, and seized by grippers which take them underneath and bring them up in front of the advancing platen, the gripper frame revolving around the frame carrying the platen by a quarter rotation at each impression. The printed sheet is taken from the grippers by one of the now well-known self-delivering arrangements. The speed is 2,500 per hour, or about three times that of the ordinary platen machine. Slurring is impossible, and the type is not injured even when only a few letters are required to be printed in the corner of a sheet. Messrs. Greenwood and Batley, Leeds, exhibit their patent continuous web platen machine, in which the paper passes from the roll, up between the platen and the forme, where it is momentarily stopped for the impression to be made. These machines will commend themselves to jobbing printers, and are not without interest to the mechanic. Mr. W. C. Horne, of Aldermanbury Postern, shows a patent duplex folding machine at work on a sixteen page paper. The sheet is laid on the table and is drawn by grippers under the falling knife blade, which takes it through the slit in the table, when it is again folded by another blade at right angles to the first, which carries the sheet to the final folder, when it is passed out to a shoot which tips it over to the heap. At the adjoining stand, Mr. J. J. Ayling, of Crane-court, exhibits the process of zincography from the photographic negative to the finished block. The drawing is transferred by photographic or other means to the zinc plate, the lines being in a bituminous ink, which is not attacked by the acid. The plate is then immersed in an acid bath, and as soon as a portion of the unprotected surface is eaten away it is again "inked up" or treated with a composition which prevents the acid from eating underneath the lines of the drawing. Plates are shown in ten different stages, exhibiting the effects of the acid at each step. Waterlow and Sons, at stand 2026 also exhibit blocks for printing purposes produced by various processes, and have several Woodbury-type printing presses at work. They also show in action a railway ticket printing machine, which numbers the tickets consecutively at one or both ends, and turns them out at the rate of 10,000 an hour. A machine for counting the tickets is at work as well, and forms the complement to the printing machine. Connected with printing, and especially important to those requiring rapid production, are ink rollers, for the speed of the modern machines is practically limited by the capability of the rollers to withstand the work they are called upon to do. The Durable Printers' Roller Co., of Shoe-lane, exhibit a collection of their exhibits, and a roller which has been at work for six months. The composition, though nearly as soft as the ordinary glue-and-treacle mixture, is very tough, as is that also shown by the Messrs. Harrild, of Farringdon-street, E.C., who have a fine exhibit of Bremner machines—fine-art, letterpress, and chromo-litho. Messrs. Richardson, Koolman, and Isger, of St. Bride-street, E.C., show what can be done with the electrotyping process nowadays, for they exhibit their fine-art moulding composition, an electro of a well-known picture issued by the *Graphic*, which contains 1,000 square inches without a join, curved electros for rotary machines, and Lanham's patent lace-printing electros, in which the mould being taken from the article, the printed representation must be exact. This method is also applied to leather and other articles in the production of rollers to impart the "grain" to artificial manufactures. Mr. Alexander Fraser (Neill and Co., Edinburgh) exhibits his type composing and distributing machine, and, singularly enough, books printed by its aid, as if the type had a different appearance when "set up" by machine. The apparatus resembles to a certain extent Kastenbein's, in which the types slide down grooves all leading to a common point of emergence; but in the Fraser machine the types are arranged in grooves at the top, and are pushed forward by metal fingers actuated by cords attached to the selecting apparatus. The keyboard consists of a number of plungers marked on the top with the letter or sign carried by the type controlled by the plunger, and the method of operating is to strike a rather smart blow with the middle finger of the right hand on the plungers, while another plunger is depressed by the left hand. The distributing machine has also a keyboard with plungers, and a plate containing a number of grooves down which the types slide; but as it is necessary for the operator to read the type and then touch the required plungers, it is doubtful whether there is much economy even in operating the machine. As is well known, however, there are several reasons why type-composing machines have never made much progress, the most important of which are that when the cost of the machine is taken into consideration and the expense of the repairs, together with the wear and tear of type sliding in brass grooves, the "economy" gradually becomes smaller by large degrees. Then, as a climax, for newspaper work, at all events, the operator must be fairly intelligent, capable of reading manuscript, and of equable temper, for at times the machines are very trying. It may be that Mr. Fraser's invention avoids all the well-known disadvantages; but, from what we have seen of its performances, we are not inclined to think that at last machines will be as numerous in the composing-room as cases. From type-composing machines it is an easy step to type-casting machines, and at the stand of Mr. O. Titchener (2,033), of Wilmington-street, E.C., we can see the latest improvements. The matrix and the mould are carried in a swing frame, which, when at work, abuts against the nozzle of the melting pot. A plunger in the latter forces the metal into the mould and an automatic arrangement knocks off the break or tail (a superfluous piece of metal at the bottom of the type) and ejects that on one side, while the types themselves are sent into a shoot on the other. The types thus cast have perfectly square edges, and only require setting up on their faces and their lower ends levelled to finish them. Two processes in the old style are thus avoided, viz., the removal of the break by hand and rubbing to take off burrs or rough edges. Titchener's patent delivery apparatus frees the matrix (the part containing the punched letter) from the mould (the part which forms the sides and body of the type) horizontally, instead of at an angle, thus preventing the tearing up of the face. The "small work" machines cast all sizes generally used in book and newspaper work, and if steam power is used one machine casts at the rate of from 3,000 to 4,000 per hour. Type-writers are exhibited in several forms, and there are sundry processes of the Trypograph pattern for multiplying copies of letters; while in the exhibits, which we suppose are classed under the head of stationery, there is quite a miscellaneous collection, from an improved envelope and a postage-stamp affixer to an adjustable portable tent! Visitors, however, will be interested in the paper-hanging printing machine exhibited at work by Osborn and Shearman, of King's-road, S.W., while many will be attracted by the ingenious envelope-folding machine of Mr. W. H. Hook, East Dulwich, S.E., which has movable boxes for adapting the machine to various sizes and shapes, and is capable of working up to 3,000 an hour. The apparatus employed in making rubber stamps—that is, the presses—are shown by one or two exhibitors, and there are some recent "improvements" in pens, penholders, drawing-boards, artists' brushes, and easels; but they help rather to fill up space than to add to the importance of the exhibition.

## ELECTRICAL INSTRUMENT MAKING FOR AMATEURS.—I.*

By S. R. Bottone.

THE amateur, especially if he be young, inexperienced, and unblest with "filthy lucre," must ever command our sympathy and respect. He, without any hope of reward, except that gratification which follows the acquirement of knowledge, works on, under the greatest difficulties, to the attainment of his end—an end which, in nine cases out of ten, tends directly to the benefit of his fellow-creatures.

Nearly all the really useful inventions and discoveries, which have rendered the 19th century so remarkable as a season of progress, must be attributed to amateurs. For this reason, if for no other, we should render every assistance in our power to the *bonâ-fide* amateur, and for this reason, along with another, have I attempted, in the following pages, to guide the tyro in his attempts at the construction of the more useful pieces of electrical apparatus. The other reason is that "a fellow-feeling makes us wondrous kind," and as I myself have felt acutely the need of assistance at the beginning of my amateur-scientific career, so I am pleased to suggest when and how much trouble may be saved, and expense spared by the adoption of certain simple modes of procedure.

§ 1. *Tools.*—The true amateur, as a rule, has not a large assortment of tools. Little by little he gets together, or constructs, those which are absolutely necessary for his purpose; but he seldom aspires to the complete paraphernalia of a workshop. Still, there are certain tools that are indispensable, of which the following is a list in order of utility:—

1 Large pocket-knife.
1 Fine penknife.
1 Archimedean drill and bits.
Pair of cutting pliers.
Pair of large scissors for metal.
Pair of small scissors.
Several files, large and small.
1 Hammer.
1 Mallet.
Bradawl, gimlet, pincers.
Small bench vice.
Small tenon saw.
Soldering iron.
Spirit lamp.
1 Wheel glass cutter or diamond.
Pair of compasses.
2ft. rule.

I should like to have put a lathe at the head of this list, for that is really the king of tools; but I would not deter the student from making electrical apparatus because he has not a lathe, as most may be made well without one, though better with.

Besides tools, the materials mentioned below will be found useful. They need not be procured all at once, but as occasion demands. If the amateur adopts the plan of keeping up a little stock of his materials and tools, as they are worn out or consumed, and more especially if he remembers that, "Order is Nature's first law," and that there should be "a place for everything, and everything in its place," he will turn out better work, keep his temper, and work better than if he allows himself to degenerate into a slip-shod style of doing things. Let him never say "that'll do" to anything capable of improvement.

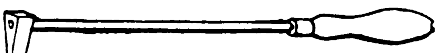
§ 2. *Materials.*—The following will be found useful in carrying out the instructions given in the ensuing pages:—

Glass rods from ⅛ to ½in. in diameter.
Ebonite rods from ⅛ to ½in. in diameter.
Glass tubes from ⅛ to ½in. in diameter.
Guttapercha.
Glass bottles, preferably green glass.
Sheets of glass; every piece is useful.
Bottoms of broken wine-glasses as stands, &c.
Tinfoil.
Sheet zinc and sheets of tinned iron.*
Sheet copper.
Sheet brass, and brass rod, ⅛in. diameter.
Solder.
Chloride of zinc.
Rosin.
Needles.
Watch springs.
White hard varnish.
Red lead.
Benzoline.
Burnt umber.
Copper wire of various sizes.†
Prout's elastic glue.
Methylated spirits of wine.

Having these materials at hand, the amateur will find that several operations are required so frequently as to render a certain amount of technical skill absolutely necessary if the work is to look neat and act satisfactorily. Among the first of the amateur's requirements must be placed the power of soldering.

§ 3. *Soldering.*—For small work, an iron, shaped as shown at Fig. 1, will be found extremely useful. The amateur can easily construct this for himself by boring a $\frac{3}{16}$ hole in a copper wedge 2in. long by ½in. thick, and ½in. wide on the base. An iron rod, 15in. long, is straightened out for the handle, and the end of this rod is heated in the fire and hammered up until it can be thrust through the hole in the upper rod; what projects is then hammered down so as to form a kind of boss or rivet head, to prevent the copper bit from moving. The other end of the rod may then be filed or hammered to a point, and driven into a wooden handle. Five inches of broom-handle will answer the purpose, if nothing better can be got at.

FIG. 1.



In order to solder successfully, four things are essential. Firstly, the portions to be soldered must be made scrupulously clean, either by scraping with a piece of sharp knife blade (kept specially for this purpose), or by sandpapering, or by filing, whichever is most convenient. Secondly, the portions to be soldered must be raised nearly to the temperature of the melted solder. For this reason the amateur would surely fail were he to attempt to make a good joint, say, between two sad irons with an ordinary soldering bit, unless he previously heated the irons to nearly the melting point of solder. In ordinary small work, where wires are soldered to wires, sheets to sheets, &c., the heat of the soldering-iron itself is generally sufficient, not only to melt the solder, but also to raise the temperature of the surrounding portions to be joined to the requisite point. Thirdly, the nose of the soldering iron must be perfectly clean, and covered with melted solder, or, as it is technically called "tinned."

To insure this result the soldering iron must be placed in a clear red fire until nearly red-hot (if allowed to get too hot it will not take up the solder at all), then quickly and lightly filed on one face, and *at once* plunged into a rod of soft solder, on which a little powdered rosin has been placed. The heat of the soldering iron will cause the solder to melt, and run into globules. If one of these be allowed to run into the lid of a milk-tin, or other convenient tinned iron receptacle in which a little powdered rosin is also placed, and the *filed* face of the soldering iron rubbed briskly over the melted solder, the surface of the copper bit will be found to have taken a coating of solder as brilliant as a looking-glass. Should this not be the case, the iron must again be heated and filed and rubbed over the solder until a perfect coating has been obtained.

When once the nose of the copper-bit is well "tinned," it is sufficient after each heating (provided it has not been overheated so as to burn off the solder) to rub the iron iron briskly on a piece of old carpet, kept especially for this purpose, just before touching the solder. Fourthly, the surfaces to be united must be kept perfectly clean and unoxidised during the application of the heat necessary for soldering by the application of some substance which prevents the access of air, &c., to the heated surfaces.

These substances are various, and some are more adapted to one metal than to another. Thus rosin is excellent for tinned iron and for copper. Hydrochloric acid (spirits of salt) is perhaps the best for zinc. Chloride of zinc (killed spirits of salt), again, is excellent for iron, for copper, and for brass, where the surfaces can afterwards be well washed.

A lump of sal-ammoniac (chloride of ammonia) is also very useful for removing the oxidation from the copper bit by rubbing it against the lump for a few seconds, after heating.

§ 4. As an example of the mode of proceeding, let us suppose we wish to solder a wire to the copper plate of a Daniell battery. We begin by cleaning the copper plate at the spot to which we wish to attach the wire by rubbing it with a piece of glass or sand paper until the surface is as brilliant as a mirror. In like manner we polish and clean the end of the copper wire. Laying the copper plate flat on the board which we keep expressly for soldering on, we place the copper wire on the desired spot.

We now put the soldering iron in the fire* (it having been previously tinned, as above described), and watch it until it shows by the melting of the solder on the surface that it is hot enough. We then remove it from the fire, give a rub on the sal-ammoniac or piece of carpet, then take up a globule of solder by touching one with the cleaned nose of the bit, and, lastly, having quickly touched the surfaces both of the copper plate and wire with a feather dipped into the chloride of zinc solution, rub the surface of the plate and wire simultaneously with the soldering iron. As soon as the surfaces become sufficiently heated, the solder will be seen to flow over them. The wire must then be pressed into its desired place, the melted solder rubbed well over the point of junction, the iron removed, while the wire is held motionless in its position until a sudden dulling of the surface of the solder shows that it has set and is solid enough to hold the parts together. After soldering with chloride of zinc ("killed spirits," "soldering fluid"), always wash in plenty of water, to prevent rusting.

(*To be continued.*)

## COX-WALKER'S ELECTRIC TELL-TALE, &c.

AT their stand in the Inventions Exhibition, No. 1362, amongst other exhibits, Messrs. Harrison, Cox-Walker, and Co., of Darlington, have an electric tell-tale, a smaller fac-simile of which has been well tested for about three years in the East Riding Asylum, York, and has been recommended in one of the "blue books" of the Commissioners in Lunacy—a recommendation which led to its adoption in several other institutions of a similar character. The instrument shown at the Exhibition is for 30 stations, and consists of a clock driving a long cylinder around which the prepared record paper is fixed. On each side of this cylinder and slightly above it are electro-magnets, the armatures of which carry little brushes with reservoirs of ink. The frames carrying the magnets swing into position over the cylinder, and are separated when it is desired to read the record or remove it. Each magnet communicates with a circuit-maker placed in some part of the building or works, and the watchman is provided with a key which he inserts into the circuit-maker and turns. A current is thus sent to the corresponding magnet, which attracts its armature, and the pencil attached to that makes a mark on the paper cylinder, which is so ruled that the exact time can be read when a given station was visited, when it was left, and the time occupied in going to the next station. The tell-tale itself is kept in a glass case, and is placed where it cannot be tampered with, while the sheets of paper as they are daily removed can be dated and filed for reference if necessary in the future. Watchmen and others whose duty it may be to make the records have an advantage in connection with this electric tell-tale that they are not obliged to be at any given station at a fixed time to record their presence. They can make the circuit at any of the stations, and the time and place are accurately indicated. Another useful appliance is a double electric semaphore for pit shafts, hoists, or other places where it is important that a definite and indisputable signal shall be given from two stations before the machinery is put into motion. This semaphore has two arms, one being worked from one station, and the other from a different station ; but the bell will ring only when both arms have been thrown up. Both arms fall automatically when the engine or cage starts. The mining and railway-signal bells for long distances exhibited deserve attention. One with a dome 12in. in diameter is fitted with a relay, and the bell magnet is actuated by a local battery brought into action by the relay. The extra-current spark is taken by a light contact spring, so that the platinum contact is preserved ; and the tapper is fitted with a spring which slides over the contact-piece, and by the slight friction at each tap effectually cleans the parts.

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* All rights reserved.

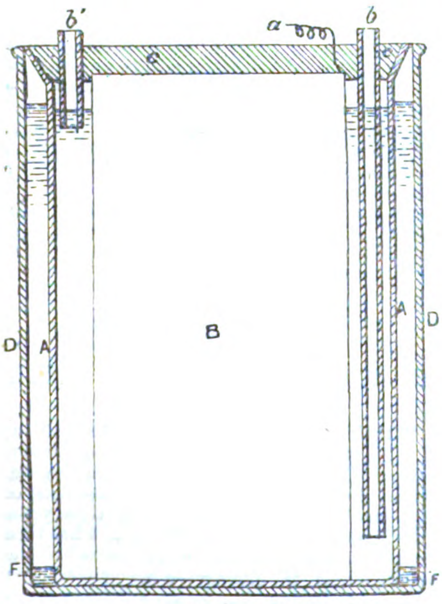
* Clean beef tins, sardine tins, &c., may be worked up very well and economically.

† This had better be procured as required.

* Care must be taken that the fire is emitting no sulphurous smoke, otherwise the iron will surely *not* take up the solder.

## SKRIVANOW'S IMPROVED VOLTAIC CELL.

AN improvement on the Skrivanow cell has been recently patented in this country by Mr. P. G. Skrivanow, of Paris, whose aim has been to devise a cell which will give a powerful current, and yet occupy only a small space. His improved battery is of the class in which two liquids are employed, and is constructed to present a multiplicity and large area of acting surfaces without a corresponding increase of bulk. The battery cell, shown in vertical section in the figure, is provided with flat or narrow vessels, or cells, A of porous material, the walls of the vessels being made as thin as possible, and as near to each other as is practicable to leave sufficient space for the liquid, and thin plates B of platinum or carbon, forming electrodes, are placed one in each of these vessels A, and are connected with the external circuit by wires *a*. The upper parts of the porous vessels are sealed preferably with paraffin wax at *c*, and two tubes *b* $b^1$ (which may be of glass) are passed through this sealing, the tube *b* descending to within a short distance from the bottom of the vessel, and being employed for introducing the liquid into the vessel. The tube $b^1$ is shorter, and is provided for the escape of air and gases from the interior of the vessel. The elements thus constituted occupy very little space laterally, and are arranged side by side as closely as possible in a trough or vessel D, constructed of gutta-percha, ebonite, porcelain, wood, or other suitable material. The other elements are formed of thin plates of zinc E, placed in the trough D, being arranged alternately with the porous vessels A, and elements B. The said plates of zinc can be most conveniently connected together electrically at their lower edges by being placed in contact with mercury F, contained in the bottom of the trough or vessel D, or by any other equivalent connection. This mercury or contact is also connected to the negative pole by a plate *d*, preferably of platinum soldered to a wire *e*, leading to the external circuit. Nitric acid is introduced through the tubes *b* into the porous vessels A, and sulphate of zinc (preferably as pure as possible) is placed in the trough or vessel D. The arrangement as described presents a large surface of the electrodes or plates to the action of the liquids or electrolytes, and the porous vessels A being made as flat or narrow and thin as possible, enable a large number of plates or electrodes to be packed or contained in a small compass.



## LIPPMANN'S APPARATUS FOR ELECTRIC MEASUREMENTS.

THE following description of Lippmann's apparatus for electrical measurements is given by M. Hospitalier in *La Nature* :—

Measurements of the intensity of electric currents is daily becoming an affair of more and more importance. Although there exists a large number of apparatus designed for this purpose, very few of them present all the qualities that are required for their practical employment. Most of these apparatus are based upon purely galvanometric actions. The type of the genus is the well-known apparatus of Marcel Deprez, in which a soft iron needle is placed in the intense magnetic field formed by the two branches of a U-shaped magnet. The current to be measured traverses a bobbin and develops a magnetic field whose lines of force are directed at right angles with those of the magnet. Under the action of these two fields the needle assumes an intermediate position that depends upon the intensity of the magnet's magnetisation and the form of its polar pieces, upon the form and dimensions of the needle, upon the form, dimensions, and number of coils of the bobbins, and upon the intensity of the current. There is, then, *à priori*, no simple relation between the deflections and the corresponding intensities, and it is only by artifices of construction that we succeed in obtaining a perceptible proportionality between these upon a certain fraction of the scale. In reality, each apparatus requires a particular graduation and a determination of a certain number of points, whence are deduced the rest through interpolation. Lippmann's galvanometers, or ampèremeters, present the peculiarity that their indications are indefinitely proportional on the entire length of the scale, and that it is only necessary to know the indication furnished by a given intensity in order to at once deduce therefrom all the rest. The new principles applied by Mr. Lippmann in his apparatus consists in balancing the electro-magnetic action of the current to be measured by a hydrostatic stress which, at every instant, is proportional to the intensity of the current. It suffices to know one in order to at once know the other.

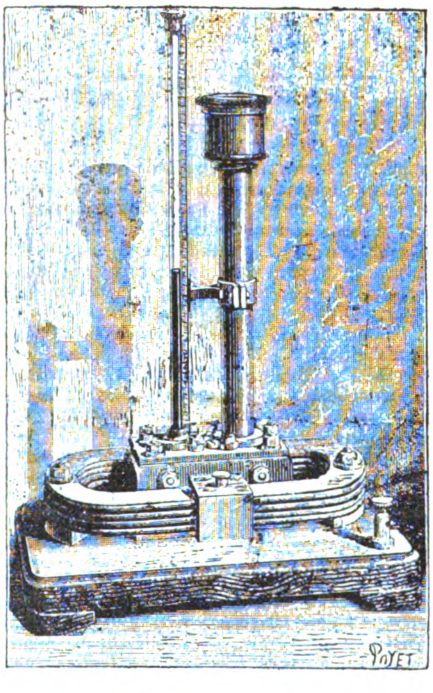
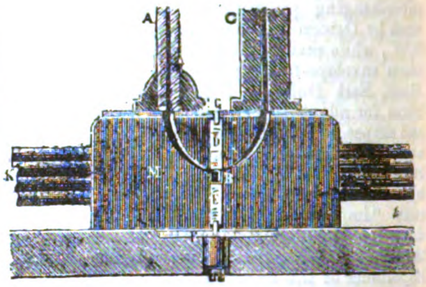
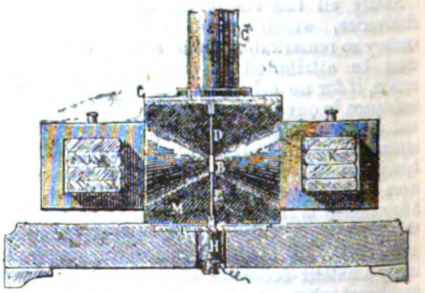


Fig. 1 gives a general view of Mr. Lippmann's ampèremeter, and Figs. 2 and 3 are longitudinal and transverse sections which exhibit its principle and mode of operation. A mercurial pressure gauge, A B C (Fig. 2), is placed between the branches of a permanent magnet in such a way that the two poles are on each side of the horizontal leg of the gauge. Pieces of iron, with ends in the form of truncated cones, serve as armatures to the magnets, and permit of concentrating the field at B, so as to render it as intense as possible at this point. The current to be measured is led to the mercury from the horizontal leg of the gauge, and traverses it vertically. It comes in through the strip of platinum, D, and makes its exit through the second strip, E. That portion of the mercurial column which is traversed by the current represents a movable current element, which, placed in the magnetic field constituted by the magnets, K, tends to move towards the right or the left. The stress exerted upon this current element is proportional to its intensity, and it therefore produces a hydrostatic action, which exhibits itself in a change of level of the mercury, which latter rises in one of the legs of the gauge until the hydrostatic pressure balances the electro-magnetic stress.





The theory of the apparatus shows that its sensitiveness is proportional to the intensity of the field, and inversely proportional to the thickness of the column of mercury. It is in order to obtain great sensitiveness that the chamber, B, is very thin, and that the field is concentrated at this point by polar appendages of conical form. In order that the reading of differences in level may be dispensed with, there is arranged upon one of the legs a reservoir of wide surface in such a way that the level in this leg shall remain constant, whatever be the change in the other leg, which is of glass of small section. The constant level leg is given a certain height in order that all the readings may be made, whatever be the direction of the current. In practice, it is convenient to so arrange the magnets that a current ascending in the horizontal leg of the gauge shall produce an ascent of the mercury in the glass leg, and a descending current produce a depression of the mercury's level. When still greater sensitiveness is desired, it suffices to incline the glass tube slightly, when a slight change of level will produce a considerable movement in the column of mercury. M. Lippmann's ampèremeter is aperiodic, in that it reaches its position of equilibrium slowly, and stops there without going beyond it. And it is reversible, too—that is to say, if the mercury be set in motion by means of an external mechanical force, and the two strips, D and E, be united by a circuit, the latter will be traversed by a continuous circuit that will last as long as the flow of the mercury does.

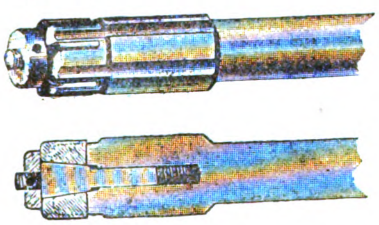
It is a true unipolar machine, that might perhaps some day be applied either as a mechanical generator of electricity, which should give little electro-motive force, but considerable intensity, on account of its feeble internal resistance, or as a standard of constant electro-motive force, in assuring of a constant flow, and a constant magnetic field that the unipolar machine would itself produce. The principle of this apparatus has been applied by its inventor to several other apparatus, and, in particular, to an electro-dynamometer and a wattmeter, which figured at the Exhibition of Electricity at the Paris Observatory last March, in the interesting collection of measures presented by Breguet. In the electro-dynamometer, a bobbin traversed by the current to be measured is substituted for the permanent magnet. Under such circumstances the magnetic field is no longer constant, but is proportional to the intensity. The result is that the changes of level in the mercury are proportional to the square of the intensity.

In the wattmeter a long, very fine-wired, and resistant bobbin is substituted for the coarse wire one, and is placed between those two points of the circuit at which it is desired to measure the expenditure of electric energy, while the mercury is, as usual, placed in the total circuit traversed by the current of intensity, I. The fine wire bobbin, mounted in derived circuit, produces a magnetic field that is at every instant proportional to the difference of potential, E, of the two points where it is fixed. The changes of level in the mercury are consequently proportional at every instant to the product E I; that is to say, proportional at every instant to the number of watts expended in the part of the circuit considered.

Aside from the originality of the principle of M. Lippmann's apparatus, they all present the valuable feature of furnishing indications which are accurately proportional to the extents to be measured, and this obliges us to use them in a large number of cases in which we could not rely upon measuring by points, a method in which so many causes of error intervene to destroy accuracy.

## BROWN'S EXPANDING MACHINE REAMER.

THE accompanying illustrations represent a new expanding machine reamer, for use where the



maintenance of standard or special sizes is essential. It is an American device, and is made by Mr. Pruyne, of Syracuse, New York. The cutters are made of the best tool steel, and are nicely fitted into unequally-spaced radial slots, cut through the end of the reamer, and bed on the conical head of a plug screwed into the head of the reamer. They are held in position more firmly by a nut on the projecting end of the plug. When it is desired to expand the reamer, this nut is backed off and the plug screwed in, forcing the cutters out the desired amount. The tool is not designed as an adjustable reamer in the strictest sense of the word, but as a standard reamer with a compensation for wear. The body is ground slightly under standard size to insure clearance, and the cutters must be expanded and maintained to that size, doing away with the objection to an adjustable reamer, that when adjusted above or below a standard size, in some special case, it is not returned to the original or standard size by the workman.

## STABILITY AND SPEED OF VESSELS.

(*Concluded from p.* 493.)

### A Problem in Mechanics.

TO explain the action of these forces, let Fig. 1 represent the cross section of a yacht in which A, B, C is the immersed portion of the midship section when at rest on an even keel. Let the centre of gravity of the entire vessel be at G, in the section taken. Let the centre of volume of the submerged portion in the inclined position indicated be at H, which point is the centre of buoyancy, and the centre of gravity of the displaced water. It is the point through which in the position assumed the upward thrust or resistance of the water acts. This point, of course, may or may not be in the cross section taken containing G, but it may be there, and it will simplify the discussion without in any way affecting the results to assume such a position of the yacht as would bring G and H into the same midship section.

Now, it is apparent that when the yacht is careened as shown in the figure, its entire weight still acts downward through G, while the resistance opposed by the displaced water acts vertically upward through H.

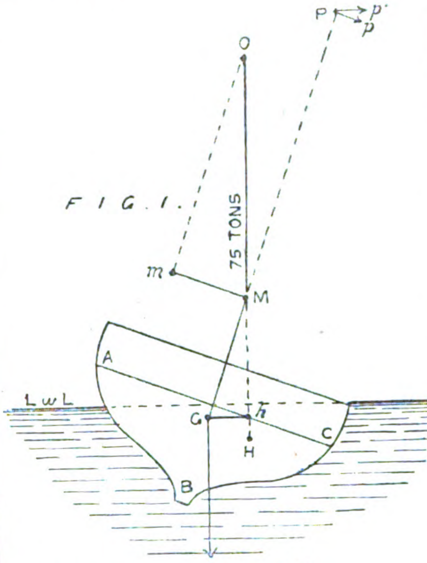


FIG. 1.

$$\begin{aligned} M\,m \times M\,g = {} & P\,p \times P\,G \\ & M\,O \times G\,h \\ & = 187 \text{ tons} \\ & = 375{,}000\text{lb.} \\ \frac{375{,}000}{27} = {} & 13{,}888 = P\,p \\ & = 6{\cdot}1 \text{ tons.} \end{aligned}$$

These two forces produce a tendency to rotation as a result of their combined and simultaneous action, one pulling down through G, the other pushing up at H, and both acting on the rigid form of the boat. The effect of the two, since they are equal in intensity, is to produce a tendency to rotation about a point midway between them, and by which the vessel seeks to regain a position of equilibrium on an even keel, and manifestly requires the action of a third or exterior force to hold it in the inclined or careened position.

From a simple principle of mechanics we know that this tendency in the boat to return to the vertical position is measured by what is known as the "moment of rotation of the couple," which is equal to the product obtained by multiplying either force of the couple by the perpendicular distance between them.

Considering the vessel free in the water, it can be shown that for slight changes of position, such as arise in practice, the vessel will careen by turning about its centre of gravity, G, which will always retain its position with reference to the load-water plane, or plane of flotation, unchanged.

The tendency to return to the vertical from the careened position may therefore be put in a somewhat simpler form for our use, for, in view of the principle first stated, the moment of the couple becomes equal to the product of the force acting upward through H, which is the displacement, or, what is the same thing, the entire weight of the vessel (so many tons or pounds) multiplied by the horizontal distance between G and H; or in other words, the tendency to return is measured by the force acting upward through H, and with *a* lever arm equal to the horizontal distance from G to H, indicated in the figure by the line, G *h*. Now the force acting downward through G may be neglected.

The question of stability consists in determining the value of this force acting with the various lengths of "lever arm" that may arise, and ascertaining for given lengths how great an external careening force in the form of wind acting abeam it is calculated to resist.

The line, G P, through the centre of gravity of the vessel, and which is vertical when the vessel is at rest on an even keel, is called "a line of rest"; it is the line along which the weight of the vessel and the upward thrust of the displaced water act in opposite directions, and hold each other in equilibrium, when the vessel is in that position (vertical) and subject to no external force. The moment the vessel careens, the "centre of buoyancy," H, through which the buoyant effect of the water acts, moves out of this vertical line to the right or left, the two forces no longer oppose each other directly in the same straight line, but their points of application become separated while their directions remain parallel, and a "couple" results. This new vertical through H, along which the buoyant effect acts, is called "a line of support," because it is the line along which the water supports the weight of the vessel partly submerged in it.

As the point, H. is the point at which the buoyant effort of the water acts, it must be the centre of volume (or bulk) of the displaced water; and the position of this point depends evidently upon the shape and configuration of the submerged portion of the vessel, and it is clear that as the vessel whose cross section is given in the figure careens more and more to the right, it submerges more and more of its hull to the right of the line of rest (or plane of symmetry), G P, and takes more and more of its bulk out of the water to the left of that line (or plane). It is, therefore, apparent that the centre of volume of the submerged part, or the point, H, must travel more and more to the right as the vessel careens, and thus increase the distance, G *h*, as the vessel continues to turn over. Now the point, M, in which the line of support, H M, cuts the line of rest, P G, is called the "metacentre" of the vessel. Its position in the vessel is important, for it will be seen from an inspection of the figure that the vessel cannot capsize, but will have a tendency to return to the upright position so long as the metacentre is above the point, G, the centre of gravity.

This results from the fact that the metacentre, M, may be regarded as the point through which the upward thrust of the displaced water (acting first through H) is brought to bear upon the line G P, where the careening force is applied (say at P). In other words, G M may be regarded as the lever arm with which the buoyant effort seeks to right the vessel, acting through M at right angles to G P, and with the intensity M *m*; that component of the "buoyant effort" which acts at right angles to G P and in opposition to the careening force at P, indicated by P *p*. It is, therefore, evident that the higher M, the metacentre, is above G, the greater will be the lever arm, M G, and the greater the advantage with which the buoyant effort seeks to right the vessel. It is for this reason that the height, M, of the metacentre above the load-water plane (or plane of flotation) is considered an important factor in yacht construction.

Let us now suppose the action of a third or external force brought to bear at some point, as P, on the line of rest, and acting in the direction, P *p'* (horizontal), and whose tendency is exerted to careen the boat to the right.

Under its action the boat will turn about the point, G, its centre of gravity, and it is evident, from a consideration of the figure, that this external force, whose intensity is indicated by the length of the line P *p'*, acts with its entire value to careen the boat only when the line of rest, G P, is vertical, for as the vessel careens under the action of this force, its effective component, P *p*, perpendicular to P G, becomes constantly smaller in proportion as the careening angle, P G R, increases; and at the same time, while the actual careening force P *p*, the perpendicular component of P *p'*, is becoming less and less as the vessel careens the point H is going further and further from G; the metacentre M further and further up the line of rest P *b'*, thus increasing the lever arm of the buoyant effort and at the same time increasing its effective component, M *m*, which resists P *p*. It is therefore apparent that an angle will soon be reached at which the buoyant effort, acting upward through H and transmitted to M (and there, we will say, acting at right angles to P G in the direction M *m*), will hold the careening force acting through P in the direction P *p* in equilibrium, and the boat will come to rest in an inclined position of equilibrium, and cease to careen. This position will be readily recognised by those familiar with sailing.

The graphical construction of these forces is simple, and will perhaps add clearness to the demonstration.

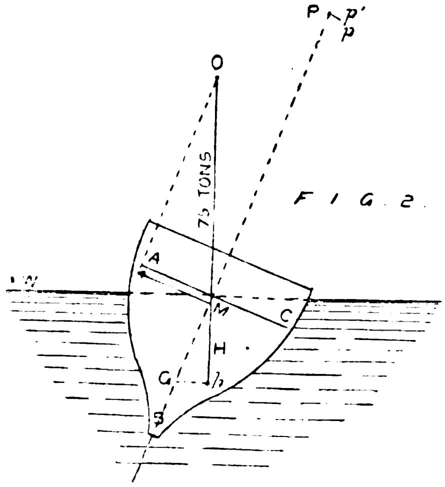
Prolong H M to O, assume a scale of equal parts in which a unit of length shall represent a given number of units of force, say five tons to the ¼in. (or any convenient scale), make M O equal to the upward thrust through H so many tons (the displacement of the vessel expressed in units of length). Resolve M O into its components by means of the parallelogram of forces acting in the direction G P and at right angles to that line. M *m* will be this component; so many tons or pounds acting in the direction M *m* through the point M with the lever arm M G, and urging the boat to the left about the point G.

The force P *p'* acting as P is the force of the wind on the entire sail area, so many pounds per square foot (depending on the velocity of the wind) for so many square feet. This entire force is laid off on P *p'* with the same scale of equal parts indicating so much force to the unit of length. P *p'* is then resolved in like manner into its components acting along G P and at right angles to it. P $p$ is the remaining effective component of P $p'$ that acts at P to turn the boat about G to the right, in opposition to M $m$ acting at M to the left. The greater force has necessarily the shorter lever arm, the lesser force the longer; both have the point G as a centre of action. From the expressed conditions we must therefore have:

$$P p \times P G = M m \times M G \qquad \text{(Eq. 1.)}$$

In a position of equilibrium the two rectangles having M $m$ and M G and P $p$ and P G for sides respectively must be equal in area, which is the geometrical interpretation of the equation of condition.

Having thus briefly determined the new conditions of equilibrium under the action of a single given external careening force, or a number of such forces having a single resultant, we find its moment of rotation or tendency to capsize the boat counteracted and resisted by a moment of rotation in the opposite direction produced by the buoyant effort of the water acting upward through H, and we conclude from the preceding that the careened position of equilibrium will be soonest reached by making the first number of equation 1 small, *i.e.*, the product P $p$ × P G; but P $p$ depends for its value upon the effect of the wind, manifestly beyond our control, while P G represents the distance of the centre of effort of the entire sail area (where the wind acts) above the centre of gravity of the vessel, but the position of this point P is fixed by the shape of the sails. It therefore seems that instead of making the first member of Eq. 1 small, we must seek to make the second member relatively large; we must try to make it so large that, for a given value of P G, P $p$ may have any possible value, without incurring the danger of their product exceeding the product of M $m$ × M G. We have therefore to ascertain how the force acting upward through H may give the greatest possible product of lever arm M G multiplied by the intensity M $m$.



$$\begin{aligned} M n \times M G &= P p \times P G \\ &= M O \times G h = 125 \text{ tons.} \\ &= 250{,}000\text{lb.} \\ \frac{250{,}000}{25} &= 10{,}000\text{lb.} \\ &= 5 \text{ tons.} \end{aligned}$$

It is clear from an inspection of the figure that this product depends, first, upon the upward thrust through H, which must remain constant in intensity, being equal, as we have seen, to the weight of the vessel, and, secondly, upon the lever arm, M G, with which it acts; in other words, the only way in which we can effect the value of the product which constitutes the second member of our equation, to increase it, is to increase the lever arm, M G, or increase the distance of the "metacentre, M," above the centre of gravity, G. But it is evident that this may be accomplished in two ways—viz., we may either lower the position of the point G on the line P G, which means simply to make the centre of gravity of the vessel very low and deep by using a lead keel or much ballast, or we may move the point M higher up by causing the point H to move rapidly to the right of G as the vessel careens, which in turn means to give the vessel a broad and shallow cross section, so that the "centre of buoyancy" in the careened position will be very far to the right of G, thus causing the line of support, H M, to cut the line of rest, P G, at a point high up above G. The latter method amounts virtually to increasing the line G $h$, which is the horizontal distance between the two centres, and it is evident this may be effected either by lowering the position of G on the line P G, or by carrying H to the right. Either way will answer so far as the theory of the matter goes; both are used in practice with good results, as we shall see.

It is clear that by making the cross section of the vessel narrow and deep, and hanging a lead keel on the bottom, we are, in fact, bringing G to its lowest possible point below the load-water plane, and are using the first of these methods. But if, on the other hand, we leave the position of the centre of gravity, G, out of consideration, and make the cross section of the boat, A B C D, broad and shallow, the point H will move rapidly to the right as such a vessel careens, and thus rapidly extends the line G $h$ to the right of G and raises the point M on the line P G, thus increasing the lever arm of the force M $m$.

These two methods of increasing the factor M G in equation 1 give us at once the principles of mechanics that underlie the deep and narrow cutter on the one hand and the broad and shallow sloop on the other. Thus are we brought in theory, by analytical investigation of the forces at work, to the same identical issue that the whittling mechanic has brought our practical knowledge of yachts through years of experiment. The analytical deductions show clearly that we may elect either of these two methods to produce the desired result. Bearing in mind the action of the different forces considered, we may proceed further to investigate the relative advantages the two methods present under given conditions in practice. The first, with low centre of gravity and narrow beam, is the usual model of the English cutter, the latter that of the American sloop. It will be seen that they differ essentially in principle, and, as might well be expected, each has both advantages and faults peculiar to its class.

Fig. 1 is a fair representation of the American sloop in cross section, while Fig. 2 represents the cutter type. In order to make our consideration of these two forms as comformable to practice as possible, the two figures with the necessary construction are draw to scale, and represent the corresponding elements of two boats having the same load-water line length, same displacement, and the same sail area nearly. The principal remaining elements are given below:

| | Sloop. | | Cutter. | |
|---|---|---|---|---|
| Length, L. W. L. ........ | 65 | feet. | 65 | feet. |
| Beam (extreme) ........ | 15 | ,, | 11½ | ,, |
| Draught ................ | 9 | ,, | 12 | ,, |
| Lead on keel .......... | 3 | tons. | 38½ | tons. |
| Lead inside ............ | 33 | ,, | 1½ | ,, |
| Ballast, total .......... | 36 | ,, | 40 | ,, |
| Displacement .......... | 75 | ,, | 75 | ,, |
| Mast (deck to hounds) .. | 41 | feet. | 42 | feet. |
| Main boom ............ | 52 | ,, | 58 | ,, |
| Gaff .................. | 35 | ,, | 39 | ,, |
| Bowsprit outward ...... | 27½ | ,, | 30 | ,, |
| Area lower sails ........ | 3000 | sq. ft. | 3450 | sq. ft. |
| Custom House bulk .... | 44 | tons. | 40 | tons. |

The centre of effort of the sail area in each (lower sails only) would be about twenty-five feet from the deck—*i.e.*, the point P at which the wind acts in both. The displacement of both boats is 75 tons, or 150,000lb.; this is the measure of the upward thrust or buoyant effort of the water in each. Let us suppose them both careened to the same angle as indicated in the figures, and ascertain the corresponding resistances afforded in each to a careening force acting through the point P to the right. The submerged portion in each cross section now becomes $a$ C $b$, but it will be readily seen that in this position the excess of the submerged portion of the boat on the leeward side of the line of rest G P over that to windward is far greater in the sloop (Fig. 1) than in the cutter (Fig. 2), and that the centre of volume of the submerged part (H) in the sloop is necessarily, on this account, much further removed to the right of G than in the cutter.

To offset this, however, the position of the point G in the cutter (the centre of gravity of the entire mass) is considerably lower down on the line of rest P G than in the sloop, owing somewhat to the shape, but chiefly to the lead keel the former carries, and this in a measure compensates for the small movement on the point H (the centre of buoyancy) to the right in the case of the cutter.

As G represents very closely the position of the centre of gravity in each case, so H also represents with little error the corresponding position of the centre of buoyancy in the two types when both are careened to the same angle. It will be observed, however, that the distance, G $h$, is considerably greater in the case of the sloop, and that the position of the metacentre, M, is consequently much higher.

In the careened position chosen we have in each case 75 tons = 150,000lb., the buoyant effort or displacement of both boats, multiplied by the corresponding distance G $h$ = $2\frac{5}{10}$ft. for one and $1\frac{66}{100}$ in the other, which for the sloop gives 150,000 × 2½ = 375,000lb. = 187 tons, and for the cutter 150,000 × 1⅔ = 250,000 = 125 tons, for the measure of the "moments of rotation" due to the upward thrust of the buoyant efforts acting along the lines of support H M, and tending to right the vessels by turning them to the left about the point G in each.

The distance G P in the cutter will be, say, 25ft., and in the sloop 27ft., the cutter having a low and long sail plan, as shown by the dimensions given, and the sloop a higher and shorter one (this, of course, considering the lower sails only, mainsail, and jib). The centre of effort being in each at the point P, and dividing the respective moments of rotation by the distance G P, the "lever arm," with which the careening force acts in the two models, we get for the sloop 375,000 ÷ 27 = 13,888lb. = $6\frac{1}{10}$ tons, and the cutter 250,000 ÷ 25 = 10,000lb. = 5 tons, which represent in each case the resistances that the internal forces are calculated to oppose to a careening force acting at the point P and at right angles to G P.

Let us suppose the sail areas in each case, or means of meeting the careening force at P, equal, or 3,000 square feet for both cutter and sloop, we have as a result 4½ pounds pressure to the square foot of sail exposed in the sloop, and only 3⅓ pounds for the cutter, to careen both to the same angle; but, as these forces are supposed to act perpendicular to the sail areas, the actual force of the wind in each case to accomplish the same result under the conditions given will, of course, be greater.

Making, then, a suitable allowance for the inclination $p$ P $p$, and the inclination of the sail to the beam of the vessel (which are never flat), these pressures would correspond to wind velocities of 30 and 35 miles per hour respectively, being in the ratio of 6 to 7 for cutter and sloop. We therefore see that for a given careening angle the sloop offers considerably more resistance to the wind or driving power than the cutter, or, what is the same thing, in a given amount of wind the cutter will careen more than the sloop, or, in common parlance, the sloop is a "stiffer boat"; other conditions being equal, she will stand up to the wind better; but not only this. It follows also, as a matter of course, that, as the wind force acting at P to drive the boat has its effective component, P $p$, diminished rapidly as the boat careens, the component perpendicular to the sail alone being available for this purpose. It therefore follows that in standing up to the wind the sloop is enabled to use a greater portion of the entire actual force of the wind than the cutter, which careens more for a given amount. The sloop has therefore more driving power for a given spread of canvas, and the cutter must carry more sail to get the same amount of propelling force.

At the same time, and for the same reasons, the cutter will doubtless stand a heavier blow with less danger of disastrous results than will the sloop, which, being stiff, will not yield beyond a given point to the gale, and is liable to lose sail or spars, while the cutter will be hove down to her beam ends, where the careening power of the wind becomes greatly diminished, but she will still be in a position of stable equilibrium, and slowly right herself as the wind ceases. A consideration of the two figures and a similar construction of the forces at work in different positions will make this clear.

For considerations of speed, however, in a wind that both can stand up to under full sail, the mechanics of the problem seem to be decidedly in favour of the sloop, whose broad beam enables her to use and derive more actual driving power from a given velocity of wind. The cutter, being hove down considerably in a moderate wind, loses much of the effective force.

Where, then, it will be asked, does the question of relative speed come in, as every one familiar with yachting knows that the cutter often rivals, and sometimes beats, the sloop in time. The answer is simple, but not of easy demonstration; in fact, it is not analytically demonstrable at all. The cutter often beats the sloop under given conditions, and the reasons for this are so complex as not to be within the bounds of exact mathematical investigation.

In a few words, the answer may be stated in general terms that the cutter, being narrower and sharper, has less resistance to overcome in moving through the water, and so compensates for other defects; but for the mere physicist it is no answer to say that when the cutter beats she does it because she goes faster, and that she goes faster under certain circumstances because she goes easier. We cannot hope to explain the matter on demonstrable grounds. The facts of the case, as yachting statistics show, are that the cutter rarely beats the sloop under like even conditions so near as they can be attained, and the results of practice seem to have fairly maintained the slight difference the theoretical principles show in favour of the sloop. The mechanical principles involved seem to incline decidedly in favour of the sloop, and practice has, in the long run, left but little question of their relative merits under the same conditions as regards speed alone.

Ever since yachts have been sailed the question has always been an open one, and both sides have strong advocates, mainly because the conditions under which the two types have been developed seemed to require the advantages peculiar to each. Wherever the principles that underlie a problem of mechanics point, as in the present instance, to two solutions, the two methods of arriving at like results will always be found adapted to different conditions that are likely to arise in practice, and the experience of years shows this to be exactly the case in the present instance.

Referring to the figures again, we see the sloop, whose chief excellence is due to her breadth of beam and consequent stiffness combined with light draught, is in every essential feature a smooth-water craft; she is evidently designed to skim over the surface of the water rather than to plough through it, while the cutter is just as evidently designed for rough water, and is essentially a sea-going craft.

The sloop has indeed great stability, but she is at the same time a quick, jerky boat; the "metacentre" rises and falls rapidly as the boat careens a little more and then returns to its former position; she rights herself suddenly at the least slackening of the wind, and is comparatively ill adapted to a heavy sea, while the cutter, owing to the slight change the centre of buoyancy undergoes in moving from one careening angle to another, is necessarily a much easier sea-going boat. She goes over on to her beam ends with perfect safety, and returns easily and gradually when the wind slackens. The same kind of reasoning applies again to the sloop, whose windward side, lifted high out of water, is subject to heavy shocks and jars from waves which are likely to impede her progress considerably in a heavy sea, while the cutter, with her straight lines, rides them easily with less change of position, or plunges through them. It would seem, therefore, natural under the circumstances and the principles involved that the cutter should be the preferred yacht with the English, who do their sailing so much at sea, and in the rough and choppy waters of the two Channels, while with us the centreboard type, more or less modified, for contrary reasons should find preference.

The question can be never definitely settled for all cases; each will always possess merits for the particular situations to which it is best adapted.

Viewed, however, in the light of mere racing machines, the question changes somewhat, as the issue then becomes one of speed alone under the same conditions for both, and from this standpoint there seems to be much in favour of the sloop against the cutter.

Speed will be the sole point at issue in the coming international race, and it would seem certainly, from theoretical data at least, that the Americans have every reason to look with confidence for the best results from their own peculiar type of boat, the centreboard sloop.

In the coming race the cutter is expected to make up for other shortcomings by her narrow beam, consequent straight lines, and low resistance to motion through the water. To offset this, however, it should be borne in mind that she is much deeper than the sloop, and that pressures (in the water) increase in proportion to the depth, and as a result of which there is probably but little gained by the narrow beam; while a sloop of moderate beam and light draught, such as the one being built by Mr. Smith to meet the Genesta, will probably be broad enough to skim over the surface of the water with comparatively light draught, and yet be sufficiently narrow to have easy lines and a compatively low resistance to motion through the water.

The mechanics of the problem seem certainly to favour such a boat. The figures 1 and 2 show practically the relative midship actions of Commodore Bennett's boat, designed by Mr. Smith, and Lieutenant Henn's cutter yacht, the Genesta, doubtless the best of her type afloat. We have looked into the mechanics of the question, where we have found that the practical yacht builder has already given us all that theory can show, and all this with a shrewd guess at the best way to overcome the resistance that water opposes to motion. Let us, for conclusion, assume his standpoint, and look at nature.

Nature has given us two types of locomotion in or upon the water, by which we may always pattern without being far out of the way. They are the fish and the duck, and the two types of yacht we have considered are in no small degree exponents of these two types of least resistance; but it will not be claimed by anyone that a yacht should sail under water or nearly so, and the most enthusiastic will prefer as a rule the type that skims over its surface. The swimming fowl has, so to speak, a broad load-water plane with light draught, its immersed section at the forward end being almost a perfect parabola; and the load-water plane of the shallow American sloop is not unlike it in plan, the chief difference being in the point where the propelling power is applied. The cutter resembles in some respects the fish, with its narrow and deep cross section and easy lines, with the propelling power equally out of place. But here the comparison ends, for though designed to offer but little resistance to motion, the elliptical cross section of the fish is doubtless mainly designed to resist severe pressures at great depths.

The question so far as the yachts are concerned will doubtless ever remain one of expediency. What do you want to do? will always be the question. Do you wish to ride out a sea without losing a spar or rag of canvas, or do you wish to hurry at any cost over a bit of easy water on a bright September day?

For the former we prefer the cutter type; but if it is a question of keeping the "cup" merely, and if there is any virtue in mechanics, we prefer the American sloop—moderate beam, light draught.

## THE LEAD BATH.

MELTED lead for heating steel articles to be hardened has become quite common in shop use. There was a time when it was employed only for articles of varying thickness, so that the part to be hardened could be heated, while that to be left annealed need not be greatly warmed; but it has been proved that a more even heat can be obtained on articles of even size, as well as on those of varying dimensions, by the lead bath, and that the heating can also be done quicker than over a charcoal fire. There is another advantage in the lead bath heating, one of great convenience at times, and that is that the article to be heated may be kept an indefinite time in the hot lead without being burned; it will not get beyond the proper heat for hardening. There is an improper use of the lead bath in the attempt to employ it for drawing to temper; the bath will do its absolute will, and as evenly and indiscriminately reduces the hardness as it heated the steel. This uniform drawing is not always desirable; there are tools and other pieces that require careful management and much humouring to bring them to their proper degrees of temper. This cannot be done in the evenly heating lead bath; the proper drawing is either over a clean charcoal fire or in a bath of heated sand. Whenever the last can be used, it is preferable on all accounts. Of course, such drawing must be done to colour, and this is one of the advantages of the lead bath for heating for hardening; the steel does not contract an oxide so thick or so discoloured that the steel itself may not be seen. In heating for hardening in a fire the surface of the steel is burned, so that it contracts a coating that must be removed by direct abrasion before the true surface of the steel can be seen. But in lead heating the lead appears to be a defence against the oxygen of the air, and the steel comes out clean. The writer has made tests that prove that the surface of machine-polished steel coming from the lead bath, and being chilled in pickle or in water, will show every gradation of colour as to temper without being previously scoured or brightened. The lead bath must be of pure lead. It will not do to use the sheet lead of old eaves, gutters, and the pipe of old drains from sinks, eaten half through with atmospheric acids and the worst corrosives of the kitchen; the lead must be chemically pure. Buy lead in pigs from the mines — the Galena brand is reliable — or buy the somewhat higher priced bar lead. Both are as nearly absolutely pure as is possible. Melt in a plumbago crucible or an iron pot. Heat the lead to a cherry red and keep it so. Cover the surface with charcoal dust. Suspend or immerse the articles to be heated in the bath until they are heated through. They need no attention until you are ready to harden them. No pewter, type metal, or junkshop stuff will do for a heating lead bath; the heat cannot be even, and the bath will not be clean. There are exceptions to the objection of drawing in the lead bath. Sometimes there are portions of an article that require softening or annealing while the remainder is left hard. In such a case the portion to be softened may be immersed in the bath and be annealed without affecting the other portions, as would be done by radiant heat.—*Scientific American.*

## PHOTOGRAPHY AND THE SPECTROSCOPE.—II.*

By Capt. Abney.

YOU now see we have a picture of this flat iron produced by the deeper blackening of the heated part, though the whole plate was given but a short exposure to the light from the phosphorescent plate. I will impress this further upon you. I have here a collodio-bromide emulsion plate. But in this case, instead of heating it by a flat iron, we will heat it by immersion in hot water. Of course, a collodion plate is not so sensitive as a gelatine plate. I put it into cold water for a short time to moisten it, and then dip half of it into some nearly boiling water; on withdrawing it, I expose it to this candle, and develop it when it gets cool, which we effect by placing it a short time in cold water. It will be seen that the part immersed in hot water is much blacker than that which was exposed cool. If I heat the plate, and allow it to cool, and then expose, there will be no effect. The plate will develop normally, for the increased amplitude of vibration will have ceased, and the light will have to perform the same work on each part of the plate. Now, in whatever manner increased amplitude is given, when the cause of the increased amplitude is withdrawn the amplitude will cease in the same manner. One of the chief reasons against what we may call the "vibration theory" of the photographic image, namely, that the molecule is unaltered by the action of light, is this—that the increased amplitude would cease with the same rapidity with which it would cease when the hot iron was applied to the back; that is to say, after five or ten minutes the amplitude of the vibrations would come back to the normal extent, a condition which is not fulfilled in the photographic image. I can illustrate this in a very visible manner. I think you can all see this phosphorescent plate. Now, what is the reason of that phosphorescence taking place? It is that the atoms of the molecules which comprise this phosphorescent material are swinging in a certain rhythm, which gives us the sensation of light. Now, if I apply a hot iron to the back of this plate, I think at once you will see that the image of the hot iron is present. Here is the same kind of action taking place in the one case as in the other. Now we come to another point, which is a slightly different one, and that is the energy of radiation. I may say that the energy of radiation is a subject on which I could discourse for a good many hours, but here I can devote but two minutes to it. I must try to make it as clear as I can. I hold in my hand a little instrument which is called a thermopile, which, you see, has a narrow slit, which could be narrowed to any degree of fineness; attached to it is a screw motion, which will make that slit travel along the base of the instrument; beneath that slit are some thermo-electric couples. It is not my business to enter into how they are made, but still we know that, when thermo-electric couples are heated, an electric current is generated sufficiently strong to cause the needle of a galvanometer to deviate; and the amount of energy of radiation which falls upon the face of the pile can be measured by the deviation of the galvanometer needle. In a great many experiments which were made, this thermopile was caused to travel along the spectrum by the screw motion, and at every part of the spectrum, at distances of, say, a quarter of a turn or half a turn of the screw, the amount of deviation which was given to the galvanometer needle was read off. By that means we are able to compare the energy existent at different parts of the spectrum. On measuring the area of the curve in which lie all dark rays, and the area of the curve for the visible rays, it will be found that, roughly speaking, the energy of the latter rays are about half that of the former. But for photographic action we do not have anything like that amount. The red rays for ordinary photographic work are useless; and why that is we shall see by-and-by. We will say that the photographic action stops at the blue, and we find that the total energy of radiation which is used for photographic purposes in the electric light is only about one-hundredth part of the whole energy of radiation. The remaining ninety-nine parts are wasted as far as photography is concerned, except in so far as they heat up the molecules in the same way as the flat iron heated up the molecules on the photographic plates. The other curves show the energy of incandescent lamps. You will see that they have very little of what is called actinic power; that is to say, they have very little blue ray at all compared with the arc light. In the lowest curve we have a lamp at only a yellow heat, the middle curve being that at a white heat, and you will notice the enormous difference there is in the energy between the two. The energy of the middle curve, which measures the total energy of radiation from the incandescent light, is about twelve times that of the visible power. Yet, when you have to measure the photographic part of the spectrum, you will see that it is only about eighty. That is to say, supposing you have a filament of an incandescent lamp which is one-hundredth of an inch wide and half an inch long, then if you take an arc electric light and cut off from the glowing positive pole the same area, the photographic value of the one, area for area, is about eighty times that of the other. I will ask my assistant to put in front of the slit something which I showed you at my last Cantor Lectures, and which I daresay you have forgotten all about. That something is a film of the same silver salt with which I photographed the spectrum at the commencement of the lecture. You see that it cuts off all the violet, and well down into the blue. I want to show you that the colour of the photographic spectrum is perfectly different from that which the human eye can see. I wish to show you a little device by which, perhaps, I shall be able to give you an idea of the integrated colour. A tolerably bright spectrum is on the screen of the camera; I raise the screen so that the spectrum falls on a lens placed a little beyond it: and if we had time, I dare say that we should be able to get a screen placed in the focus of the second lens, so that the recombined colours would form a white patch, without the slightest tinge of colour. We have got a white circle, however, which is sufficient for our purpose, though at one margin there is a very narrow red fringe to it. In the place where the coloured spectrum is in focus I place a horizontal aperture, about ¼in. wide, and by a little arrangement I can, by strips of card, cut off any colour I like from falling on the collecting lens, so that it recombines only the remaining colours. You remember that the photographic spectrum does not extend as far as the green, ordinarily speaking, so now I cut off all rays as far as where the photographic spectrum begins, and you can see the colour of the light, which is really useful for photography. It is a sort of sea-green colour. If I were to take that light, and pass it through a slit and a prism, you would soon find that the whole of that spectrum would be photographically active, because all the light which is not photographically active has been cut off. I will show you one more method of recombining the photographically effective colour disc; that is by taking the ordinary disc, and cutting out the red and orange. We have, then, only the green, the blue, and the violet; and those, when they are combined together, ought to give you pretty nearly the integration of the colours which are ordinarily photographically active. I will ask my assistant to spin it in front of the lantern. I do not know whether you can all see the colour-charts which I hold in my hand, but those who can will see that the colours, when placed in the blue-green light, appear totally different from what they did in the whiter light. The yellows are much deepened, and the reds are blacker. I will ask now to have the spectrum thrown upon the screen once more, and we will again pass this colour-chart through the spectrum. The colours are very pure for pigments. I think that it is the finest colour-chart of the spectrum which I have ever seen. It is one prepared by Professor Piazzi Smyth, and appears in his Madeira spectroscopic observations. Notice that the blue appears perfectly black when the chart is in the red, the red at the left hand being brilliant. Passing it into the yellow, the yellow is vigorous; the blue is black, and the red undimmed. Upon my passing it still further on in the green, you will see that the red is blacker, and the orange is blacker, whilst the yellow still keeps its colour, and the blue begins to get more bright. Passing it still further on into the violet, we see that the yellow is now perfectly black, the red has gone, and the blue begins to shine out. Passing still further, you will see that the blue still shines out, but is less intense, all the other rays appearing black. Upon my passing it again rapidly through, you will now be prepared for the changes that take place. In this lantern, which has been used to form the spectrum, the light passes through a slit. The slit, you see, is perfectly straight, with parallel edges. Now comes the question, "Is it necessary that light, in order to be decomposed into a spectrum, should be passed through a slit of this description, or what shapes may it be allowed to take?" I propose to try to answer this query in an experimental manner a little. First of all, we will see what the effect will be if we use no slit at all. You see that the colours are not pure. I replace the slit, and you will see at once that we now have, not the various colours overlapping, but a tolerably pure spectrum. Now let us take a slit of another shape—a zigzag slit; and here we have another form of spectrum delineation of the rays. Placing a metal in the arc, the bright lines due to the vapour flash, and, it will be seen, take the zigzag form of the slit. There is, then, no particular reason for using a straight slit, except convenience. Then, again, I may take a ring slit, and to test its value we will put a little silver in the arc to show you. I am not simply showing this as a pretty experiment, but I want to show you that such a slit is absolutely useful in photography; the spectrum of silver now on the screen shows rings of different coloured rays. It is a very pretty spectrum. This form of slit is extremely useful in one branch of spectrum analysis. You are perfectly aware that, during a total eclipse, the body of the moon covers the sun; but that there are seen beyond the dark moon certain red protuberances which belong to the sun, and are known as "prominences." It has been the work of astronomers to determine the composition of those protuberances, and also to form a definite idea of the corona of light which surrounds the body of the sun, and can only be properly seen during a total eclipse. The picture on the screen is a representation of the total eclipse of the sun as observed in Egypt in 1882. It is a negative picture, and of course the dark halo which you see around was seen as a bright halo, and the white disc is the black moon. On the left-hand bottom corner you may notice the comet which was discovered during the eclipse, and which received the name of Tewfik, after the Khedive of Egypt. Round the disc of the moon are little prominences. Those prominences are vastly more bright than the corona itself, which is the halo extending some distance round the sun. Thus we have a bright ring of light round the moon surrounded by a feeble light. The former, when viewed by means of a lens in front of which a prism is placed, shows rings of colour composing these prominences, and of course these rings can be photographed.

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* The substance of the Cantor Lectures delivered before the Society of Arts.

## THE HANDLING AND DEVELOPMENT OF DRY PLATES.*

THE subject will be briefly treated under three heads: the man, the light, and the development.

And first, in regard to the man, though qualified to go through successfully with the various manipulations connected with the production of gelatine negatives: The critical dicta that, "any one can make dry plates, but it takes a genius to develop them," or that "one science only will one genius fit. So vast is art, so narrow is human wit," are rather sweeping to apply to development, which is only a branch of science; but still, the higher the mental training, and the more perfect the command of all the faculties, the greater will be the success of our man. But no great thing is achieved in a rush; there is a great deal of preparation, a succession of events, preceding a crisis, or a great achievement; so that the guiding hand and the governing will, to be successful, must be disciplined by previous habits and modes of action. One must be ready for the decisive moment wherein the fit achieves success, the unfit suffers defeat. In the tide of one's affairs, how can he take it at the flood, if he has neglected his schooling in the methods which guarantee success?

### The Light.

In the attainment of perfect chemical results, the management of the light is of supreme importance. It matters not how perfect the plates, the lens, or the development may be, if the lighting is defective the result will not be a first-class negative; for in such cases, with the best materials, only a map representation can be obtained. In portraiture, should one so light the face as to have crescents in the eyes, with possibly stars in the pupils for high lights, perfect modelling or definition is out of the question, because the same flood of light which has made a caricature of the eyes has utterly obliterated the delicate curves about the most important features of the face. This criticism is made because too many photographers, even to this day, have these defects, and judging from these too many what are considered first-class galleries use the same quantity of light for dry plates that was found absolutely necessary for the wet. This charge lies mainly against those who, having clung to wet plates till they were compelled by the force of circumstances to use the dry, have gone off on a tangent trying to make all sorts of difficult positions without head rests, and to achieve this they flood the subject with so much light as to sacrifice definition to effect. But it is now possible, without risk of the subject moving or of underturning, to model up the subject with light somewhat as a painter or sculptor would under similar conditions. This can readily be accomplished if the light is brought under absolute control by properly curtaining the skylight. For a twelve foot light there should be at least two curtains for the sidelight and two restrictively fastened at the top and bottom of the top light. With such an arrangement the light may be so adjusted as to bring the high lights in the eyes to a mere point, and, if at the proper angle, the whole face will be so lighted as to give good modelling and, with proper timing, good definition. Under such conditions the pupils will not contract nor will the subject frown. But what light you have, have it clear and brilliant, as it is folly to talk of brilliant chemical effects without a brilliant light. Proper or full timing will give all the softness required. Use rapid plates and light boldly for relief and brilliancy. Silver plates demand too much light or too prolonged timing to get the best results as to either definition or expression. In regard to the exposure, the only safe criterion is the relative brilliancy of the images on the ground glass; and one should school himself to judge critically of the brightness and colour of the image, decide that this subject requires so many seconds, more or less. Rely on and cultivate your judgment; there is great demand for it in lighting, posing, &c. If one cannot put confidence in himself, who should?

### The Development.

This shall be confined to my present methods of procedure, stated as concisely as possible. Two kinds of development are used:

### The Ammonia Pyro.

| | | |
|---|---|---|
| Sulphite of soda (crystals) | 6 | ounces. |
| Bromide of ammonium | 1½ | " |
| Bromide of potassium | 2 | " |
| Pyro | 4½ | " |

Dissolve thoroughly, and add sulphuric acid, 240 minims; and liquid ammonia, 6 ounces, and enough water to make 80 ounces solution. Use 8 drachms of this stock solution, and from 8 to 11 ounces water.

### The Soda Pyro Developer.

| | | |
|---|---|---|
| A.—The pyro portion—water | 96 | ounces. |
| Acid | 96 | grains, dissolved |
| Alcohol | 6 | drachms |
| Pyro | 16 | ounces |
| B.—Soda portion—water | 120 | ounces |
| Carbonate of soda | 16 | " |
| Sulphite of soda (granulated) | 16 | " |

Use 1½ to 4 drachms of the pyro solution, 8 of the soda, and 7 ounces water. The ammonia pyro and the pyro portion of the soda developer are kept in 6-ounce bottles, and will keep indefinitely. Ordinarily the developers are mixed as follows: 3 drachms of pyro solution, 8 drachms of soda, and 7 ounces of water; the ammonia pyro 8 drachms, and 8 ounces water. The trays are used in developing the smaller sizes; partly for expedition, and partly because slight modifications may be made quickly in the mode of development. The timing is judged to be absolutely right, but a little short, the soda developer is poured into the tray and the plate placed in it. Should development progress too rapidly, place the negative in it, or the tray into which some ammonia pyro has been poured. Should the timing be considered a little full, start with the ammonia pyro first. If the exposure be first right, the ammonia pyro brings up the image almost as rapidly as in wet-plate development, and the negative has a light straw-colour bloom with excellent printing qualities. Should its exposure be much too short, it gives too much colour and contrast. In such cases the soda developer is far superior. With the two developers combined in various proportions many modifications may be made. There is a peculiar relief or atmosphere effect given to the negative, which is distinguishable from that of either alone. In developing 18 by 22 or 20 by 24 plates, the ordinary method is modified in the following manner: In the 16-ounce bottle is mixed 3 or 4 drachms of the pyro solution, 2 ounces soda solution, and the bottle filled with water. Into another 8-ounce bottle is poured 3 drachms pyro solution, 1 ounce soda solution, and filled with water; into another 8-ounce bottle, 1 ounce ammonia pyro, and the bottle filled with water. The developing tray is partly filled with water and the plate placed in it and allowed to soak for a few moments, or until the water will run off without ridging, when it is quickly poured off, and the developer in the 16-ounce bottle is dashed on, and the tray rocked to secure even development. Should the exposure prove short, this developer weak in pyro will save it; or the exposure proving about right, pour it in 8 ounces of normal soda solution; or if full exposure is indicated, use instead the 8 ounces ammonia pyro solution, which will check rapid development and give intensity without making a slow-printing negative. It has been noticed in the development of large plates, when the developer is in any ways near the right power or strength, the image will come up quite rapidly at first, but will soon check up and proceed quite leisurely, and the mode of procedure prove just right. But if the shadows come up too much before the checking of it begins, without the addition of more developer stronger in pyro, the negative will have to be over-developed to get printing strength; or if the stronger pyro solution be added when really it is not needed, the negative will then have too much contrast, and, if not speedily checked, too much intensity also. It takes an exceedingly quick apprehension to realise in time to correct a mistake made in the commencement of development, and what modifications are necessary to redeem the negative. It is simply impossible in all cases to begin development just right. Ample preparation should be made for all contingencies, as one should not rely too much upon his wit to help him out of a tight box; and yet his mother-wit may be the *ultima thule* in the redemption of an otherwise hopeless situation. The great thing is the ability to comprehend the situation in each particular case, the readiness to make possible modifications, and the grit and alertness to make them in time. It takes a brave man to avoid getting rattled and winding up with a negative too thin, too intense, or with too much contrast.

We will close with an answer to the question "Does rocking the plate during development secure contrast?" That evenness and cleanness are obtained by it is not questioned, so directly to the answer. The molecules of bromide of silver disturbed or changed, by a proper exposure from the highest light to the deepest shadow, are in progressive diminution. All, or nearly all, of the bromide of silver on or near the surface of that portion of the plate which represents the highest light is changed, while but a small amount is a light effected in the deepest shadows. These mechanical agitations of the developer cause a more rapid chemical action, so that before the developer has had time to penetrate the film to any considerable extent the reduction in high lights has been carried to a much further point than it otherwise would had the developer remained quiescent. The start the high light has secured over the shadows is maintained throughout ordinary development; also the shadows requiring all, or nearly all, the changed silver, both in and on the surface of the film, to give proper definition, the high lights have time to darken sufficiently to produce proper contrasts. But there is still another factor contributed to the same result. The greater amount of free bromine thrown off in the high lights, and combining with the quiescent developer lying immediately over the high lights, retards development in the lights, which, in the shadows, the developer being less retarded from this cause, progresses too rapidly to secure contrasts, but by agitation the power of the developer is kept uniform over the surface of the plates, and the high lights retain all other advantage secured in the exposure.

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* By W. H. Potter, in the *Photographic Times*.

## SCIENTIFIC NEWS.

THE death is announced of the Rev. John Baron, D.D., rector of Upton Scudamore, aged 68 years. Dr. Baron was the author of several works, amongst them "Scudamore Organs; or Practical Hints Respecting Organs for Village Churches."

Dr. Henry William Reichardt, the distinguished botanist, and professor of botany in the University of Vienna, died while in a fit of temporary insanity last week. Dr. Reichardt was an occasional contributor to English periodicals, but the majority of his papers were published in the *Journal* of the Vienna Academy. He was born at Igiau in 1835.

Dr. R. H. Gilbert, the inventor of the elevated railroad system of New York, died recently in his 53rd year. After serving in the war of the Rebellion, Dr. Gilbert devoted all his time to the rapid transit problem. He first got up the pneumatic tube system, but abandoned it finally as impracticable. He then brought out his patent for an elevated railway, and obtained a charter for a road through Sixth Avenue and Second Avenue. The patent was for an arch thrown from one side of the street to the other, upon which a local train and a through train were to run on independent tracks, and which would afford a support also to the telegraph wires. It was some years before the work was begun, but Dr. Gilbert's unremitting efforts in the United States and Europe finally created confidence, and the required money was eventually obtained. The structure in Sixth Avenue was begun, rapidly carried forward, and on May 1, 1878, the first car was run from Trinity Church to Fifty-ninth-street.

Dun Echt Circular No. 96 says that a telegram from Professor Krueger announces the discovery of Tuttle's comet by M. Perrotin, at Nice, the observed place being G.M.T., Aug. 9·6124, R.A., 7h. 23m. 43·1s.; N. Dec., 28° 1′ 24″.

In No. 2,675 of *Astronomische Nachrichten*, Dr. E. Lamb gives an orbit of Barnard's comet which will reckon as Comet II., 1885, the return of Encke's comet reckons as No. I. Dr. Lamb makes the perihelion passage on August 9 at a distance from the sun of 2·5 in terms of the earth's mean distance, which it will be seen differs considerably from other computations.

The Institution of Mechanical Engineers during last week held their summer meeting for the first time in Lincoln, and the Mayor, in welcoming them, said that the city owed much to mechanical engineers, who in the course of 30 years had transformed a quiet cathedral city into the most important centre for the production of agricultural engines and machinery. The address of the president, Mr. J. Head, was read by the secretary, and forms a valuable contribution to the literature dealing with the relative advantages and disadvantages of iron and steel for various classes of constructive work. A number of interesting papers were read, including one of special value, in which Mr. R. C. Neville, of Wellingore, detailed his experiences with a private installation of electric light—viz., 125 incandescent lamps fitted in his own house. The discussion in connection with this paper turned chiefly on the modified form of Richardson's electric regulator. Dunbar and Ruston's steam navvy was also the subject of a paper by Mr. Joseph Ruston, M.P. Several visits were paid to the important works in the city and neighbourhood.

Mr. Arthur Smithells, of Owens College, Manchester, has been elected to the professorship of Chemistry at the Yorkshire College, Leeds, vacant by the retirement of Dr. Thorpe, who becomes Professor of Chemistry at South Kensington.

A lectureship of comparative embryology is to be instituted at Edinburgh University, and the Senatus has appointed Mr. G. Brook, F.L.S., subject to the approval of the University court.

The recently-founded Scottish Geographical Society purpose to form a loan collection of maps, plans, itineraries or guide-books, and views relating to Scotland, for exhibition at the Aberdeen meeting of the British Association next month. The address of the secretary is 80A, Princes-street, Edinburgh.

The International Geological Congress, whose meeting was postponed last year, owing to the epidemic of cholera in Southern Europe, will hold its third meeting at Berlin on September 28, under the honorary presidency of Prof. H. von Dechen.

Two important papers on cholera have been recently published—one from the pen of Professor Burdon Sanderson, based on the lecture he recently delivered before the Royal Institution; the other by Dr. Cameron. Professor Sanderson considers that cholera, like other epidemic diseases, owes its power of spreading to a living and self-multiplying organism, though he hesitates to admit that Koch's comma bacillus is the specific organism. The liability of a locality to attacks of cholera depends on the physical character of the soil, and on certain changes which it undergoes in the course of the seasons; but no combination of soil and season will produce a harvest unless the seed has been sown. Dr. Cameron accepts the bacillary hypothesis, and contends that Dr. Ferran's inoculations have done as much to prevent cholera as vaccination has to prevent smallpox.

At a recent meeting of the San Francisco Microscopical Society, Dr. J. M. Selfridge read a paper on "Bacteria, and their Relation to Health and Disease," in which, after recounting the views of the authorities, he stated his opinion that bacteria are the result, and not the cause, of the decomposition of organic substances. An "exceedingly animated discussion" followed, and it is expected that more papers on the subject will be forthcoming. Professor Hanks presented two slides of gold from quartz collected by him at the mines near Dahlonega, Georgia. The peculiarity of the gold consisted in its crystalline condition, its purity, and its absolute freedom from coating. Slides of this material will be furnished to members interested, and we presume that mineralogists and others can obtain specimens. Mr. A. H. Breckenfeld is the secretary of the San Francisco Microscopical Society.

An expedition under the auspices of the Royal Dublin Society and the Royal Irish Academy, the latter bearing all expenses, left Queenstown lately on a dredging excursion in the Atlantic, 120 miles west of Cape Clear. This is the first deep-sea expedition of the kind from Ireland, and much interest will be felt as to the result of its operations, which altogether occupied five days. A detailed report will be presented to the Royal Irish Academy.

The Sadlers' Company have established four studentships, each of the annual value of £30, and tenable for two years, at the Finsbury Technical College of the City and Guilds of London Institute. The studentships will be competed for at the entrance examination to be held at the college on October 1, and are open to pupils above 14 years of age who are attending or who have attended any public elementary school in the United Kingdom.

M. Chevreul, the oldest chemist in the world, reaches his hundredth birthday on the 31st inst., and the Parisian students intend to have a special celebration of the event.

Chloride of zinc used as a soldering fluid is said to poison the contents of the tins in which food is sealed, and an inventor has patented a solution of lactic acid and glycerol in water as a soldering flux which is said to be perfectly harmless. If any of our readers try it, we shall be glad to hear the results.

The Board of Trade has declined to permit the opening of the Blackpool electric tramway on the ground of faulty construction; but it appears that the blame does not rest with the electrical engineer.

M. Carnot, in the *Bulletin* of the French Society for the Encouragement of National Industry, says that an alloy of 75 copper, 25 manganese has no tendency to form cuprous oxide, which causes the formation of soluble salts, which in turn accelerate the corrosion of copper sheathing on ships. This surface corrosion of copper has always been considered an advantage by those who like to have their vessels as free from barnacles as possible.

The *Etruria* has made the passage from New York to Queenstown in 6 days 9 hours—the quickest on record.

The Municipality of Paris has voted the requisite funds for the erection in the cemetery of Père La Chaise of three cremation ovens, which will together be capable of reducing to ashes twelve bodies per day. The ovens are to be constructed purely by way of experiment, and are to be used only for consuming the bodies of hospital patients who—being owned by nobody—after their decease find their way to the dissecting-room.

## LETTERS TO THE EDITOR.

*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* **EDITOR** *of the* **ENGLISH MECHANIC**, *332, Strand, W.C.*

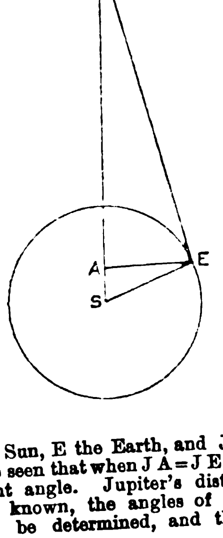
*All Cheques and Post-office Orders to be made payable to* J. PASSMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original."
*-Montaigne's Essays.*

### THE EQUATION OF LIGHT—A CHEAP TELESCOPE—WHAT IS "CREATION"?—ARE "TWO EYES BETTER THAN ONE"?—AN INSOLUBLE PROBLEM—THE CINCINNATI OBSERVATORY REPORT ON THE COMETS OF 1883—WHAT RENDERS TERRESTRIAL OBJECTS VISIBLE AT NIGHT IN A TELESCOPE—A POCKET FIELD MICROSCOPE—PLACES OF DOUBLE STARS, &c.—AN INSTRUCTIVE FORM OF WEATHER CHART.

[24590.]—THE formula given by "Light" (query 57120, p. 463) is quite correct, if it be desired to find the heliocentric time of a minimum of Algol, but scarcely so as applied to the Eclipses of Jupiter's Satellites: for (see figure)



If S be the Sun, E the Earth, and J Jupiter, it will easily be seen that when J A = J E, E A S is not really a right angle. Jupiter's distance, however, being known, the angles of the triangle J E S must be determined, and then S A by plane trigonometry.

I was as grieved as I was astonished to hear that the well-known 9in. reflector, belonging to the late lamented Prebendary Webb (speculum, tube, Berthon mounting, circles, eyepieces, and all) was sold the other day at Hardwick for £6 10s.!

[The above two paragraphs were for some reason omitted from my letter (24537) on p. 473.]

"H. B. F." (letter 24552, p. 477) must forgive me for saying that his use of language is of a very lax description. When I say that gravitation keeps the earth in its orbit, I simply predicate something of a phenomenon. When he attempts to account for certain facts in evolution by ascribing them to "creation," he lugs in a *final cause*, of which he can know less than nothing. "What is the secret of the appearance of so-and-so?" "Creation." "What is the cause or operative agent in Creation?" "The Creator." "Well, and how came He into existence?" and so on, *ad infinitum*. This is not Science, whatever your correspondent may think.

I rather fail to see how Mr. Kennan's contention in letter 24561 (p. 480) invalidates Mr. Nelson's statement in his previous communication (24511). Surely Mr. K. does not mean to contend that a man looking through a monocular telescope sees more when his unoccupied eye is open! If he uses his unoccupied eye, the view of his observatory dome, &c., which he will get with it will scarcely tend to improve the vision of the one looking through the telescope. I invariably observe with both eyes open; but by long practice I have brought myself to see nothing with the one not in use at the telescope. It is much more comfortable to observe in this way; but that is all.

"R." (query 57122, p. 485) must, one would fancy, see at once that his own data are insufficient for the trigonometrical solution of his problem, because the position of C is not given. If he were to move the foot of his 50ft. ladder 43ft. or so out from the wall, the top of it would touch his wall AB some 25 or 26ft. up; but if he brought it within 17 or 18ft. of B, then would the top of the latter touch AB more than 45ft. up, the ladder in each case resting upon the edge of his porch E.

The Cincinnati Observatory has just issued a volume of "Observations of the Comets of 1883," which will be found of very considerable interest to all students of the strange and erratic type of celestial visitants of which it treats. It embodies the results of the observations of Comets I. and II., 1883, made there by Mr. H. C. Wilson, while acting, *pro illâ vice*, as Astronomer at Cincinnati. The observations for the determination of the places of the comets on successive nights call for no special mention; but those of their physical structure and aspect are well worth studying. Any of my brother readers who may have made careful sketches of the Pons-Brooks Comet during the end of 1883 and the beginning of 1884, who will compare them with the numerous and admirable lithographic reproductions of Mr. Wilson's drawings which illustrate his text, will be struck with their wonderful fidelity. This is very notable in small matters of detail. "It is confidently hoped," says Mr. Potter, in the concluding clause of his preface, "that the present publication will prove a welcome addition to our knowledge of these wonderful bodies, and materially aid in the solution of the problem concerning their physical constitution." Readers of the volume which that preface introduces will admit that the hope thus expressed has been justified.

I, and many others, have to thank Mr. Sadler for his reproduction in letter 24564 (p. 497) of Professor Holden's curious record of his experiments on the light-grasping power of a large object-glass at night when directed to a terrestrial object. But I think that most people who have devoted any attention to the subject will agree with Mr. Holden in the words of his peroration that, "So far as I know, there is no satisfactory explanation of the action of the ordinary night-glass, nor of the similar effect when large apertures are used." For, irrespectively altogether of the enormously greater amount of light concentrated by a large object-glass in comparison with that which falls upon the unassisted pupil, I am certain that mere *magnification* acts in some way in rendering things visible after they have ceased to reflect sufficient light to be fairly discerned with the naked eye. To give a simple illustration: My thermometers hang in a frame attached to the external north wall of my observatory. Now I sometimes go out when the twilight has so deepened that I cannot see a division on their scales; but by the use of a little pocket lens I am enabled to read them without difficulty. This appears to me to be a subject deserving discussion.

The water microscope described by Mr. Hippisley in letter 24586 (p. 502) was invented by Stephen Gray, at least as early as 1696 (*Phil. Trans.* No. 221, p. 280). Prior to this Hooke, in his *Micrographia* (published in 1667), thus describes his method of making globule lenses, which any one can manufacture for himself, and which have the advantage of being permanent. "If," says Hooke (loc.cit.) "you take a piece of clear Venice glass, and, in a lamp, draw it out into fine threads, and then hold the ends of these threads in the flame until they melt; they will run into a small round globule or drop, which will hang to the end of the thread. Having made a number of these, they are all to be stuck upon the end of a stick with a little sealing-wax, with the threads standing uppermost; these ends are to be ground off first on a whetstone, and then polished on a metal plate with tripoli. The lenses thus finished, if placed against a small hole made in a thin piece of metal, and fixed there with wax, will both magnify and make some objects more distinct than any of the great microscopes can do." A lens of this sort—or several of varying powers—might well be fixed in Mr. Hippisley's V-shaped metal strip, and carried in the pocket for instant use whenever required. For a permanent fluid lens see Mr. Beck's remarks reported on p. 299.

Mr. Ruthven appeals to me personally in query 57186 (p. 507) to give him the accurate places of certain stars; but several I quite fail to identify, and writing away as hard as ever I can to save Friday night's post, assuredly cannot wade through many volumes to do so. Notably is this the case with his three B.A.C. stars; for, as far as I know, the B.A.C. numbers are never given in Webb at all. Two only of his objects can I find easily. The first is T. Coronæ, of which the Mean Right Ascension and Declination on Jan. 1, 1885, were 15h. 54m. 42s., and 26° 14′ 54″ north respectively, and Σ Neb. 6 (Tauri Poniatovii) of which the mean place at the same date was 18h. 0m. 32s. and 6° 49′ 29″ North. The co-ordinates of objects given in "Celestial Objects for Common Telescopes" to the nearest minute, both of time and arc, are amply sufficiently accurate, though, for finding them with any moderate power. Perhaps Mr. R.'s telescope is not powerful enough to divide the stars and so furnish means of identifying them.

That well-known amateur and occasional contributor to these columns, Mr. J. Rand Capron, F.R.A.S., of Guildown, Guildford, has just issued, for private circulation, a most ingenious and instructive chart, which exhibits at a glance the whole of the atmospheric and other meteorological conditions for every day in the year 1884. The days of the year from the abscissæ, and the heights of the barometers and thermometers, depth of rain, sun hours, wind direction and force, &c., &c., the ordinates, by the aid of which curves are laid down representing the sequent variations in the meteorological states of the Guildford climate during the past year. Of course one has often seen barometric curves, and those of temperature and the like described in this way; but it is the combination of the whole of the instrumental indications in one chart (or rather two, for it is in halves) which seems to me to be such a useful feature. The copies that I have seen are apparently photographic facsimiles of the original.

**A Fellow of the Royal Astronomical Society.**

## NEW (?) DOUBLE STAR IN CORONÆ.

[24591.]—I undertook the other evening to look at the new double star discovered by Mr. Gaudibert (letter 24439, p. 410). I think there must be an error in the place given, and that Mr. Gaudibert has been examining some known pair which he has failed to identify for that reason. There is not only no double there, but no star of the magnitude described. The brightest in the immediate vicinity is but little, if any, brighter than eighth magnitude. The only pair of any consequence near is Σ1964, but that differs entirely from the one described, and has a different R.A. and decl.

Chicago, July 28. **S. W. Burnham.**

## 36 OPHIUCHI.

[24592.]—While the matter of 36 Ophiuchi is before your readers, I would like to ask whether the variability of either of the components has been definitely settled upon as yet. I find this star was observed by me on June 22, 1883, with my 4in. equatoreal, by Cooke, p. 120, and the following notes were made:—

10h. 12m. Clear and beautiful. A double in field, magnitudes nearly equal; about 5½, distance 5″. Counting the preceding star as A, position about 40°.

At the time I was under the impression that 31 Scorpii was under observation, the telescope having been set for that object; but the instrument, having been only recently remounted, was not in very accurate adjustment, and as this double was noticed at once it was taken to be the star sought after. After making the notes I turned to Webb, out of curiosity, to see how the observations compared; but was much surprised to find such a difference in magnitudes. A more careful observation was then made, and the following additional notes entered:—

If this is really No. 31 the magnitudes and position are certainly different from Webb. The companion is nothing like an 11th mag. star; it is fully equal to the other, and difficult to tell which is the brighter. By a more careful estimate I make the possible angle about 30°, counting the preceding star as A. There is a distant 6½ or 7 magnitude star, n.p. about 3′, pos. about 315°.

Afterwards I looked into the matter more fully, and was convinced that the star really observed was 36 Ophiuchi; but still the magnitudes differed from Webb much more than any other observation made on the same night. Whilst the absolute brightness might not have been exactly 5½, yet I am satisfied that if either of the stars had differed from the other by half a magnitude, or even less, the difference would have been so perceptible that I would not have been under the necessity of designating the star from which the positive angle had been estimated as the *preceding* one.

Both the "Handbook" and Webb speak of one or other of the stars being suspected of variability; but I cannot find it in "Gore's Catalogue," nor in any other catalogue that I possess. The positive angles and distances above were estimated, not measured. **W. H. Numsen.**

Baltimore, U.S.A., July 31.

## DAYLIGHT OCCULTATION OF ALDEBARAN.

[24593.]—It is difficult to understand the meaning of the first paragraph of Mr. Pearson's letter of August 1, when taken in connection with my previous communication on the same subject. It appears that he is confusing the prediction of the circumstances of an occultation with the times obtained by actual observation, which, as given by me, are those when the immersion and emersion took place as recorded by a sidereal chronometer, previously rated by transits for local sidereal time.

Of course, as Mr. Pearson says, the times of immersion and emersion will vary very perceptibly at places in different geographical positions, and it is this very difference in time from Greenwich, obtained by observation, which is so valuable to the traveller in enabling him to compute his longitude.

Though I am at all times willing to receive advice from experienced astronomers, I must say that I think it would have been well if Mr. Pearson had made himself thoroughly acquainted with his subject before assuming to himself the rôle of mentor. **C. E. Peek, M.A., F.R.A.S.**

Rousdon Observatory, Devon, Aug. 7.

## ASTRONOMICAL.

[24594.]—In reply to Mr. J. W. Ruthven (query 57186, p. 507) I give the places of the objects named by him for epoch 1880·0, so that they may be comparable with those given in "Celestial Objects." The five years' procession will make so little difference that there need be no difficulty in identification:

(1) T Coronæ. 15h. 54m. 29s.: + 26° 15′ 36″. Authority: Gore's "Cat. of Known Var. Stars."

(2) Σ. 6 N. Taur. P. 18h. 6m. 16s.: + 6° 49′ 18″. Authority: H.'s "Gen. Cat. of Nebulæ."

(3) B.A.C. 6624 Lyræ. 19h. 14m. 57s.: + 40° 8·4′. Authority: Gore's "Cat. of Suspected Var. Stars."

(4) H. 5112 Sagittarii. 19h. 16m. 29s.: − 18° 14′. Authority: Vol. XL., R.A.S. "Memoirs."

(5) Bu. 142 Aquilæ. 19h. 21m. 30s.: − 12° 23′. Authority: Bu.'s "Third Cat. of New Double Stars."

(6) H. 1470 Cygni. 19h. 59m. 19s.: + 37° 59′. Authority: Vol. XL., R.A.S. "Memoirs."

(7) B.A.C. 7001 Cygni. 20h. 14m. 35s. + 38° 36·8′. Authority: Gore's "Cat. of Suspected Var. Stars."

(8) B.A.C. 7219 Cygni. 20h. 43m. 13s. + 45° 8′. Authority: Gore's "Cat. of Suspected Var. Stars."

(9) B. 658 Cassiopeiæ. 23h. 55m. 9s.: + 59° 41′ 12″. Authority: "Gore's Cat. of Known Var. Stars."

### Notes.

(1) D.M. + 26° 2765, 9·5 mag. Schmidt and Schönfeld, probable period 94 days.

(2) Planetary nebulæ: Small, but very bright, bore 400 well—like star out of focus. Fr., June 10, 1885.

(3) Lal. 36503 (6½m.): 7m. Harding: Pale orange, 7½m. Fr., May 10, 1885.

(4) Pretty 8m. triplet, like letter V, and all three white: 12 not seen. Fr., June 13, 1885.

(5) Lal. 36712. White: Exquisite pair, and not difficult. Fr., June 17, 1885.

(6) Lal. 38428. Pale orange, vivid blue, very beautiful. Fr., Jan. 6, 1885.

(7) There is an error of 10° in the decl. of this star, as given in Gore's catalogue. It was wrongly identified by me in 1877, the ruddy star being really B.A.C. 7008 (20h. 15m. 54s.: + 39° 1′ 32″), which is a little *n. f.* B.A.C. 7001. Both these stars are called 6 mag. in the B.A.C., and also by Groombridge, but they are certainly much smaller.

(8) About 40′ *s p.* 55 Cygni. Dull orange, 7-7½m., Fr. January 7, 1885. Gore 7m., May 21, 1883; below 7m., August 17, 1883.

(9) This is the variable U Cassiopeiæ. The estimates of mag. vary from 6 to 9: period unknown: It has a blue *comes*, similar to U Cygni.

May I now remind Mr. Ruthven that, in the last edition of "Celestial Objects," some 1,500 new objects were added to the sidereal portion, and most of these were taken from Struve. In his great work, the "Mensuræ Micrometricæ," containing above 3,000 double stars, the right ascensions are only given to tenths of a minute of time, and the declinations to single minutes of arc. The places of the brighter double stars might, of course, be found in various meridian catalogues; but, even then, it would look peculiar, to say the least of it, if part of the objects were given to seconds of R.A. and decl., whilst the remainder were only to the nearest minute of time and arc. Would not the compositor who set up the index of positions shower untold blessings on somebody's devoted head?

Surely, though, Mr. R. cannot be serious when he says, referring to objects in my lamented friend's work, that he cannot find them from the descriptions! I can emphatically assure him that I have never heard anyone else utter such a complaint. The nearest minute of arc is certainly sufficient in decl. for most people, including myself; and, as to the R A., the seconds would be perfectly useless without an accurate sidereal clock and transit instrument, or, in lieu of the latter, a time ball signal from the telegraph office. Such refinements are not within the reach of most amateurs, for whose benefit "Celestial Objects" was meant. I may tell Mr. R., further, that during the past nine or ten months I have examined over 2,000 sidereal objects, mostly from Webb, and the number of failures in identification is very, very small indeed.

**W. S. Franks.**

### STAR DISCS.

[24595.]—In letter 24538 I expressed the opinion (in opposition to Mr. Franks) that although high powers reduced the intrinsic brilliancy of star discs, the total quantity of light reaching the eye was the same as with lower powers. Further thought has modified my opinion, and I now conclude that any power that raises a disc reduces both the intrinsic brilliancy and the total amount of light. I will endeavour to state why I think so, for the purpose of benefiting by the criticism of Mr. Franks and others.

A star disc is not uniformly brilliant, but is brightest at the centre and fades gradually to the edges. Any cause that reduces the intrinsic brilliancy of disc, therefore, reduces the apparent size of that disc, because a portion of the circumference becomes too faint to impress the retina. Thus haze reduces star discs, and thus they are smaller with an unsilvered than a silvered mirror with equal magnifying power, and thus, also, a small star has a smaller disc than a large star. The theoretical disc is the same for all magnitudes: but the human eye requires a certain intensity of light to be visible at all, and with small stars this intensity only exists in the centre portions of the disc, and the outer annulus fades from view. The light is there, however, if the eye were sensitive enough to perceive it. Now, when we use a high power and enlarge a star disc, the intrinsic brilliancy of the whole disc is reduced, and a portion of the outer zone becomes too faint to impress the retina. The greater the enlargement the wider the zone which will fade. Now, this light in outer zone is entirely lost to us, and thus the total quantity of light impressing the retina is reduced. I hope not to be misunderstood: the same total quantity of light is present as before with a high power as with a low one; but the intensity of the marginal part of disc is so much reduced as to be no longer powerful enough to affect the human retina.

It follows from this that a very sensitive eye sees larger discs to small stars than a less sensitive one; that a high power reduces both intrinsic brilliancy and total light; that a high power gives smaller star discs than a lower power proportionately to the power, i.e., doubling the power does not quite double the diameter of disc; and therefore a high power will divide what a lower one cannot. How far the darkening of the sky which goes on side by side with increase of power tends to compensate for this loss of light depends very much upon the actual darkness of the sky at the time. It evidently does compensate to some extent.

Will Mr. Franks pardon me for asking how it is I am sneered at as wrong in saying the very things he says Mr. Dodge is right in.

**Edwin Holmes.**

### TELESCOPE POWERS.

[24596.]—In reference to this question, I may be allowed to remark that in No. 191 of the *Astronomische Nachrichten* there is a description of Mars, together with 24 sketches of the markings as drawn by Messrs. Beer and Mädler, at the opposition of 1830. The instrument employed was a 3in. o.g. by Fraunhofer of 45in. focus. The observers state that with a power below 185, but little detail could be made out, and that usually a single lens, magnifying upwards of 300 was employed with effect, owing to the excellent quality of their instrument. Occasionally a power of 400 was used; and on one night, when definition was specially fine, a power of 550 was brought into requisition. From this it appears that in certain instances at least 100 to the inch has been most successfully utilised.

With regard to the controversy on star discs, it does not need much optical knowledge to see that Messrs. Holmes and Dodge are correct in their deductions. Mr. Franks might have acknowledged his error in better form than he has done in letter 24565, p. 497.

**W. C. Rogers.**

August 7.

### CHEAP TELESCOPE STAND.

[24597.]—It has been remarked of my telescope stand, that the name of gimlet and string is so unphilosophical-instrument-like, as to be objectionable. My object has been to describe to our readers a cheap and efficient stand that can be made by anyone who can obtain the necessary tubing; but there is no necessity for either gimlet or string, or wooden arms to be used, as the necessary motion may be easily given to the telescope by screws, as in the usual altazimuth stand, thus, a fast and loose arm of wood or metal, carrying a screw, must be placed on the top of the upright socket in which the spindle turns, and another fast and loose arm carrying the nut of the screw must be placed on the upright spindle. These, when fast, will draw the telescope in altazimuth, and when loose will allow the telescope to be turned in any direction, so that the observer will always have the head of the screen handily placed for his use. A similar arrangement placed on the end of the sleeve, and on the end of the crosspiece, near the eyepiece of the telescope, will draw it to altazimuth. Thus all gimlets and string will be done away with, and the stand may be made as optical-instrument-like as desired.

The refracting telescope should have a diagonal reflector or prism at the eye end, so that the eyepiece may be always in the centre of motion, and the observer always facing the centre of the stand. With these alterations I believe the objection will be done away with. The telescope should be balanced without tendency to move in any way.

**Philip Vallance.**

### THE CASSEGRAIN.

[24598.]—In reply to "A. S. L." (letter 24456), it is very easy to find A B or A D when the foci of the mirrors and their separation are known. Thus, referring to Fig. 2, page 380, B D is the known separation, B C the given focus of the great mirror; hence (B D – B C) = C D = $u$, which is thus given, and by the formula—

$$\frac{1}{v} = \frac{1}{AD} = \frac{1}{f} - \frac{1}{u}\cdot$$

from which A D is readily found.

Two parabolic mirrors, placed at the sum of their focal distances apart, would certainly receive and reflect parallel rays without aberration; but would they, in this condition, be of any service as a telescopic arrangement?

**Orderic Vital.**

### NEW OPTICAL GLASS.

[24599.]—It will doubtless interest your practical optical readers to know that I have just received from the eminent glass makers, MM. Feil Père et Mantois, 30, Rue Lebrun, Paris, a specimen of what, I presume, is a new kind of optical flint glass. It is very heavy, and has a very pale yellow, or rather a very pale amber, tint. The specimen is cut from a plate ⅜in. thick, and is polished on one edge, is clear and transparent and free from any specks or air-bubbles. The label on it says "Flint, extra dense, No. 1738," and the density number is either "4 . 7" or "4 . F." I cannot make out what the latter (if correct) means, but 4·7 is more likely to be the true reading.

It is probable that this glass will be of much service to those engaged in spectroscopic and microscopic work; as, from its density, it must have a high refractive and dispersive power. I have no other particulars respecting this flint; but if any practical reader has received and worked any of it, I hope he will tell us what are its chief characteristics.

**Orderic Vital.**

### PYROLOGY—MANUFACTURE OF ALUMINIUM—CALCIUM.

[24600.]—Col. Ross is quite right in supposing that chemists desire him to examine the aqueous solution of his boric-acid bead for lime, though scarcely by the simple addition of oxalic acid to the liquid. An examination for lime by accepted methods, properly conducted, would be the way to prove his case to chemists, whom, Col. Ross complains, have an "animus" against him. I repeat that no one doubts the accuracy, so far as the small amounts of material permit, of Col. Ross's observation that he obtains a ball of four times the weight of the lime he uses, and that he does that repeatedly; but the complex molecular formula ($5CaO, 12B_2O_3$) corresponding to the experimental observation suggests to chemists that the composition of the ball requires rigid verification. This verification Col. Ross seems not to see the necessity for; but until it is performed chemists will be apt to consider his case "not proven."

Col. Ross conducts the operation in question in a small loop made at the end of a platinum wire. I suggested a platinum crucible as a suitable substitute for the platinum wire, and one which would allow of reasonably large quantities of materials being used. Col. Ross replies that "these reactions cannot be produced in that," that is, in a platinum crucible, though he does not state why a change in the form of the apparatus should alter the chemical reactions. However, if he prefers the "aluminium open furnace," by all means let him use it, and work on such a quantity of material as will satisfy chemists.

It is quite clear that if a balance be used which indicates $\frac{1}{10}$ of a milligramme, and that five milligrammes of lime be taken for an assay, the amount of lime used cannot be known within 2 per cent. On the other hand, if Col. Ross employed 5,000 milligrammes of lime, he would know the amount taken to within 0·002 per cent., and, assuming no error to arise from faulty manipulation or defects in the process, the accuracy of the determination would be correspondingly increased. Chemists ordinarily employ such amounts of material as can be readily manipulated, washed, &c., while allowing of sufficient accuracy in weighing. There is no balance in existence which would render the use of five milligrammes preferable to five grammes, on the score of diminished friction on the fulcrum.

The reference of Col. Ross to the delicacy of spectrum analysis is wholly beside the point. Spectrum analysis is a qualitative test, whereas the wet methods of chemical analysis aim at quantitative accuracy. Both are invaluable in their own way, as is the system of anhydrous analysis which Col. Ross has done so much to advance. But until Col. Ross can, with the blowpipe, determine accurately the lime present in a complex mineral, such as iron ore, his attempts to ridicule the only methods by which such a desideratum can be effected are, to say the least, out of place.

I am sorry I have trodden on the corns of "P. E. W." in my criticisms (p. 434) of his reply to query 56949 on the "Manufacture of Aluminium." But as his answer began with the words, "The following is Webster's process for the manufacture of aluminium," I thought it only right to state the details given did not refer to the preparation of the metal. This seemed the more necessary as a similar description of the preparation of alumina appears periodically in one journal or another, and is liable to mislead those who are unaware that Webster's process still necessitates the use of sodium as a reducing agent. According to "P. E. W." the product costs only about £100 per ton, instead of £1,000." Readers should understand that by the "product" must be meant alumina and not aluminium, the metal not having been appreciably cheapened by Webster's improvements in the preparation of the oxide. Certainly, from the reply of "P. E. W.," it might be supposed that the *metal* had been reduced in cost to one-tenth, especially as he immediately proceeds to describe the tensile strength and other properties of the metal.

This question of the cheap reduction of aluminium is highly interesting, and chemists are prepared at any moment to hear that the problem has been solved. Various patents have been taken out from time to time, in which a number of methods, more or less improbable and unscientific, are described. But what are we to say of the correspondent writing under the initials "F. W. G., Wolverhampton," who, on page 438, states that he obtained aluminium "in a simple and inexpensive way," and then calmly asks "if any person can inform him of the present price of aluminium." Now, if "F. W. G." and "P. E. W." will only put their heads together, the one producing pure and cheap alumina, and the other reducing it to aluminium in his simple and inexpensive way, there is no doubt that the metal will be much more largely used, and the proportion to be found in Webster's alloys will be greatly increased. As Mr. Grey reminds us, "E. G." wrote some time since that he had succeeded in reducing alumina by means of sugar, and *still* the metal is expensive.

"F. W. G.," who, on page 481, gives his name more fully, has not only reduced aluminium simply and inexpensively, but has also obtained calcium from lime by the same process. His description of calcium as a beautiful white metal which will not odidise is a most interesting and novel statement, as calcium has hitherto been obtained (as a chemical curiosity) as a yellow metal, oxidising with facility in moist air, and violently decomposing water. But is it not a pity that Mr. F. W. Gerhard should have kept this information to himself, when, by publishing it in some scientific journal and sending specimens of the metal (say, of a few pounds in weight) to the Chemical and Royal Societies, he would have made himself the scientific lion of the season? He has another chance in the British Association, which will meet at Aberdeen next month. If circumstances prevent him from personally attending and exhibiting his calcium and calcium alloys, I shall be very proud and happy to do it for him, and will take care that he receives full credit for his interesting and valuable discovery. There is no occasion for him to make known the process by which he achieved success, and by which he will, no doubt, acquire riches as well as fame. But why, oh why, did Mr. Gerhard first announce his discovery under mere initials, and in a reply to a question on another subject? Here is a discovery that some of us would have given our ears to have made, and the modest Mr. Gerhard appears to think it of "no consequence." I hope it is not another disappointment for us, like the manufacture of diamonds, the production of quinine, and the decomposition of chlorine.

Sheffield. **Alfred H. Allen.**

### CAN ALUMINIUM BE EXTRACTED CHEAPLY?

[24601.]—I AM afraid that letter 24585, page 501, does not throw much light upon the above question, which I have copied therefrom. The difficulty lies, not in the production of alumina, but in the extraction of the metal from its oxide after the latter is obtained; even were alumina got free of cost, it would, I believe, not very materially lessen the price of aluminium, for the cost of reducing the chloride of sodium is much greater than the cost of the two preceding processes—i.e., the preparation of alumina from bauxite, and conversion of it into the double chloride of aluminium and sodium. The great reducing agent in metallurgical work is C, or CO, and unfortunately the reduction of alumina by either of these bodies is absolutely impossible, according to the principles of the conservation of energy. I pointed this out some time ago, in reply to a correspondent, "A. E. S.," who said he had reduced $Al_2O_3$ by means of sugar; his reply was not altogether respectful to the conservation of energy; but I have not seen cheap aluminium yet. Mr. Allen is well able to hold his own in his controversy with Colonel Ross as to the borate of lime beads, and I do not intend to interfere; but I would like to say that I entirely agree with the Sheffield gentleman that so far the Colonel has not proved anything as to his beads.

**Wm. John Grey, F.C.S.,**
Newcastle-on-Tyne. Analytical Chemist.

### GRAY'S WATER MICROSCOPES.

[24602.]—UNDER the heading "A Pocket Field Microscope" (24586), a form of microscope is described for utilising lenses composed of drops of water.

Permit me to remark that the microscope in question is an inferior form of the "Water Microscope" I invented some 200 years ago, and which I communicated to the Royal Society near that date.

The inferiority consists in the practically impossible condition that with a magnifying power of 100 diameters the hand will be steady enough to focus by merely pressing together two blades of bent metal connected as a V. Such an arrangement is worthless. My plan provided a thumbscrew for adjusting the focus.

Nearly every textbook of the microscope in English, French, or German, published since that date, refers to my water microscopes.

In the ENGLISH MECHANIC of June 5, p. 299, my water microscopes were described with commendation—a commendation that was gratifying to me in spite of my years.

**The Ghost of Stephen Gray.**

### FLOWER-POTS.

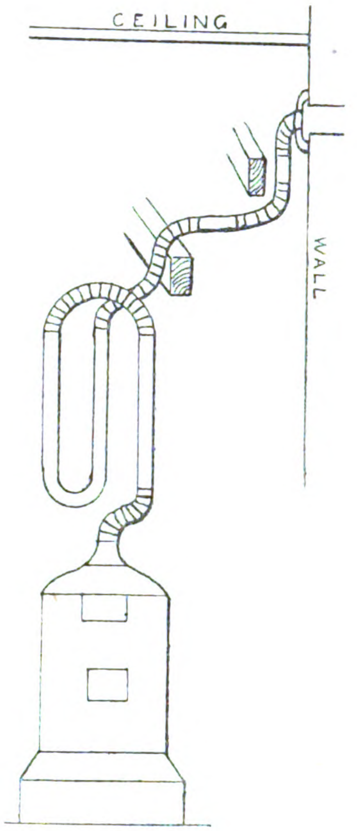
[24603.]—IN reply to "Conservator," letter 24553, four years ago I had a lean-to greenhouse 18ft. by 7ft. erected; it faces the east. When I selected plants for it at the nursery, I asked if glazed pots would be suitable for growing the flowers in. I was told they were not suitable, and that if I wished to have fine growing flowers, I must have the usual unglazed pots. Although I had never seen the glazed pots used, I was sceptical of the universal opinion expressed by the florist, so resolved to have a trial of the glazed pots. I bought about 70 them assorted, 5in., 6in., and 7in., and had the flowers put into them in the usual way. About a year after this a gardener happened to call, and I showed him my greenhouse, and he was surprised at the healthy green appearance of the plants; in fact, they were far healthier-looking than his own. I have never failed to grow the usual greenhouse plants in them; quite the contrary, they grow well and keep an appearance to be seen in very few greenhouses as far as healthy look is concerned. There is one drawback, however, not with the pots, but the exposure of the house (east). It tends to draw the flowers too much.

I do not know anything about the scientific views on the subject wished by "Conservator"; but from practical experience I may say all the difference I can find is that the glazed pots require much less water, and probably a little better attention to prevent overwatering. That is all I can make out, and I have had four years' trial of them. They always look nice on the shelves, and never get green. I believe if some potter was taking it up and bringing out something unique, pretty, and cheap, he would have a large sale for them.

**M. C. J.**

### A CURIOUS STOVE.

[24604.]—IN an old house on the hills near to Zugg, in Switzerland, I found a bedroom warmed by a stove of which the pipe was convoluted in the strange fashion indicated in the inclosed rough sketch, and the pipe was without support, running clear of, and over the lower, and under the upper, of the beams which are indicated. The segments seemed to fit and "bite" by merely twisting them together.



The bends of the pipe were all made in the manner of what we know as the lobster-back cowl, used upon our chimneys. A workman took this apparatus down, and put it up again in less than two hours, while I was there, and no solder nor rivet was used in doing so. Can any reader kindly tell me if a similar arrangement of 3in. 3½in., and 4in. stove pipe is known in England? Personal inquiry of the attendants at the stove departments of both the Healtheries and the Inventions has failed. **Wm. Lane Sear.**

### DAY OF THE MONTH CLOCKS.

[24605.]—I THINK letter 24559 on this subject, with a mysterious French signature, is right; but I have no means here of looking further into the construction of such clocks. Perhaps the writer can give a drawing and description of "the Ithaca construction," which he mentions.

He is wrong, however, in saying that I attributed to Americans the conversion of what certainly used to be written "bunkum," and to mean bluster, into "buncombe," meaning (he says) flowery language for the captivation of a place of that name. I attributed it to Englishmen who are familiar with the name of the Duncombe family, though probably Americans are not. "Bunkum" is a word that somehow suggests its own meaning, which "buncombe" certainly does not in England.

**Edm. Beckett.**
Batch Wood, St. Alban's, Aug. 6,

### COLLIERY EXPLOSIONS.

[24606.]—IN your issue of the 10th of July I notice a letter (24447) from Col. Shakespeare, in which certain suggestions are made under the belief that if carried out they would tend to prevent such occurrences in the future. The desire of your correspondent to benefit the thousands who are interested, and in many cases unable to help themselves, deserves some attention from those who, by experience, are well versed in this important question. As a mining engineer, it will not be difficult for me to show that Col. Shakespear's suggestions are practically of little value for the purpose intended; although from the lack of particulars as to the exact method of carrying out the ideas of your correspondent, I shall only be able to deal with what is really stated. It is quite true that a fall of the barometer to the extent of ½in. reduces the atmospheric pressure 35lb. on the square foot; but the further statement that the action of a furnace or fan reduces the pressure another 35lb. is scarcely applicable to ordinarily managed mines. Col. Shakespeare says a ton of hewn coal is capable of giving off 10,350 cubic feet of carburetted hydrogen. This, under some circumstances, may be so, but in the mine I question whether anything to prove this statement has ever occurred. Your correspondent further states that a blower is known to be under pressure of 30 atmospheres, which being more than 400lb. per square inch, I would ask What use would the maintenance of the ordinary atmospheric pressure of 14lb. be to such an enormous pressure as stated above? And further, Col. Shakespear must know that a face of coal is constantly generating gas which, if kept back by a greater pressure, would in a very short time in itself overcome that increased pressure, and gas would flow as freely from the coal, and in such quantities, as from time to time were generated, just as if no increased pressure had been supplied; whilst on the slightest reduction of the artificially increased atmospheric pressure, the pent-up gas in the seam would be liberated in greater and more dangerous quantities than under ordinary circumstances could occur. To attempt to prevent the natural escape of firedamp is always dangerous; escapes both large and small will always take place, and the only way to prevent or minimise colliery explosions is by enforcing a good uniform discipline which will provide for these occurrences by never underrating or treating too lightly the risks which those having had experience in fiery mines know sadly too much of. **G. Worlands.**

Aug. 3.

### MAGNIFYING POWER OF REFLECTORS.

[24607.]—WILL you allow me, as an old subscriber, to say a word about high magnification of telescopes. W. P. Dodge (letter 24545) writes as if a 12in. mirror will bear 600; and again, he says his 6½in. raises a disc with 300 and 600. Does this apply to bright stars? I have an 8½in. mirror by one of our first makers, but I cannot obtain a clear disc with 200. I have a friend with an 8½in. by the same maker and he cannot do it. I have had several letters from him in which he complains that Arcturus is nothing except with a very low power. He has been staying with me for a short time, that we might compare notes together. My 8½in. performs exactly as his own. With 53 on Arcturus I get a clear and beautiful disc. Raised to 130, the disc is surrounded with rays like the small diagrams that represent first-magnitude stars on maps. With 200 it is a smudge, like a nebula with intensely bright points. A 5in. achromatic by Grubb will show distinctly a disc and diffraction rings when using the higher powers. But with the reflector neither disc nor rings are visible. May I ask if any other observers have been thus troubled when looking at first-magnitude stars. I had the same annoyance a few years since with a 6½in. mirror, and I know others with the same experience.

The question arises, Are mirrors a failure on bright stars? Can anyone tell us how the giant mirrors perform? Are they used only on minute stars? **T. H. Browne.**

### WATER-WASTE PREVENTERS.

[24608.]—"MONTMARTRE" (letter 26522) has found a common defect in water-waste preventers. I have found those in the market so trumpery, that I have special patterns made to supply what I consider a great want—namely, a good, strong, useful water-waste preventer. I should expect to find "Montmartre's" trouble lay in the pulling of chain and lifting the lever so high, and ball with it, that it cuts the rubber through before coming to the stop. Care should be taken in fitting that the stop should stop the pull, not the rubber and seating of ball-cock, which is usually the case. **E. Knight.**

### SAFETY BICYCLES.

[24609.]—THE opinion of the cyclist portion of your correspondents on the above subject would be very interesting and instructive to others besides myself. The geared bicycles have been in the market about two years now, so that there has been time to test the virtues of the various patterns. Before I rode one of these machines, I had big expectations of the speed I could be able to fly over the country; but actual experience has, up to the present, shown those expectations to be hardly fulfilled.

I ride a "Kelsey," 36in. wheel, geared to 54in.

I find it a great strain on the wrists to steer, and cannot get up a speed on level road above 9 miles per hour without undue exertion; then, not being of a suicidal tendency, I have had to dismount at every patch of fresh-metalled road, and if I fall at all it is over the handles, which, with these safeties, is supposed to be impossible under ordinary circumstances. I have to walk up hills which with a tricycle (Greyhound) I have ridden up with comparative ease. Any roughness or inequality in the road is painfully forced on my attention by being jolted almost out of the saddle, and I could almost plant a tree in the dust deposited on my trousers after a five-mile ride. There is no doubt that these geared bicycles make splendid track machines; but a 36in. wheel is too small to roll over the impediments in a rough road. The difficulty of driving may be that it is geared too high. Am I alone in these experiences? I should very much like to know. (P)

## THE OTTO BICYCLE.

[24610.]—In answering "A South Australian Bicyclist" I do not propose to say anything about the merits of this machine, as they are now pretty generally recognised, but shall give the result of the last year's experience as to the most desirable size, &c.

I used to speak in favour of the high 56in. wheels as being on the whole preferable to smaller wheels, though for mere pace on a good road the smaller size, geared up, was found best. For all-round work most riders preferred the large wheels.

Now that the best riders of the Otto have adopted the elastic spokes, there is a change. A 50in. or a 52in. elastic wheel gives far more than all the comfort of the ordinary 56in. wheel, while it has in other respects all the advantage of a light, small wheel; and so each rider who makes the change from 56in. straight spokes to 52in. elastic spokes finds an increase in his average speed of from one to two miles an hour.

I have now ridden my elastic wheels over 2,800 miles, which is enough to show that the spokes retain their form. As to the strength of these wheels, I have treated them more severely than I should have dared with the old rigid wheels.

I still use rubber-lined bands; but flax-lined bands are now supplied, and give, I believe, satisfaction. I find the rubber-lined bands behave perfectly in the hottest and dustiest weather, and in the wet and snow of winter; but some riders found them give trouble, and so the flax-lined bands have become general. It would be quite unnecessary for "A South Australian Bicyclist" to have more than one, or at most two, pair of spare bands. **C. V. Boys.**

[24611.]—In reply to "A South Australian Bicyclist" (letter 24571), I have much pleasure in saying that my enthusiasm for the Otto, and delight at that method of conveyance, are unabated.

The machine wants learning, and is well worth it. For my own part, after a year's experience, I am learning it yet, in the sense of the illustration given in your pages a few months ago by a skilful rider. He explained, with reference to an inquiry as to simultaneous stopping and turning, that proficiency on the Otto is akin to proficiency on the piano; and where one performer can only manage straightforward tunes and simple passages, another can emulate the variations of Mr. C. Hallé.

Unfortunately the Otto is not so widely known as it deserves to be. It is strange that the makers do not send an itinerant representative from town to town, who could introduce the machine to the cyclists of each locality. Perhaps South Australia is rather too distant for missionary enterprise of this character: but your correspondent would find the published "Hints on Riding" amply sufficient for his guidance. **Antares.**

## ON THE CONSTRUCTION OF A WHEATSTONE'S BRIDGE.

[24612.]—A perfect Wheatstone's bridge is a piece of apparatus which is very expensive to buy, and in its usual form not very easy to make. Below I give the necessary description of and directions for constructing a form of bridge which has given very good results in my hands.

The first step is to make a box to contain the coils, the bottom and sides of which may be made of deal, stained black and well varnished or French polished. The top, however, which is to hold the necessary apparatus for manipulating the coils, must be of hard wood, such as oak or mahogany, well seasoned, and varnished on top; the whole, when complete, to be similar to Fig. 1.

The most useful set of coils to use are, for the variable arm: 1, 2, 3, 4, 10, 20, 30, 40, 100, 200, 300, and 400 ohms; and for the others, 10 and 100 each. With this set any resistance between ·1 and 4,000 ohms may be accurately measured. We have now to make these coils. For this purpose we shall require a differential galvanometer and a 1-ohm coil. (I shall be glad to send anyone desirous of constructing a bridge a 1-ohm coil.) By means of the coil and galvanometer, another 1-ohm must be taken, and with the two coils coupled together a 2-ohm must be measured, then from the 1 and 2 ohms a 3-ohm is obtained, and on on. It is obvious that by this means coils of any value may be taken. They are made of German-silver wire, No. 30, for the small coils, and No. 38 or 40 B.W.G. for the larger ones. Each coil is next wound on a core of paraffined tissue paper, each layer of wire when completed being dipped in melted paraffin, when the whole of the wire is wound on except the two ends, which are to be left free. It is placed inside a small wooden tube (which may be obtained from any wood turned for a small sum); the coils now have the appearance of Fig. 2, and will be ready for mounting in the box.

FIG. 1.

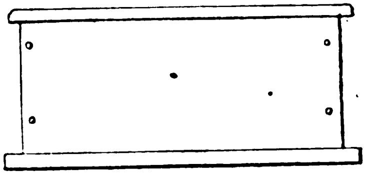
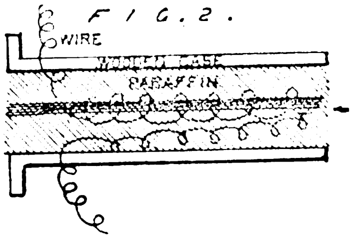


FIG. 2.



The box-lid, however, still requires the necessary apparatus for throwing the coils in and out of circuit. For this purpose cut out of sheet brass (about the thickness of a postcard) a number of pieces equal to the number of coils used—2, similar to Fig. 3; also 4 pieces as Figs. 4, and 2 of Fig. 5.

FIG. 3.

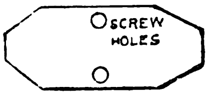


FIG. 4.

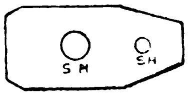


Fig. 6 will indicate the respective positions of the different shapes. To the middle point of one side of each of these brasses, solder a thick copper wire, about 3in. long; next, bore holes in the wooden top in such place that the brasses may be arranged as in Fig. 6, whilst the wires project through to the other side. Procure 18 binding screws, as Fig. 7, and screw them up tightly at *a*, so that they will not come unscrewed.

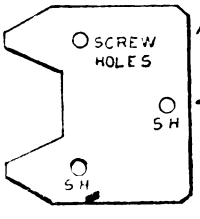


FIG. 5.

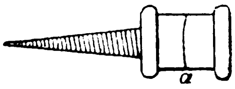
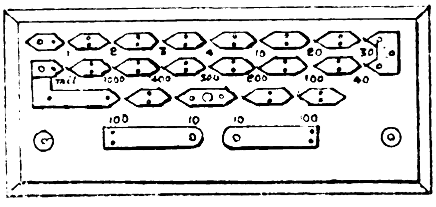


FIG. 7.

FIG. 6.



Between every two brasses on the box-lid, drill a hole, and place therein a binding screw, so that the shank shall not touch either of them; Fig. 8 will explain itself.

When the binding-screw is screwed fully down, the flange makes contact between the two brasses, and throws the coil beneath it out of circuit, and *vice-versâ*. The coils may now be placed in position, which is done by means of glue and screws, the ends of the coils being soldered to the copper wires projecting from the brasses (as seen in Fig. 8). The connections are now to be made by soldering thick copper wires underneath the lid of box. Connect A to K, H to L, M to C, B to E, F to $G^1$, $G^2$ to D (Fig. 9).

FIG. 8.

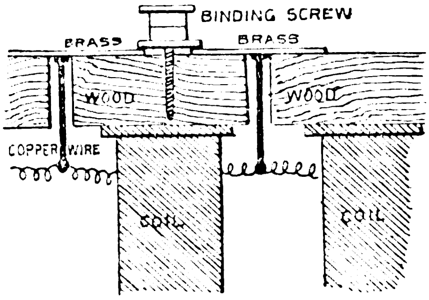
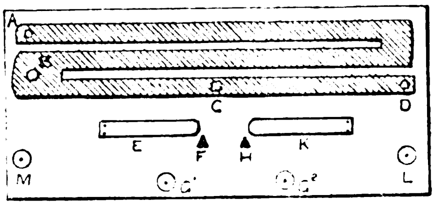


FIG. 9



The galvanometer is connected up to $G^1$ and $G^2$. The battery terminals to M and L, whilst the resistance to be measured is placed between A and D. E and K are contact springs, F and H being the buttons underneath upon which they strike to make contact. **Fred Loundes.**

## SIGNAL RETURNS.

[24613.]—I am rather astonished that "Coral," in last week's number (letter 24576), should ask for an explanation of these returns, because they are as clear as they can be.

A junction between "passenger lines" means exactly what it states. Junctions between a passenger line and a goods line also is perfectly plain. "Any siding" means, of course, what it says, *any* siding, passenger or goods. "Safety-points" refer to "Safety points required to prevent trains running out on main line," not to runaway catch points. A "loop line" has two junctions, one at each end; an ordinary double line junction is one junction. The Return *re* Signals gives all that is wanted, so I don't see why "Coral" wishes for more. **Signal Post.**

## FAILURES OF BRAKES.

[24614.]—Would "Midland" or other reader be so good as to explain the cause of that long "72 minutes delay" mentioned last week? Was it the ball-valve sticking, or was it dirt in the leak hole? The leak hole brake did not cause such delays as the above, and the change seems a doubtful improvement.

On the 25th July, 1885, there was a series of delays to a special of volunteers returning from Portsmouth to Derby. The train was made up of L. and S.W. carriages with the ball valve brake. The hose pipe opened and admitted air, and the brake went on and caused delays as the vacuum brake would not come off, and at Bedford they had to take a carriage out of the train and move the passengers.

There was another vacuum failure on the 6th inst. A hose pipe on the 11 noon Manchester to St. Pancras broke and destroyed the brake. The strange thing was that when the vacuum automatic brake failed it did not stop the train. Perhaps "Meteor" or some of "Ours" would say where the automatic action went to? **Loco.**

## THE PENISTONE ACCIDENT.

[24615.]—In reply to your correspondent "Traveller," p. 500, last week, I regard the failure of justice in the action brought by Mrs. Woodhead against the Manchester, Sheffield, and Lincolnshire Railway Company as a very serious matter, both for the widow, the travelling public, and the railway servants. The company employed Smith's vacuum brake, which is well known, and admitted to be inefficient and useless in case of accident; it has persistently disregarded the conditions of the Board of Trade laid down as long ago as August, 1877. It was conclusively proved in evidence that the absence of a quickly-acting automatic brake was the cause of the fearful loss of life. It therefore follows that the company neglected its duty within the meaning of Lord Campbell's Act of 1846. I was in court throughout the hearing of the plaintiff's case, and after the evidence given by Major Marindin and other witnesses, I am perfectly at a loss to understand upon what grounds any jury could return a verdict in favour of the company.

Attention may here be directed to a comparison of the Penistone and Downton accidents; in both instances the trains ran off the line, down the embankment, and persons were killed in consequence of there being no efficient brakes.

In the former case the jury awarded no damages, and appeared to consider there was no "neglect." In the latter instance a jury concluded that there was serious neglect, and very properly gave fair damages accordingly.

The result of the Penistone case may be regarded in a serious light not only with reference to this accident itself, but as a precedent to the future. In point of fact, it simply means that companies can run their trains as they choose, may kill passengers at pleasure, and cannot be made to pay for the results of their own "neglect."

**Clement E. Stretton, C.E.**

Leicester, August 8th.

### THE PENISTONE ACCIDENT—WOODHEAD v. M.S. & L. RAILWAY COMPANY.

[24616.]—"Traveller" (in his letter 24577, page 500) asks for the opinion of railway correspondents on the above, and as to what negligence is. From his remarks offered, he is evidently one of those who "Damnant quod non intelligunt."

In the first place, his statement as to "persons being killed in consequence of neglect of 'company' to provide proper brakes" is entirely incorrect, as a slight review of the facts will show.

The accident was caused primarily by the breaking through of the web of the crank-axle. This caused the connecting-rod to break, which plunged into the ground, and tore up the check rail and the line generally, the tender leaving the metals. The next coach to the engine, having no rail to run upon, naturally continued in a straight line, and as the rails here took a curve the couplings (regulation pattern and strength) broke, and the train was precipitated down an embankment, the engine keeping to the rails.

The question now resolves itself into numerous points, the principal, however, being as to whether the company had employed sufficient care in providing and examining the crank-axle, and whether they had in use an efficient brake, or whether, under the circumstances, a brake would have been of any avail at all.

I may here explain that negligence is "want of attention in exercising due care, skill, and foresight in everything that concerns the safety of passengers."

Let us now examine the facts elicited at the trial. It was proved to the satisfaction of the Judge and a more than usually competent jury (a number of them being engineers) that the "big end" had been taken off only a fortnight previously, and a careful examination made, and no flaw detected (the spot where the flaw occurred was covered by the big end, and therefore it could not have been seen in the usual daily examination); that it was not the custom or practice of *any* railway company to take the big end off more than once a month (the engineer of the Great Western stated that on that line it was only taken off once in two or three months). That the flaw was an internal one, which grew outwardly, and most probably was not visible until the very moment the accident occurred. So much for the crank axle.

With regard to the brake, the plaintiff's own witness, Major Marindin, stated that, in his opinion, no brake in the world could have prevented the train from running over the embankment. This being so, the probability of any other brake than the one used lessening the mortality is merely conjecture, and I endorse the very general opinion that an automatic brake might, by prematurely locking the wheels, have caused the carriages to tumble topsy-turvy, instead of running down, and thus made the result even more deplorable than it was.

A small point, I may mention, was raised as to the position of a horse box in the train, it being the first carriage after the engine; but although Major Marindin said the proper place for it was at the end of the train, still, in his opinion, he said that would not have in any way avoided the accident or decreased its results.

The company, therefore, having provided the best crank axle procurable (the cost of a locomotive crank axle, "Traveller" may be surprised to learn, is usually about £125), and examined it at intervals, which, according to all railway engineers, exhibited sufficient due care, skill, and forethought, and the brake not in any way, according to the plaintiff's principal witness, affecting the accident, why, I should like to ask, should the company be liable?

I am sure that with the above circumstances before him "Traveller" will have no occasion to again ask, "Justice! where art thou?"

**Vera pro Gratiis.**

Manchester, 10th August.

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[24617.]—I am a strong advocate for automatic brakes; but I cannot arrive at the conclusion which your correspondent "Traveller" does in last week's issue, that the verdict in the Penistone case was wrong, and that "24 persons [were] killed and 62 injured through neglect to have a proper brake." I think the verdict was quite right, and further believe that no automatic brake in this case would have avoided the loss of life. Automatic brakes are of the utmost use in many cases; but there are many cases where they will not prevent a calamity, and I quite think, having heard the whole case, that the Penistone disaster was one. It was generally admitted that the train was running about 50 miles per hour down an incline of 1 in 124, and on a 40-chain radius. The axle of the engine broke west of the signal-box, and by some extraordinary means tore up the check rail opposite the signal-box, which was found imbedded in the bottom of the tender. This rail injured the vacuum appliances under the tender, and no doubt the hose coupling was then broken. The signal-box is 102 yards from where the left rail was broken up, and the carriages ran off at a tangent down the embankment. An automatic brake takes about two seconds before it comes into full operation. Fifty miles an hour is practically 25 yards a second, so assuming that the train had been fitted with an automatic brake, and that the hose pipe was broken when the rail was torn up at the signal box, the train would have run 50 yards of the 102 before it was full on. Now the question is, Would any brake have pulled the train up in the remaining 52 yards, or, at any rate, have slackened the speed to any considerable extent, and so have averted the loss of life? I do not think it would, and rather think the silence of some of your esteemed contributors on railway matters know it would not. In Captain Galton's trials with an automatic brake on the L. and T. Railway, a similar train to this on a like gradient, was reduced from 45 to 37 miles in 102 yards, and in some experiments on the Midland made some time ago, a similar train to the Penistone train, on the level, was reduced in speed in 102 yards from 50 miles an hour to 44½, and, in another case, to 44. If, therefore, the Midland train travelling at 50 miles an hour on the level could only be reduced to 44 miles in 102 yards, how could the Penistone train, going at 50 miles an hour on a falling gradient, though on a 40-chain radius, be reduced much below 44 miles an hour? The first carriage, in which all the loss of life took place, must have gone over the embankment while the speed was very great, and in the 102 yards available, I do not think any known brake would have prevented it. The question is an all-important one, and I think, and hope, the day is not far distant when automatic brakes will be in general use; but, as an old subscriber, and feeling that the verdict, under the circumstances, was right, I cannot let "Traveller's" letter go unanswered.

Manchester, Aug. 10. **W. G.**

### MIDLAND ENGINES.

[24618.]—"Kappa" says (p. 476) that the new M.R. engines "are, or will be, amongst the finest in the kingdom."

Would he explain his reason for thinking so, and is he aware of the number of failures and breakdowns with these engines? No. 1675 alone has failed, and had to give up the Scotch expresses on many occasions, and only so lately as the 6th inst. the 10 a.m. Nottingham express from London had to make a special stop to put off engine 1674, hot and broken down. With all these failures on record, I can't agree with "Kappa"; but quite agree with those who have said the 800 class are the finest on the Midland. **Express.**

### HYDRAULIC RAMS.

[24619.]—As information respecting rams seems to be wanted, it may not be out of place to give particulars of two or three which are at work under what I consider extra low falls.

One has a fall of 3ft. 9in. from head to tail; water has a rise to cistern on top of house of about 100ft. This ram delivers about 1,000 gallons in 24 hours, and has a 4in. drive pipe.

No. 2 ram has a fall of 2ft. 8in., except when the water is stopped back for watering meadows; then it works under water with less fall. This ram, a 2½in., delivers, with the 2ft. 8in. fall, between 900 and 1,000 gallons daily to a height of 36ft. When the water was first let into this machine, the valve would not rise, but let the water continually run to waste through it. I had another valve made; you would suppose a lighter one, but I had a heavier one made, with less waterway through it, and it has answered well since.

The third ram I was sent for last week to repair, and once before soon after it was fixed. This ram has a 1¼ drive pipe, and was put in some two and a half years back by a London firm; it has a fall of about 3ft., and a rise to cistern of about 30ft. This ram is fixed in such a way that it is a wonder it works at all. When I left it, it would only rise the water to the ground level at house about 20ft., it would not lift to the cistern about 10ft. higher. It is fixed about ⅜in. out of level, in a pit close to dam, with 12ft. of horizontal drive pipe laid 1ft. 6in. under water, with a bend and elbow before entering ram. If this ram were properly fixed, with sufficient drive pipe, I am satisfied it would do double what it has done. **E. Knight.**

### SULPHATE OF SODA IN DANIELL'S BATTERY.

[24620.]—It has been suggested to me that mention of the following fact, in which I have very likely been anticipated, but which I described in the *School Guardian* of last Saturday, might not be without interest for the readers of the English Mechanic.

I have been in the habit of using Daniell's cell for the electric bell, dispensing with the porous-pot and the dilute acid, and leaving the zinc as well as the copper in immediate contact with the copper sulphate. I may well be asked how I prevented the deposition of copper upon the zinc rod through local action where the circuit was broken. I suppose that the difficulty would have arisen earlier had I not filled up the cell with sawdust and wrapped the zinc in paper or cloth. With this arrangement, however (which I had adopted for entirely different reasons), the gradual deposition of zinc sulphate upon the rod protected it, to a great extent, from the polarisation, which could not be entirely prevented. Curiously enough, even the moist cloth or brown paper seemed to act as a conducting plate, and received a considerable deposit of copper when I omitted the sawdust.

Considering, however, that the dilute sulphuric acid which, in the usual arrangement of Daniell's cell, is in contact with the zinc, serves the purpose of preventing permanent polarisation through the deposit of copper, and that this is the only purpose which it does serve, it occurred to me that I would recur to the porous pot and the two-fluid system; but would substitute a strong solution of sulphate of soda for sulphuric acid. I at once found, as I expected, that whether I used sulphate of soda or acid (the latter was diluted in the proportion of 1 to 12 by measure—say, 1 to 8 by weight), the needle of the tangent galvanometer assumed and retained exactly the same position; but that whilst the acid corroded the zinc, and produced a large development of hydrogen bubbles (owing, perhaps, in part to imperfect amalgamation), the neutral sulphate was perfectly harmless, and might be left in contact with the zinc, after the circuit was broken, as long as I pleased. Of course, the principle is the same as that of the Leclanché cell, in which the sal-ammoniac is perfectly passive until the circuit is completed.

It is quite clear that the sulphuric acid ordinarily used in Daniell's cell can furnish no energy to the combination, because, as fast as it is decomposed by the zinc, it is recomposed at the expense of the sulphate of copper. It simply transmits, so to speak, the molecules of $SO_3$ from the outer cell to the zinc, and so far as it does more than this it is mischievous. **Abner E. Brown.**

Wadenhoe, Oundle, Aug. 10.

### HIGH CHIMNEYS.

[24621.]—In your impression for July 31st you say "the highest chimney in England is said to be Messrs. Muspratt's chemical works," &c. This chimney does not exist, it was blown down with gunpowder about nine years ago.

The highest existing chimney-shaft in England now is that of Messrs. Dobson and Barlow, Kay-street Machine Works, Bolton, Lancashire; it is 367ft. 6in. high from ground line, and measures 14ft. on each side of octagon at base, and is 44ft. girth at top. In its construction there were used 800,000 bricks and 120 tons of stonework, and cost £3,000.

I wish correspondents would give references as to where they get the information from which they are answering questions: it would add much to the value of their contributions.

My authority for the foregoing correction is "Bancroft on Tall Chimney Construction," pages 40–41, new edition.

**James Walters.**

20, Traffic-street, Derby.

### A NEW FIRE-ALARM.

[24622.]—In the English Mechanic of Aug. 7 you illustrate what is called a "New Fire-Alarm," said to be invented by a Mr. Pritchett. Will you kindly allow me to state that this is a mistake? It is exactly the same as one invented by me in the year 1866, an improved form of which I patented in 1870. For this instrument I obtained the highest and, in fact, the only award given for an electric thermometer at the International Exhibition, South Kensington, in the year 1871. (See Official Catalogue.) This was not only a fire-alarm, but also intended for gardeners to record in their dwellings the temperature of their plant houses; hence it was specially noticed in the horticultural journals at that time—see *The Gardeners' Chronicle* of Nov. 5, 1870, and *Gardener's Magazine* of Nov. 26, 1870, where a full description, with illustration, will be found. It was also noticed in most of the scientific papers at that period as well.

A very fine account of it appeared in a German paper, *Der Bazar*, Sept. 11. Unlike the description you give, they carefully excluded my name in connection with it. They gave even an exact copy of the engravings which appeared in the English papers, except that they removed the words "Rothnie's patent," which was on all English copies.

**Geo. Rothnie.**

21, Elthorne-road, Upper Holloway, N.

## RIFLE SHOOTING.

[24623.]—I CANNOT quite agree with "Invicta," letter 24587, p. 502, as to the utility of the various contrivances at present in vogue for obtaining rifle practice (?) without rifle ranges; for it must be remembered that it is only one part of shooting to be able to hold a rifle steadily and pull without jerk. Certainly it is a very important part, but even after it has been mastered there remains very much to be learnt. The absence of recoil in the said contrivances is against their usefulness as a means of education in shooting, for it is quite possible that a man would pull steadily with them who would prove the very reverse of steady when subjected to the recoil of the Martini-Henry in actual practice.

It must be admitted, on the other hand, that their use in Volunteer corps would probably do something to get rid of the present system of class-firing, in which a recruit goes to the range, loads a rifle, points it in the general direction of a target, pulls the trigger, and *opens his eyes* to see what has happened. And when a man has got through this performance a certain number of times (60), *even though he never hit the target* at all, he is an "efficient" Volunteer. The contrivances for converting Martini-Henry rifles into pop-guns do not enable a man to learn anything as to allowance for wind, or as to change of elevation on account of variation in light; and until these are mastered a man cannot shoot. Many a novice wonders why he is missing the target when he is aiming placidly straight at the bull's-eye, while a 6ft. wind is blowing, and the light changing for every shot. I well remember some years ago asking a comrade who had just got up, after finishing with four bulls, where he had been aiming. He replied that he had not aimed twice at the same spot. I thought then he was unwilling to help me, but I know now he was speaking the truth. It is much to be regretted that shooting is so little taken to even amongst the Volunteers themselves. Perhaps one reason is that it is too quiet to suit the average young man, who wants something more energetic as an outdoor amusement than lying down and holding his breath while he aims at a mark nearly half a mile away. The fact that a rifle meeting is not so interesting a spectacle as compared with a cricket match or bicycle meet is doubtless another reason. There is usually not much for visitors to see, and an outsider scarcely knows, or has means of knowing, whether he is watching a pair of crack marksmen contending for the bronze medal of their county, or a couple of novices who have to do all they know to avoid missing outright. On the other hand, the amusement is entirely free from cruelty in any form, and a man may listen to the sharp splash of the bullet on the target at 200 yards, or the faint tap which is heard at the long ranges, with a pleasure unalloyed by the knowledge that a living thing is quivering under the blow. Again, accidents are *very* rare, and when an accident does happen it is almost invariably to a marker, and not to a competitor. Last, but by no means least, the science of rifle shooting has not been prostituted to betting; a friendly wager between comrades is frequent enough, but that nuisance of the nineteenth century—the professional betting man—has no scope for his nefarious practices at Wimbledon, Altcar, or Morpeth.

**Wm. John Grey, F.C.S.,**
Sergt. 5th Durham,
Hon. Sec. Derwent Rifle Club.

Newcastle-on-Tyne.

[24624.]—IN the interest of all true lovers of good shooting, I hasten to dissuade readers of the "E. M." from following "Invicta's" vicious advice. The abortive attempt which has been made to convert the regulation rifle into a small bore will ruin the prospects of our embryo crack shots, if they persist in practising with this wretched arrangement. Now that firing at moving objects has become an important part of the army rifle drill, it is more than ever necessary to accustom ourselves exactly to the weight of the weapon we use; and the man who cannot distinguish a difference of half a pound in the rifle is not safe to half a yard on the target. No. 1 bulleted caps cannot by any stretch of imagination be considered practice for the Henri-Martini cartridge; and as for the absurd close-quarter paper targets, they are, in my opinion, simply ridiculous.

**Bacchus.**

## BI.'S AND TRI.'S—SPRINGS—CLUTCH GEAR—BALL BEARINGS.

[24625.]—IF "South Australian" (24571, p. 498) were in England, he would see that the two things most remarkable about riders of the Otto are their scarcity and their apparent caution. Though the machine has been out for some years, they are still so rare that they are stared at as they pass. Many tricycles that have not been out half the time, or near it, are much more numerous, and I have rarely seen an Ottoist bowling along at high speed as tricyclists do. There are tricycles that will carry 14 stone over all roads, weighing no more than 60lb. to 65lb.; one of these would suit him better. Rough roads are the last place for an Otto, from all I have heard of them. For rough roads, the main thing is a very soft spring, with 2in. or 3in. vertical play—this one can have on a tricycle—and there are some new, low-built, safety bicycles, with steering wheel running *in front*, driven by chain gear like a tricycle, on which one can enjoy the advantage of a tricycle spring; but on an ordinary bicycle, unless one rides a wheel much under his size, there is not room for a proper, high-play spring.

On the subject of springs I have some strong ideas; but as they are founded on positive experience and experiment, I am not afraid to insist on them. I may summarise them by saying that the springs usually supplied to riders by the makers are simply preposterous. Most of them are not worthy of the name of spring at all. Either they take a set and give way in course of time, so that the saddle falls out of position and tilts out of the horizontal; or if they are capable of holding up, it is simply by virtue of having no elasticity at all worth speaking of. But even suppose one has an Arab spring (and I think this is too well known for me to be thought guilty of advertising by assuming it the best), what happens then? The springs are stamped, each one with the weight they are thought suitable to carry, and happy (comparatively) is the man who gets one with his own weight stamped on it. But numbers of makers and agents (they have told me themselves) are in the habit of recommending their customers a spring marked two or even three stone heavier, and I have been told by riders that they could not get on without such extra-strength Arab springs; otherwise they got "bumped" down on the spring-carrier over rough roads. Well, I will explain the cause in a moment, but let me first give my experience. My weight varies from 13 stone to 13½, and I always ride a 10-stone Arab. It is perfection, and mind there is no mistake in the mark, for I have had four or five different ones on different machines, all 10 stone, nor has one ever broken or taken a set. My brother, who is 12 or 12½ stone, by my advice changed a 12 or 13-stone spring for a 10 stone, and is so pleased with the result that he thinks of changing for a 9 stone. With such a spring, and the saddle properly placed, one can ride all day without the least soreness, and roads that were a misery to ride on become comfortable. When roads are very good the spring is of little importance to speed, but when they are rough it is everything. No one without trying, as I have often done, can imagine the difference in speed that such a spring makes over rough or even ordinary roads. It is marvellous simply, and more important than any other single point about the machine.

Now, why is it some cannot ride even their proper weight Arabs without bumping? The difference is in the placing of the saddle. An Arab spring, firstly, should be placed so that the looped end of the spring points backwards. Some place it reversed, but the inventor recommends this position, and I have found it best. Then the saddle must be placed so that it rises and falls with the rider horizontally, or always parallel to itself, not more in front or at back, but always keeping horizontal from its lowest to its highest position. The position varies somewhat for different riders, and can only be found by shifting it till you feel it rises and falls parallel as you jump up and down sitting on it. Half an inch backwards or forwards from this position will cause it go all down, either back or front and bump as complained of, but when so placed you may safely ride a spring 25 per cent. below your weight, as I do, and thoroughly enjoy it. You will find, moreover, that the saddle seems to fit no matter how you sit on it; that a saddle which formerly cut you will now be perfect comfort in many cases, and that you may go for miles without bearing on your handles without finding any tendency to slip off the saddle, either backwards or forwards.

A great deal of this is not new; but I wish to insist on the huge importance of riding the softest spring, and with the highest play you possibly can. You should be able to make your saddle dance again with a blow of your fist, you should be able to bend it about in all directions with one hand on it, and it ought to settle down most perceptibly when you get on to it, and over rough ground it should dance like a "baby-jumper." To do this it must have a good high play; some springs have not an inch of play in them, they should have, I should think, about three. Bicycle riders do not know what a real spring is—they have no room for it.

I wish "D. H. G." would continue his advocacy of the free pedal; what a rest and comfort it is in a 50-mile run over undulating country, and what a pity people are oppressed with the idea that one ever practically needs to back-pedal when he has a decent brake. The use of it can be learnt in an afternoon.

I have ridden my machine (not intentionally) with the ball bearings full of sand. No harm was done, and very little heaviness was noticed. How about plain ditto with sand in them. How often do the plain-bearing people clean up?

I should very much like some opinions of the B. S. A. Safety Bicycle (Birmingham Small Arms Company) from any who have tried it.

**Norman.**

## MICROSCOPICAL—TWO EYES ARE BETTER THAN ONE—MONAD.

[24626.]—I CAN see no possible advantage in going to the expense of a right-angled prism, as in the commonest microscopes I find the mirrors quite good enough. One mirror I have gave me four or five images of the flame, which would, of course, be fatal to good definition. This, however, was corrected by turning the mirror round in its cell until a point was found where all the images overlapped. Another mirror I have is a concave, of about 10ft. focus. I find no difference for ordinary work. Any concavity in a plane mirror is bad, and ought to be avoided, because it shortens the focus of the condenser, which will be quite short enough, if it has any angle in it, without any further shortening.

I cannot say I can mention any definite object or object-glass in which I could perceive any difference with mirror or lamp direct. If anyone is doing very special work, and fancies some error due to mirror, then turn it aside, and use the lamp flame direct. I cannot see any advantage of a prism, which cannot possibly be so good as nothing at all. One special advantage in using the lamp flame direct is that one is not so liable to get the light out of centre. When a mirror or prism is used, a slight touch, or shake of the table even, is apt to throw it out of centre.

I regret that I know of no advantage in keeping both eyes open when using a terrestrial telescope. It would be a great saving to the eyes if you could do so. The following is the rule both for the microscope and telescope. You can use both eyes only when the stronger light is in the instrument; when the weaker light is in the instrument, then you must shut the unused eye. Microscope by diffused daylight.—The light in the instrument is the weaker: you must shut the other eye. By artificial light in a dark room, you can keep both eyes open. One hour of steady hard work with the microscope by diffused daylight will tire you more than a whole day's work in a dark room by lamp light.

With the terrestrial telescope, as 999 in 1,000 have smaller emergent pencils than ·11in., the light in them is less than the light in the unused eye, therefore the unused eye must be closed.

Sailors, as a class, know nothing about telescopes. In the merchant service they are never used, and seldom by the men in the Navy; it is only when the latter become shore loafers—i.e., coastguardsmen, that they have much telescope work to do. The instruments they are then supplied with are hardly worthy of the name of telescope.

Monad is rather an indefinite term; some monads' flagella should be easily seen with ½in., others, again, would be difficult objects with much higher powers. Perhaps the following may help E. B. Fennessy. The flagella of Volvox globator should be easily seen by a ⅓in. on dark ground by artificial light when they are in water.

**Edward M. Nelson.**

Shetland, August 3rd.

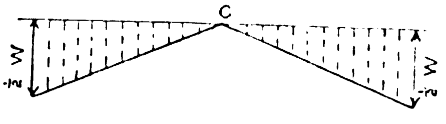
**Astronomical Instruments.**—An illustrated catalogue of Astronomical Instruments, Observatories, &c., manufactured by Howard Grubb, Dublin, has been issued, and will be found useful by astronomers and others, as it contains, besides a number of engravings of instruments and buildings, an explanatory diagram of Grubb's new ghost micrometer. W. Watson and Sons, High Holborn, are the London agents for Mr. Grubb.

# REPLIES TO QUERIES.

*⁂ In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[56676.]—**Free Reeds.**—I feel it my duty to reply to the remarks made by "G. L. B.," p. 503, in case anyone may be misled by his false ideas. 1st. The two queries (from which this discussion has emanated) were written by the same identical author, a gentleman who is anxious to know how to tune reeds simply for his own personal benefit. I do not hesitate to tell the truth, and inform interested readers that "G. L. B.'s" reply on p. 457 is "wide of the mark," and not my reply. I am justified in keeping to my previous statements, and to expose false ideas, even if they emanate from "an old member of the trade." 2nd. "G. L. B.," p. 503, quotes the prices charged for reeds as those of one London agent. To prove that reeds vary in price, irrespective of quality, I quote those charged by a well-known London firm. Esteve's, 4ft., 8ft., or 16ft. set, 18s.; best extra broad, 22s.; Turban's reeds, 17s. per set; extra broad, 21s. I could quote prices from numerous other lists; but what I have now quoted will enable "G. L. B." and those interested to draw some conclusion as to why I retain the "unalterable opinion" referred to by "G. L. B." on p. 503. 3rd. As "G. L. B." forms a false idea as to what I mean by "theoretical humbug," I will explain my true meaning on that point. In speaking of "theoretical humbug," I refer to replies which consist chiefly of suggestions regarding the subject of reed-voicing and tuning. Both reed-voicing and tuning can only be acquired by constant practice and experience in the art. To simply tell a querist, or explain to him the mere operation, is not sufficient in such a case, for that is really theory without practice, and as such is of little or no value. Hence the consistency of my previous remark, that we want more "practical information" and less "theoretical humbug." Theory is all very well in its place, but in many instances, theory alone is better omitted, because it does not always benefit the querist practically. 4th. By "misconception," I simply refer to false and mistaken ideas combined with rash conclusions, which are, from time to time, drawn from certain statements. I did not use either of the above terms in reference to any of the recent remarks made by "G. L. B." 5th. Personally, I do not object to be styled an "amateur," particularly when we come to consider that a real "professional" does not, in a general way, give advice or instruction gratis, either through private correspondence, or through the agency of a mechanical paper.—G. Fryer.

[56679.]—**Supported Beam.**—For the sake of the original querist, in a uniformly-loaded beam the shearing at the centre C is nothing, and increases to half the value of the load at the points of support. The intercept at any point between the horizontal and the sloping lines is proportional to the shearing at that point. When the load is at the centre the shearing at every point in the beam is half the value of the load. Will Prof. Goodeve give the meaning or intention of the original question in the number of May 22nd?—J. S. C.



[56937.]—**Tons Measurement.**—This is simply builders' or dock measurement. Builder's is taken from the dimensions.—J. M. T.

[56945.]—**Clarionetta, Oboetta, or Bassoonetta.**—Will this querist kindly say where he finds any mention of these instruments? Being personally ignorant of them, I hesitate to express an opinion; but if they are of the free reed type he may safely assume that they have not exactly the same tone as the instruments they are intended to represent. As I am professionally interested in learning all I can of the modern automatic instruments (so-called), I shall be glad of the information where these examples can be seen.—Gray's Inn.

[56948.]—**Gas-Producing Apparatus.**—To "Invicta."—My engine draws in the charge at every revolution, which is fired at about one-third of out-stroke without compression. "Z. Y. X.," in replying to this query, warns me that gasoline gas is more dangerous than common gas unless the generator has a good safety chamber attached; but I presume the generator you have described is perfectly safe, for I do not want to run the risk of an explosion. You will find my address in the proper column, and I shall be obliged if you call the manufacturer's attention to it. Many thanks for the information you have given me.—Gaseous.

[56950.]—**Hat Lining.**—The best thing "Saffron" can do is to have a new lining of unstained leather. I should take the hat to the dealer, and have something to say to him.—Essar.

[56950.]—**Lead Burning.**—In reply to "Finem Respice," we cannot see how, in your column of Replies to Queries, we are getting a gratuitous advertisement. We do not think it advisable to publish a copy of the specification of our "patent apparatus." What does it matter whether it is patented or not, so long as it does the work represented? If "T. R." will apply to the Patent Office he will be able to read, and also to obtain, a copy of our specification and number of patent, &c. We do not consider it necessary to have an attendant at our exhibit at the Inventions. Mr. Briggs is always there from 4 p.m. on Saturdays to answer all inquiries.—Briggs and Co.

[56950.]—**Lead Burning.**—For the information of "Finem Respice," and others interested, I may mention that application for a patent for "Apparatus for use in Soldering" was made by Thomas Briggs, on 1st October, 1884. The complete specification, bearing No. 13,026, of the said year, was accepted on 31st July, 1885. The complete specification will be published in a few days, most likely, and any notice of opposition to it may be given, on the prescribed form, within two months of the latter date. I agree with "Finem Respice" in thinking that Messrs. Briggs and Co., in exhibiting their apparatus at the Inventions Exhibition, might have indulged the public with some details as to its construction or mode of working—the more so, since, by application to the Comptroller on "Form O," this may be done without prejudice to the inventor.—H. B. F.

[56950.]—**Lead Burning.**—I am sorry to find that Messrs. Briggs and Co. are annoyed at my last letter, wherein I spoke of their lead burning on the merits of the actual work itself, which was true in substance and in fact. When people put specimens of lead burning into exhibitions, it is taken for granted that they do not exhibit the worst which they can do, and if these specimens are the best, they are certainly very inferior to ordinary lead burning. So far as their patent goes, I am a disinterested person, for I certainly would not use it in the present age, nor do I think that any one would, after they had tested the merits of gas-generating machines. If Briggs and Co. will take the trouble to make an appointment to meet me at my workshop, I will show them a machine constructed upon the same principle as theirs, and which was made and used at some buildings at South Kensington in the year 1880, but which was discarded by reason of its irregular action and unsuitability for lead-burning purposes; but as "Finem Respice" requires to know something more about this wonderful machine, I will, for his information, give him a few practical particulars. In the first place, the machine is cylindrical, ranging from 6 to 12in. diameter, about from 9in. to 18in. high. Inside the machine, or at any other convenient situation, is fixed an air-pump. In the bottom of the machine is fixed from 3 to 6in. of ordinary cotton waste, or other absorbing material, such as tow or the like, this material being saturated with methylated spirits, benzoline, petroleum, turpentine, or such like inflammable matter. From the before-mentioned air-pump we take a pipe to force air to the under side and through the before-mentioned saturated inflammable material, which air becomes charged with hydrocarbon gas, which is collected in the top part of the before-mentioned cylinder, which hydrocarbon gas is conveyed to one of Cotton and Johnson's or other blowpipe in the usual manner. I may add that, instead of using a pump direct, the air is much best if pumped from a water column bellows, such as is shown at Fig. 66, "Standard Practical Plumbing," which will allow the blast to work more steadily than is possible without such regulating apparatus. I have tried to overcome this irregularity by using Sugg's and other gas regulators, but prefer the water column.—P. J. Davies.

[56953.]—**Boracic Acid.**—Better leave boracic acid out of your jam. Boil your jam properly, and it won't ferment.—Housewife.

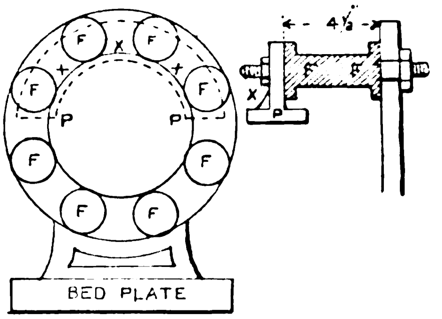
[56956.]—**Steam.**—This is simply copied from an examination paper, and can be readily answered by reference to the tables in the pocket books, or by looking up back numbers.—Essar.

[56957.]—**Ball Bearings.**—I can quite understand "R. R. N.," p. 481, preferring ball bearings because I fear sure he has never ridden a bicycle with plain bearings made broad enough and fitted properly. I have seen a great number of bicycles with plain bearings, and not one of the bearings was as broad as they should be—viz., about two and a half times the diameter of the shaft. If ball bearings are so exceedingly good and easy to work as some of your correspondents wish to show, how is it our railway engineers don't apply the ball bearings to railway carriages and so save a consumption of fuel; and, further, why is it our road carriage builders are not using the ball bearings and so save horseflesh? As an engineer, my advice to all bicycle riders is to abandon the ball bearings, and to have bicycles with plain bearings, made broad enough, with the patent needle lubricator.—Chas. Hosken.

[56962.]—**Legal Telephone Query.**—If the royalty has been paid, and the payer has to keep his telephones in order himself, I don't see how any action would lie against those who did the repairs.—Limb o' th' Law.

[56964.]—**Steam Blowing-Engine.**—A steam blowing-engine is simply an engine working a pump that pumps air. The pump cylinder has valves which open inwards and admit air which is driven out by the motion of the piston. An engine that condenses the steam has only about 3lb. back pressure (or less), instead of 15lb. See any textbook.—Essar.

[57049.]—**Gramme Dynamo.**—To Mr. Bottone.—In compliance with your request, I submit sketch of my dynamo. The circular supporting frame is of malleable iron, to which the field magnets F are bolted at one of their ends; they also are of malleable iron, and were described on page 442, and a preceding number (1057). I have only shown the upper pole piece, and that in dotted line, to be better understood, and to further explain my meaning, I have separately sketched a field-magnet, F F, bolted to one of the semicircular pole pieces. Having spent much time and expense in fitting up so far, I am anxious to have the correct size of armature and consequent width of embracing pole pieces; also to know the number of cogs on the ring, and the width of the sections between them. References to sketch: F, flanges of field magnets; F F, body of field-magnets where wire goes on, and $1\frac{3}{8}$in. diameter; X are feathers for strengthening pole pieces.—Subscriber from No. 1.



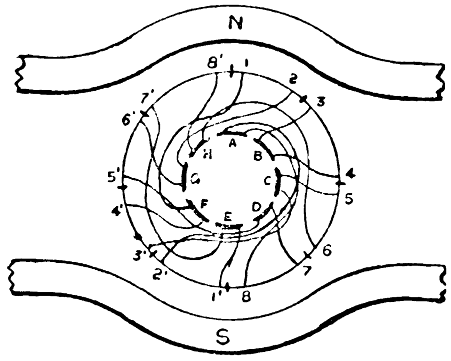
[57055.]—**Electric Bells in Series.**—To "M. S. E."—I understand that you require the bells to be in series, and that they are to ring independent of each other. I think we are as far off the problem as ever we were. The description of Jolin's double-wound bell, given by Mr. F. B., p. 483, July 31, does not give the required object—independent working (he does not state that it does. I merely wish to call your attention to the fact.) The double winding in that particular case simply obviates the contact pillar, common to the generality of bells. While, against it, I have the following ideas:—That if the iron cores are not exceptionally pure (ditto armature) the preponderating current will cause it to "stick" in a certain degree. If the wires are not the same resistance, ditto, ditto. If they are not practically differential, ditto, ditto. The lessening of the resistance is immaterial in a house bell, but two stations, A, B, five miles or more apart, would find it is not so convenient or reliable as a single-wound bell of double the resistance. Perhaps it is not generally known that no machinery is required for double winding beyond the usual "throw" and one's hands. The main object is that the two wires are not allowed to separate in running on the bobbin. I have wound dozens of differential galvanometers, so speak from practical experience.—Experimenter.

[57057.]—**Transmission of Power by Belts.**—To "S. S. N."—Thanks for your offer to correspond. I here find another difficulty—namely, in finding the tension of the belts.—N. E. Crosthwaig, The Lodge, Baggnalston, Ireland.

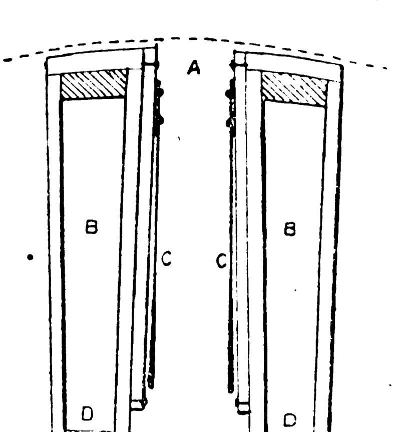
[57059.]—**Power.**—I beg to call "Nester's" attention to what is evidently a mistake, or misprint, in his answer to this query. Leaving out of the question the work done by the man in carrying his own body upstairs, as well as the work done in moving it, and the weight the horizontal distance measured on the plan of stair—viz., 22 cos. 60° feet, we have the useful work as $\sqrt{\frac{3}{4}} \times 110 \times 22$ ft.-lb. This also should be the work done when the weight is lifted by means of the pulleys, leaving out, of course, the weight and friction of pulleys. The answers given, however, differ to the extent of about 550ft.-lb.—David Stephen.

[57064.]—**Bisulphite of Soda.**—In his directions for preparing this substance Percy W. Stanley makes a strange blunder. Sulphurous-acid gas should, of course, be passed through the solution of sodium carbonate, not sulphuretted hydrogen.—J. T. M.

[57072.]—**Siemens - Alteneck Armature.**—To Mr. Bottone.—A laminated armature would not do for this. The principal distinctive feature in this armature consists in the length of the core, as compared to its diameter, and in the mode of winding. Longitudinal coils of wire completely envelop an iron cylindrical core, all the sections being wound at equal angular distances from each other around the surface of the core, and parallel to planes passing through its axis, longitudinally there being as many planes as there are sections to be wound. The sections of wire wound upon the core consist each one of two separate coils, having naturally two extremities; so that there are twice as many ends as there are coils. These ends are brought out two by two to a number of copper sectors, insulated from one another, which together build up a cylindrical commutator, much resembling that of the Gramme machine, and rigidly attached to the armature spindle; the currents are collected in a similar manner by conducting brushes pressing against the commutator as it revolves. The annexed diagram shows, as far as it is possible in a sketch, how the ends of the coils are connected to the sectors of the commutator. In this diagram the two ends of the same coil are figured respectively 1 and 1′, 2 and 2′, &c. To avoid confusion the armature is supposed to be built of eight coils only, though the more are used the steadier the dynamo is in action. If these connections be traced, it will be seen that all the coils are united into one continuous circuit, the commutator sections being traversed in succession.—S. Bottone.



[57079.]—**Windway.**—As a supplement to the replies on p. 484, I send a sketch which will explain one plan how to arrange two sets of reeds to be actuated on the suction principle, with paper bands or strips. In this case I have chosen the system without levers as the most simple for explanation. In sketch, A shows the opening or pallet aperture through which the wind enters, and over which the perforated paper (shown by the dotted line) passes. B B are the reed channels or tubes similar to those of the harmonium pan. The reeds C C are allowed to slide in or out, but differ from those of the American organ as regards position, as the reeds in this case must be situated outside instead of inside the tubes. The air is drawn downwards through the apertures D D in lower end of tubes, as shown by the arrows. The American organ cavity boards are not in any way suitable for automatic reed organs except they are constructed on the barrel system, as suggested by a correspondent on p. 484. I am afraid that "A. B. C." requires too much in a small compass. I may suggest that he can have three, or even four, rows of reeds in a very trifle more space than that occupied by two sets of reeds, if he intends to use the A. O. cavity boards on the barrel organ system. This would not be a very portable affair, it is true. I have now in preparation my promised instructions how to make an automatic reed organ to contain thirty-seven reeds or three chromatic octaves, which I hope will prove interesting to many of "ours."—G. Fryer.



[57080.]—**Siphon.** — In reading the valuable replies to my query I am very much struck with the uniformity of opinion. Having held the same idea, I took steps to provide for this air escape by fixing on a small valve at the summit. The valve was placed inside a large-sized air-vessel (same as used on force pumps), having a small stop-cock on top. By this arrangement I anticipated that the air which escaped out of the siphon would have room to expand in the vessel, and would not hinder the working of the valve for some considerable time, meanwhile acting as a sort of spring weight thereon, and when there were signs of sluggish flow the stop-cock could be opened for a little so as to reduce the pressure again. I also tried the effect of leaving the stop-cock open and covering, or trapping the valve with water poured through the tap. Unfortunately, I had good reason to doubt the tightness of the main pipe, and the valve failing to mend matters confirmed my suspicions. A small nozzle $\frac{3}{16}$in. was let into the main at the neck of the ball-cock, to try, by continuous flow, to make the siphon clear itself. Possibly, if this aperture was made larger, it would do so, but the water cannot be spared. As I wish again to try a valve on the pipe before condemning for leakage, I would be glad of drawing and description of a suitable valve. "Invicta" appears to have mastered the difficulty before; will he kindly come to the rescue? There is already a suction pump fixed up at a point below level of tank bottom, and within 150 yards of the ball-cock, which draws the water in five minutes. Would "R. R. N." and others kindly note that the slip was mine—not the printer's?—Surveyor.

[57083.]—**Freemasonry.**—I do not think "Z." was far from the mark when he spoke of "Freemasonry as a mere benefit society." As such it is entitled to all respect, and if it is now looked upon only as the fossil remains of what it once was—viz., an institution to which we are indebted for the most wonderful works of art the world ever produced, it ought still to command a certain amount of interest and respect. Sinnett, in his "Occult World" traces it up to a very early age; but he says that though it has copied the old formula, its *raison d'être* has expired here with the expiration from Freemasons of the occult philosophy on which their forms and ceremonies are shaped to a larger extent than they generally conceive.—Z. A.

[57083.]—**Freemasonry.**—In reply to "Z," there is no advantage in becoming a Freemason in the sense of a friendly society. There are two schools, one for boys and one for girls, splendidly maintained, and which are probably not equalled by any similar institutions. There are, however, usually more candidates than vacancies, so that a considerable amount of influence is generally required to be successful. There is also a charity for the aged, conducted in a similar manner. Any person having from £10 to £15 to spare, and without feeling its loss, and who would not object to pay from £2 to £3, or more, annual subscription, would, if he joined a good lodge, have the advantage of being introduced to a society of considerable respectability and often of influence, which would be of considerable service to him in the event of being compelled to reside in another town to which he is a stranger. Any Freemason meeting with misfortune would, in all probability, be assisted if he applied for assistance; but he would be entitled to nothing by right. But any person becoming a Freemason, and advertising himself as such for the purposes of trade, either by wearing scarf-pins, or using the sign in circulars or invoices, &c., would most certainly be ignored by all those Freemasons whose good opinion is worth having. Such a practice, although it is frequently resorted to by publicans and others, is thoroughly contrary to the principles of Freemasonry.—Hiram.

[57086.]—**Colliery Warnings.**—After reading Mr. Murray's reply to this question, I suppose "Ralph" will, for obvious reasons, respectfully decline to believe in the accuracy of the so-called colliery warnings.—Bacchus.

[57121.]—**Mountain Snow.**—"Nester," page 485, only gives a statement of facts, and not an explanation; but perhaps the following will help "Ignorant" over his difficulty:—The rays of the sun consist, in addition to the luminous rays, of invisible heat rays, which last, in passing through the atmosphere, are absorbed by the aqueous vapour present in it, so that only the small heating power of the luminous rays is able to be used to melt snow. Now, on striking the snow, these luminous rays are reflected back unaltered, and, therefore, their heat is not used to melt the snow; but on striking the earth these luminous rays are reflected upwards, principally as invisible heat rays, and since the aqueous vapour in the atmosphere absorbs these considerably, the farther a place is from the general level of the ground the less warmth is it able to get, and therefore on the tops of high mountains the summer sun is insufficient to melt the winter snow, so that it accumulates.—W. Scudamore.

[57122.]—**Problem.**—Let $\angle CAB = \angle CEF = x$. Then—

$$\frac{1}{\cos. x} + \frac{2}{\sin. x} = 5$$

$$\frac{\sin. x}{5 \sin. x - 2} = \sqrt{1 - \sin.^2 x}$$

$$25 \sin.^4 x - 20 \sin.^3 x - 20 \sin.^2 x + 20 \sin. x - 4 = 0.$$

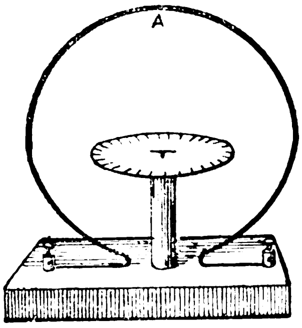
$$\text{or, } \sin.^4 x - \cdot 8 \sin.^3 x - \cdot 8 \sin.^2 x + \cdot 8 \sin. x - 4 = 0.$$

Which gives sin. $x = \cdot 52$, and $\cdot 94$ nearly; and B C = 50 . sin. $x$ = 26ft., and 47ft. nearly. The ladder may evidently assume two positions, both fulfilling the terms of the problem. I do not see how the biquadratic equation is to be avoided.—W. A. S.

[57124.]—**Lifting Bar.**—To "J. S. C."—If your view of this matter is correct, it would appear that the querist could exert himself greatly without doing any work; and by sequence it is reasonable to assume, by the same line of argument, that a man's muscular energies might be altogether exhausted in this manner, without ever being brought into motion. Would "J. S. C." be prepared to support his theory to this extent.—Bacchus.

[57124.]—**Lifting Bar.**—If you seize the bar near the end to lift it, you certainly do no more work than you do when you lift it by the centre, for the simple reason the bar will take up a vertical position, the centre of gravity falling to the lowest point; but if you wish to hold it in an inclined or horizontal position during the process of lifting, then you are quite wrong in supposing no more work is done. A pillar supporting a heavy weight does no work; but if I were to assert, as some do, that a man standing with a weight on his back does no work, I should be contradicting my own experience. In this case, the hand is the fulcrum of the lever, the reaction of the elbow is the power that balances the weight of the bar and keeps it in the inclined position. It is this reaction that causes the extra work over and above that done in lifting the bar, though it no more moves than does the man who stands with a weight on his back: it does work in the true mechanical sense of the term.—David Stephen.

[57126.]—**Obach's Galvanometer.**—In the ordinary tangent galvanometer, of which the annexed is a rude sketch, the ring A, which conducts the current is a fixture. In Obach's modification the ring can be inclined from the vertical; when, if the ring be inclined at an angle $\theta$, and $\delta$ be the deflection, then the current is equal to tangent $\delta$ secant $\theta$.—S. Bottone.



[57127.]—**Lactic Acid in Milk.**—Milk containing this acid in any quantity strongly reddens blue litmus paper. The amount can be determined only by chemical means.—J. T. M.

[57127.]—**Lactic Acid in Whey or Milk.**—In order to determine the amount of lactic acid in milk you must titrate the sample with a solution of soda or potash of known strength, and from the amount of alkali required for neutralisation the quantity of acid can easily be calculated.—A. Price.

[57128.]—**Storage Battery.**—I beg to thank "Bunsen" for his offer with respect to the above; but not being an adept at algebraical equations, I cannot give him the E.M.F. of lamp and battery, but will give him full particulars, which I think will answer the same purpose. The lamp is one of Swan's 5 c.p. incandescent globes, fitted on small lamp stand, and kept in position with spiral spring, and is connected directly on to the battery by about a yard of wire from each terminal. The battery consists of 8 carbons and 5 zinc plates, the carbons being 8in. by 3in., and the zincs 4in. by 3in., and the charge a single fluid, bichromate of potash solution. For convenience it is wished for the storage battery to be circular, 3in. in diameter. How many plates will it require this size, or how would it answer for one plate 4in. deep, coiled into a spiral 3in. in diameter? Thanking any of our readers in anticipation for their opinion on this subject.—WERDNA.

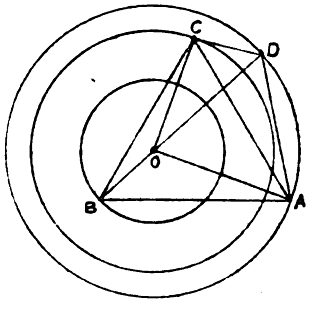
[57130.]—**Pump.**—I could tell you of a plan which would not necessitate pumping at all, and would deliver the water in a continuous stream without any labour. If you will advertise your address, so that I may have full particulars as to what quantity of delivery, &c., you wish for, I could then communicate with you, or anyone else, on the subject.—P. W. R.

[57130.]—**Pump.**—Since the height which the water has to be raised (about 30ft.) is nearly the length of a column of water equal to the pressure of the atmosphere (averaging about 34ft.), and the water has to run through 450 yards of piping, most probably a force pump at the bottom of the field would be required, although possibly a common suction pump at the top of the field would do the work.—W. SCUDAMORE.

[57134.]—**Easton's Syrup.**—This a solution of quinine, strychnine, ferrous phosphate, and sugar in diluted phosphoric acid. It is a powerful tonic, but should not be taken without medical advice. —J. T. M.

[57135.]—**Varnishing Fancy Woods.**—My brother recommends "T. J. A." to brush his box over with a thin coating of glue; this will act as size always does, by filling the pores and preventing the varnish sinking in.—H. O'B.

[57147.]—**Geometrical Science Examination.**—From a point O as centre, and the three given distances as radii, describe three circles as in diagram. Draw any radius O A to the outer circle.



From A as centre and radius A O, describe an arc cutting the outer circle in D. From D as centre and radius O B describe a circle cutting the middle circle in C. Join A C, and make the angle O A B equal to C A D, and let A B cut the inner circle in B. Join B C, then A B C is the required equilateral triangle. Because A D = A O, and A O = O D, therefore the triangle A O D is equilateral; and in the triangles A O B, C A D, we have A D = A O, and D C = O B, and the angle O A B equal to the angle C A D; therefore the triangles are equal, and A C = A B, and therefore the angle A B C = A C B. But from the construction the angle B A C = the angle O A D; and therefore = 60°, therefore each of the angles A B C, A C B = 60°; and hence the triangle A B C is equilateral, and the distances from the angles to the point O are equal to the given distances respectively.—J. E. GORE.

[57154.]—**Horse Taming or Breaking.**—"The man of kindness to the beast is kind," and the beast fully appreciates his master's kindness. Try it! Be your own pony tamer; you will feel proud all your life long in being so, and may save your five guineas. Put away the whip, never let the pony see or hear the crack of one! Make a pet of him, as you would a little child; stroke his nose, scratch his ears, rub his skin with your hand; feed him with a "tit-bit" every time you go near him—a lump of sugar, a crust of bread, a carrot, an apple—all the while speaking to him in a soft voice and with coaxing words, all of which he will understand fully as well as yourself; never lose your temper with him, and then you will never excite his. Men (and women) have done this; so may you. But be very patient. The years of hard usage have to be obliterated from the animal's memory, and this will require months to effect—possibly the year round; but I again say, Be very patient and invariably kind and good tempered, and you will be amply repaid in the future obedience and friendship of the pony, and please to let "Ours" have the result of your efforts. I think our indulgent and judicious Editor will insert your letter. The horse tamers do wonderful things, I well know, one of which is to *tame* the ostlers, &c., who are engaged in the stable, and if *you*, "M. H. J.," use the whip as you describe, you require *a taming* also!—H. O'B.

[57156.]—**Gauging Railway Waggon Axles.**—I think if a pair of waggon wheels are found 1¼in. out of gauge, it is something "to speak of," and would say the cause of the waggons leaving the rails was not far to seek if the wheels were this far out of gauge. There should be no sign of strain in a waggon axle when under load. If vehicles were running with wheels anything like 1¼in. out of gauge, there would be no end to accidents such as the one which led to the inquiry "T. J. S." writes about. There would be more broken axles, and everyone knows that many of the most serious of railway accidents have occurred from the breaking of an axle. If deflection does take place, it must continue while the wheels are rotating, because the load which causes it at rest is still upon the axle while it is revolving. It would depend entirely upon the diameter of the wheels to determine how much the axle is bent when the wheels are a certain amount out of gauge. That is if the wheels were (as I expect they have been) gauged between the tires.—TOPIC.

[57158.]—**Bird Taming.**—The best way to tame your birds is by kindness and familiarity with your company, tempting them to come to you by litttle treats in food, &c., petting and coaxing them in all ways, and getting them to have no fear of your voice and figure. This is easily done. It of course requires a little time; but by patience and perseverance you can get a bird to do almost any little trick, and when he gets into it he will enjoy the fun as much as you. Of course the birds most easily tamed are those of your own breeding. There is no wonder the Italians would not tell you their method, for you and all right-minded persons would quickly withhold any sympathy with them. Their process is cruelty; the bird is kept in darkness, in a cage barely large enough for him to stand in, without food or water, except such as his owner gives him on his going through some little performance. Hundreds of birds are sacrificed in their training process by these vile rascals, and few comparatively attain to such proficiency as to be exhibited before a crowd of gaping fools, who are satisfied to see the antics of the poor little creatures, and do not think nor care about the cruelties they have survived in learning them. If you want your birds to be tame with you, give them light, air, freedom to exercise, good food and water, and plenty of your company, and you'll succeed, or the fault will be yours; but don't attempt the means used by those Italian scoundrels as you value your self-respect and the affection of your little captives. —MARCUS.

[57159.]—**Watch Query.**—Although "Caribbean" says that his watch is in good order, I very much doubt it, as if he cannot put on a hair spring he is less likely to know whether the rest is in good order. The principal part of the verge is the escapement; if this is not in order, it is useless to put on a hair spring until made perfect. I advise him to study the papers that appeared some time back for reference to above, and if he likes I will tell him what I may know to help him.—P. W. R.

[57162.]—**The Micro. O.G.**—To "ROB. CRUS." —I feel sure that "J. T." will find brass, iron, glass, or zinc, almost anything in fact, better than lead for grinding lens surfaces. It would be better also to get the mastery of emery alone, and eschew rottenstone, &c., in the grinding, for it really is not hard enough to grind glass, being only silica itself. The polishing of all lenses down to ¼in. focus may be done best on pitch with rouge, and will never succeed on lead. For shorter-focus lenses the materials used are of a harder nature, because the tiny lens penetrates the rotating polisher. Up to ⅛in. focus, polish on pitch hardened with resin "to taste"; up to $\frac{1}{16}$in. or $\frac{1}{20}$in. focus, polish in good sealing-wax. A bit of *pure tin* may be used for lenses up to $\frac{1}{30}$in. focus. After that you must find out for yourself what to use. The words "when cemented" mean when united by means of Canada balsam. I never permanently fix my lenses in their cells for many reasons, but principally because amateur work is always more or less experimental, and I find it very convenient at times to be able to make experimental changes in an o.g., such as could not be done if the lenses were fixed. The other lenses required to complete the microscope are two plano-convexes for an eyepiece. The field lens should fill up the body tube as much as the necessary fittings will allow, and as the tube is 1¼in. diam. the field lens may be 1⅛in. diam.; and if made of 4in. solar focus, it might have a ⅝in. eyeglass mounted at a distance of ⅝in. from it, which would make an ocular equal to a 2in. lens—that is, having a power of five diameters or times. I believe that an ocular of twice the above power might be made with a field glass as large as the above. I will endeavour to send another letter for our next issue on the mounting of the various kinds of lenses used in the microscope; but if any more queries are addressed to me, I am afraid they will have to stand over for about three weeks, as I am away from home for about that time, and "our" paper does not follow me. The assertion above that the field lens should fill up the body tube only applies to low-power oculars, for the higher powers it means, make the lenses as large as possible for the sake of the field; but do not misunderstand the word "possible."—ROB-CRUS.

[57163.]—**Employment in the Arsenal.**—It may interest the querist to know that employment at this place is so much sought after, that for every opening there are a hundred applicants.—BACCHUS.

[57163.]—**Employment at Woolwich Arsenal.**—Apply at the office any morning at nine o'clock. A letter of recommendation would be of service. I only write of the Royal Laboratory, as I know nothing of the mode of entry to the other departments.—SENSITIVE FUSE.

[57164.]—**Trigonometrical.**—The complement of the greater angle of depression is equal in this case to the lesser angle of depression. Calling this angle $a$, the height of the vertical column is

$$\frac{108 - \sqrt{\frac{4\,(108 \tan. a)^2}{3}}}{2} = 72\text{ft.}$$

—BACCHUS.

[57164.]—**Trigonometrical.**—Let A B be the top and bottom of tower respectively. From A make the angle B A C = 30°, C being on the ground, through C draw the vertical C E, meeting the horizontal through A in E, then make E A D 30° cutting C E.

$$AE = \frac{1}{\sqrt{3}} \times 108 = \frac{\sqrt{3}}{3} \times 108 = \sqrt{3} \times 36$$

$$ED = \frac{1}{\sqrt{3}} \times AE, \text{ i.e., } \frac{1}{\sqrt{3}} \times \frac{\sqrt{3}}{1} \times \frac{36}{1} = 36$$

$$CD = CE - ED = 108 - 36 = 72\text{ft.}$$

—E. E. P.

[57164.]—**Trigonometrical.**—Let A B = height of tower, C D that of column; join A C, A D; then from the given angles of depression we have L A C D = 120°, L A D C = L D A C = 30°. Now from the fact that the sides of a △ are proportional to the series of the opposite angles, we have

$$\frac{108}{AD} = \frac{\sin. 60^\circ}{\sin. 90^\circ}$$

$$\therefore AD = \frac{108 \sin. 90^\circ}{\sin. 60^\circ}$$

Again, in the △ A D C,

$$\frac{AD}{DC} = \frac{\sin. 120^\circ}{\sin. 30^\circ}.$$ Substitute value for A D.

$$\frac{108}{DC \sin. 60^\circ} = \frac{\sin. 120^\circ}{\sin. 30^\circ}.$$

$$DC = \frac{108 \sin. 30^\circ}{\sin. 60^\circ \sin. 60^\circ}$$

$$= \frac{108 \times \frac{1}{2}}{\frac{\sqrt{3}}{2} \times \frac{\sqrt{3}}{2}} = \frac{54}{\frac{3}{4}} = 72\text{ft.}$$

It is interesting to note that (Bk. I. vi.) the distance of top of column from top of tower is also 72ft.—DAVID STEPHEN.

[57171.]—**Hardening Punches.**—I think, with you, that the difficulty is in the shape of the punch. A taper punch will, of course, jam. Is it not possible to punch the shoes hot? or to drill the holes first, and then punch out what is left to make them square; there would not be quite so much metal to take out, and you could use a straight punch, or even relieve it a little at the back. I suppose the holes are square. There is really only one way to harden and temper the punches, and I don't expect you want that information.—OS.

[57173.]—**Easing Force Pump.**—Perhaps the packing is too tight, or the pump handle too short. —OS.

[57173.]—**Easing Force Pump.**—"Rector" does not say what class of pump he has. If, as I presume, an ordinary brass 3in. pump, fixed on plank, and bolted to wall, with 30 vertical feet, 1½in. suction pipe, it is clear it is now doing more than it was ever intended for, and in cases of this sort I should recommend a deep well pump, with vertical suction—say, 20ft. However, his best plan to adopt will be to apply a fly-wheel to the pump motion, which will certainly have a beneficial result.—W. H. WILDIG, Grosvenor-road, Chester.

[57177.]—**Soldering.**—Dip the nose and tin it over. Take care not to overheat it afterwards.—BACCHUS.

[57177.]—**Soldering.**—Perhaps you have a bad piece of copper in the iron; if so, it is very troublesome. I would advise not using it any longer. Of course you file the copper clean, smooth it off with an old file, take off corners, tin on a piece of sal-ammoniac. You must not get your iron to so high a heat as black.—R. PARKS.

[57177.]—**Soldering.**—Heat the copper bit and file it clean; then tin it properly with solder and soldering fluid, and don't let it get too hot (that is the great secret), or the solder will get burnt on to the copper and leave hard spots. Use a clear coke fire. Make a little round stove out of a piece of sheet iron, and take care that the bit is placed in such a position that it cannot burn. Keep your eye on it, and judge the heat by holding it up to your face occasionally.—Os.

[57177.]—**Soldering.**—If "New Beginner" will only keep his soldering-iron properly "tinned," and use properly-made solder, he will have no difficulty in keeping the solder on the iron. To tin on iron, heat it to the usual heat, and file the soldering surface well. Have some powdered rosin ready, put it on a piece of tin or a flag of stone; melt a small piece of solder over it, and rub the filed portion of the iron backwards and forwards through the melted mass until the iron is tinned. Any further information will be gladly given.—Greta.

[57177.]—**Soldering.**—I am afraid "New Beginner" fails to place his copper bit in order before he commences to solder; he must face it, before attempting to solder, by filing end perfectly clean while slightly hot, and rubbing same, say, on a piece of tin, using at the same time either rosin or spirits of salts killed, with a little fine solder, taking care in future not to burn away the face by getting the iron too hot. By attending to this he will, with a little practice, get on all right with his soldering.—W. H. Wildig, Grosvenor-street, Chester.

[57177.]—**Soldering.**—In reply to querist, Is he soldering with rosin or spirits of salts? If the former he must clean his bolt end very carefully with the file while hot, but not too hot, as the copper oxidises too quickly, then rub the copper along with some rosin and solder on a firebrick. If he uses "spirits" the bolt tins more easily; when moderately clean the copper only requires its point to be dipped into the "spirits," tinning readily on the solder. We used to use sal-ammoniac in Germany to clean and tin our bolts with; but I don't think it was better than our usual way here.—A Tinker.

[57177.]—**Soldering.**—It is not clear to me, as you sign yourself "New Beginner," whether you are trying to do the work with a plumber's wrought iron, or with what you should have, which is a "copper bit." As I am well used to soldering the various metals used in experimenting by me, it may be of some use to others as well as yourself to know my modus operandi. First, then, procure, say, 2d. worth of hydrochloric acid or spirits of salts, as it is usually termed; put some of this into, say, an empty jam-jar, also some pieces of zinc, pure if you can get it, but the sheet will do at a pinch. Do this in the open air, or, at least, on the kitchen hob, as the fumes are deleterious. When it has ceased to effervesce add an equal quantity of water to what remains in the jar, and it is ready for use. I use an arrangement of Bunsen burner of my own design, which keeps the bit at a uniform temperature all day, so that it does not require to be re-faced once in a month. To face the bit heat sufficiently to feel pretty hot when held near the cheek, file up with a smooth file which has never come into fellowship with paraffin oil (which is the enemy of solder and lead, but the friend of him who wants to clean his hands after the day's work). Have a strip of tin in the bottle with the soldering fluid, and put a drop or two upon the solder, and then apply the copper bit with clean face and sides. If your tin sheet is new, and you don't want to use the fluid, have some sal-ammoniac and powdered rosin damped, in a little box, and tin the bit with this (by dipping its nose in it), and then use powdered rosin alone on the new sheet tin. Run your solder into long light strips by melting in a ladle, and pouring on to a slate set at an incline, and by practice you ought to be able to hold bit in one hand and solder in the other, and so go ahead quickly. Mem.—Rinse the work well after using the acid.—A., Liverpool.

[57181.]—**Heating Greenhouse.**—"Thermo" cannot do better for success in his horticultural efforts than the "hot-water pipe again," of which numerous cheap and ingenious apparatus are advertised in *Gardening*, and elsewhere. The chief merit of the hot-water apparatus is the moist heat it gives off, which is a great deal more beneficial than the peculiar dry heat of the stoves. The fire, the source of endless dust and rubbish, on the floor of the greenhouse and the leaves of the plants, is outside, which enables the house to be kept in a respectable state of neatness. The presence of a fire in a greenhouse, apart from the question of neatness, is in the highest degree injurious to the well-being of the plants, causing the leaves to wither, and the advent of a respectable flower, except on some accommodating plant, an event of somewhat rare occurrence. The hot-water pipes are under the staging; whereas the stove is usually in the middle of the greenhouse, is a source of continual annoyance, besides taking up valuable space. Another consideration in frosty weather is when the fire goes out, which will rarely happen after some experience in banking-up at night; in the one case the hot water takes some time to cool, and consequently the fall of the temperature is not so rapid as when a stove goes out. Again, should the stove smoke, there is an exceedingly disagreeable odour, and a thick layer of soot over every leaf, flower, shelf, and in fact anywhere it can possibly be found. This takes an incredibly long time to get rid of thoroughly, and would be enough in itself to cause an inexperienced amateur to give up in disgust. Beyond the initial expense, I do not think that there is any real difference in the cost for a small greenhouse between the two methods of heating.—Amateur.

[57182.] — **G.N. Locomotives.** — Cylinders, 18in. by 28in., diameter of driving wheels, 8ft.; diameter of trailing and bogie wheels, 3ft. 6in. Wheel base: From centre of bogie pin to driving wheel, 10ft. 9in.; from driving wheel to trailing wheel, 8ft. 8in.; extreme wheel base, 22ft. 11in. They are not the largest, for most of the G.W.R. b.g. singles are 8ft., and I believe a new b.g. engine is building with 9ft. wheels.—Angus MacMuir.

[57182.]—**G. N. Locomotives.**—The cylinders of these engines are 18in. by 28in., bogie wheels 3ft. 10in. diameter, trailing wheels 4ft., driving wheels 8ft., extreme wheel-base 22ft. 11in., length of connecting rods 6ft. 10in. Their weight in steam is 39 tons, 16 of which are on the drivers. The largest wheel in this country is that of old 173—"Cornwall"—on the L. and N. W. Railway, built in 1847, and the only one of her class, which is 8ft. 6in. in diameter.—W. B. P.

[57182.]—**G.N.R. Engines.**—The chief dimensions of the G.N.R. single drivers are these:—Cylinders, 18¼in. by 28in.; wheels, leading bogie, 3ft. 11in.; driving, 8ft. 1in. (with tire); trailing, 4ft. 1in.; tubes in boiler (brass), 217; diam., 1¼in.; total wheel base, 22ft. 6in.; rigid, 8ft. 9in.; centre of trailing axle to bogie pin, 19ft. 5in.; connecting rod length, centre to centre, 6ft. 10in.; heating surface (tubes), 1,043; firebox, 122—total, 1,165; grate area, 18in.; weight, leading bogie wheel, 7tons; trailing, 8tons; driving, 16tons; trailing, 9tons 10cwt.; total weight in working order, 49tons. These engines have not quite got the biggest wheels; the L.N.W.R. have an 8ft. 6in. loco. called the Cornwall, running on the Liverpool portion of their line. It is not a success, and was only made for an experiment. No more have been made. The G.W.R. broad gauge have the same size of wheel as the G.N.R. I do not know the length of the boiler, but will do my best to find out.—A. A. C., Chiselhurst, Kent.

[57182.]—**G.N. Locomotives.**—If by "single drivers" "V. J. B." means the bogie single engines, the following are some of the leading dimensions thereof:—Diameter of wheels: bogie, 3ft. 11in.; drivers, 8ft. 1in.; trailers, 4ft. 1in. Wheelbase: Bogie, 6ft. 6in. (the bogie-pin being 3ft. 6in. behind the leading axle, and 3ft. before the trailer); bogie-pin to driving axle, 10ft. 9in.; driving axle to trailing, 8ft. 8in.; total wheelbase, 22ft. 11in. Boiler: Length of barrel, 11ft. 5in.; height of centre line above rails, 7ft. 1in.; minimum internal diameter, 3ft. 9½in.; maximum internal diameter, 4ft. 0½in.; plates, ½in.; 217 tubes, 1⅝in. diameter, 11ft. 8in. long. Outside casing to firebox: Length, 6ft. 2in.; width at bottom, 3ft. 11½in.; width at centre line of boiler, 4ft. 1½in. Firebox: Length at top, 5ft. 4½in.; at bottom, 5ft. 5in.; width at bottom, 3ft. 3in.; height at front, 5ft. 10½in., at back, 5ft. 4½in. Grate area, 17·6 sq. ft. Heating surface: Tubes, 1,043, firebox, 122; total of 1,165 sq. ft. Boiler pressure, 140lb. Smokebox: Length inside, 2ft. 8¾in.; radius of top inside, 2ft. 4½in. Diameter of blast-pipe, 4⅝in. Length of connecting-rod, 6ft. 10in.; eccentric rods, 5ft. 10in.; throw of ditto, 3¼in.; expansion links (curved), 1ft. 4in. long. Length over buffer beams, 28ft. 1in.; distance apart of frames, 4ft. 0¼in.; thickness of ditto, 1⅛in.; width of footplate, 7ft. 5in.; height of ditto from rails, 4ft. 2in. Weight of engine No. 1 in working order, 38 tons 9 cwt.; tender, 26 tons 10 cwt., carrying 2,700 gallons of water and 3½ tons of coal. Average consumption of coal, 26lb. per mile. In conclusion, I might add that the cylinders, being 18in. by 28in., give a tractive force of 91½lb. per lb. of steam pressure.—St. Aubyn's.

[57183.]—**Planing Machine.**—The smallest planers all take from 8in. to 10in. in height. Consequently you should find no special difficulty in that respect. To talk of 4in. being the maximum in the case of your machine seems ridiculous. But firm fixing is always essential, and I should say your angle plates are undoubtedly too small to hold work 10in. in depth. You had better have another pair 6in. or 7in. deep. A deep angle plate firmly bolted to the table will hold work as deep as the planer will take. When the nature of the work will permit, it is often held firmly by screw bolts passing from flanges or through holes at or near the top down to the grooves; either with deep angle plates having broad feet, or with long screw bolts, deep work can be held securely.—J. H.

[57184.]—**Headstock.**—To "Cui Bono."—An unsteady arrangement, I should imagine. Before I could say what alteration the pattern would require, I should want to know how it moulds at present.—J. H.

[57187.]—**Repairing Marble Ornament.**—The usual way to separate marble put together with plaster of Paris, is to carefully drive a small chisel into the joint. This should be done by a person used to the job, for although a simple matter, an unskilled man would be more likely to break the article than open the joint. The gloss spoken of by "W. E." is the polish. The article will have to be repolished.—W. Potter.

[57189.]—**Income-Tax.**—The tax is levied on individuals, not on partnerships or firms. Let each partner send in a separate return, and no mistake can be made.—Os.

[57190.]—**L. B. and S. C. Railway Engines.**—No. 214, "Gladstone": Cylinders 18¼in. by 26in., cast in one piece; leaders and drivers, coupled, 6ft. 6in.; trailers 4ft. 6in., grate area 20·6 sq. feet, tubes, 331 in number, 10ft. 8¼in. long, 1½in. diameter; heating surface of tubes 1,873 sq. ft., of firebox 112½ sq. ft., wheel-base 15ft. 7in., weight in steam 38 tons 14 cwt. No. 605, G.E.R.: Cylinders, 18in. by 24in., bogie and trailing wheels 4ft., drivers 7ft. 6in., grate area 17·1 sq. ft., tubes, 203 in number, 11ft. 8in. long, 1⅝in. diameter, heating surface of tubes, 1,097 sq. ft., of firebox 111 sq. ft., wheel-base 23ft. 1in., weight in steam 42¾ tons. "Lord of the Isles," G.W.R., broad gauge, as originally built 35 years ago: Cylinders 18in. by 24in., carrying wheels 4ft. 6in., drivers 8ft., grate area 21 sq. ft., tubes, 305 in number, 2in. diameter, heating surface of tubes 1,799 sq. ft., of firebox 153 sq. ft., weight in steam 35 tons.—W. B. P.

[57190.] — **L. B. and S. C. R. Engines.** — "Piston Rod" will find full particulars of Mr. Stroudley's front-coupled express "Gladstone" in a number of the "E.M." issued about a year since, while the bogie single engines designed by the late Mr. Massey Bromley for the G. E. R. were described in these pages but a very short time since. However, I believe that the third on the list, the G.W.R. broad-gauge express, has not been mentioned for some considerable time, so the chief dimensions are at "Piston Rod's" service:—Total weight, 41tons 8cwt., distributed as follows—four leading wheels, 15 tons 18cwt.; drivers, 16tons; and trailers, 9tons 10cwt. Cylinders, 18in. diameter, 24in. stroke. Boiler: length, 11ft. 3in.; inside diameter, 4ft. 6in. Height of centre from rail, 7ft. 7in.; 305 tubes, diameter, 2in.; length, 11ft. 3in. (?). Heating surface: firebox, 153; tubes, 1,799; total, 1,952 sq. ft. The grate area is 21 sq. ft., and the boiler pressure 140lb. to the sq. in. Diameter of driving wheels, 8ft., carrying ditto, 4ft. 6in; wheel base, 4ft. 10½in. by 6ft. 4in. by 7ft. 5in. from leading to trailing axles, giving a total of 18ft. 7½in. Length of framing, 24ft. 8½in. The tender weighs 15 tons 10cwt., and carries 2,700 gallons of water. These engines have been almost entirely rebuilt; but I fancy that no material change has been made in the dimensions.—St. Aubyn's.

[57190.]—**L.B. and S.C. Engines.**—I inclose a table of the dimensions of the "Gladstone":—Cylinders, 18¼in. by 26in.; driving wheels, 6ft. 6in.; leading, 6ft. 6in.; trailing, 4ft. 6in.; total wheel base, 15ft. 7in.; total length (engine and tender), 51ft. 10in.; firegrate area, 1,500 sq. ft.; No. of tubes, 331; total weight (engine and tender), 66tons 1cwt.; total gallons in tank, 2,250. The "Gladstone" (No. 214, 1882, Brighton Works), is an express loco on L.B.S.C.R. It has a great many peculiarities. The chief one is the use of such large wheels coupled in front for express passenger traffic. It was thought by many well-known loco superintendents to be dangerous; but there is no reason why it should be so. The chief opinions against it were that large wheels were more likely to mount the rails than small ones. Mr. Stroudley has used as large wheels for some time. In 1877 he designed some engines, cylinders 17¼in. by 26in., 4ft. coupled in front, 6ft. 6in. wheels. These engines are very neat, and capable of doing heavy work at moderate speeds (on a bad road). In proof of what I have mentioned, Mr. Stroudley has never had a single accident as regards the coupling of large wheels in front (such as mounting the rails, &c.) The weight of these locos in working order is 36 tons. Another peculiarity is the boiler, which has great heating surface in proportion to its size. The tubes are not only small, but very closely set; they are 331 in number, 1½in. in diam., and 10ft. 8½in. long. They are made of steel. To work this boiler properly great precautions have to be taken as regards the feed water. It is very well known that when water is heated it throws down lime-salts, &c. Mr. Stroudley has for many years heated the feed water by turning a portion of the exhaust steam into the tank, and does so in this loco. The line from London to Brighton is heavy (compared with 60 miles out on the G.W.R., L.N.W.R., M.R.) The chief gradient which appears is 1 in 264 and 1 in 100 for 2½ miles per New Cross. The trains on the L.B.S.C.R. have been getting heavier and heavier every year, and now the City express from Brighton to London Bridge, leaving at 8.45 a.m., weighs 350 tons (engine and tender included). To convey this in one hour and five minutes is difficult work, on account of the gradients. To feed the boiler, as the feed is heated, pumps, and not injectors, are used. The pumps Mr. Stroudley uses are of peculiar construction: they have three inlet and three outlet valves, and an air chamber placed close over the outlet valves. Two small valves are provided on the suction pipe, which take in air at every stroke, and so soften the working of the pumps and keep the air-vessels supplied. When the water in the tender gets very low and very hot, these valves do not work, and a small cock is provided on the Westinghouse main pipe, by which the driver can allow air to escape into the pump, thus keeping it perfectly quiet, as when the water is colder, engines fitted with pumps alone are liable to get into trouble if they have to stop for any length of time with a heavy fire on, and no means existing of getting water into the boiler; so Mr. Stroudley has placed an auxiliary feed-pump under the Westinghouse pump, and has provided a valve by which air is allowed to circulate in the air-pump without being forced into the receiver. The Westinghouse engine being then put in motion, it will feed the boiler at a rate sufficient to preserve it from all risk while the engine is standing still. The arrangement of the reversing gear is very ingenious. The reversing wheel and screw can be worked by hand; but the compressed air from the Westinghouse reservoir is employed to do the heavy work. A small cylinder, 4½in. diam., is fitted with a piston and rod attached to the nut of the reversing screw, and a small cock allows air from the Westinghouse main reservoir to pass in behind the piston. This forces the engine into back gear, and the screw has merely to be used to regulate the movement. By allowing the air to escape, the weight of the valve motion puts it into forward gear. There are no balance weights. There are many other features on this engine which are common to many of Mr. Stroudley's engines—viz., the electric bell in communication with the guard, the duplicate gauge glasses, the two pressure-gauge glasses, with two hands each (one gauge for the steam), one of its hands tells the boiler, and the other the steam-chest pressure; the other gauge is for the Westinghouse brake (one of its hands tells the reservoir, and the other the train-pipe pressure), and speed indicator. Mr. Stroudley places the outside cranks in a line with the inside ones (and not opposite, as they usually are). The piston rod and crosshead are in one forging of steel. The motion plate is of cast steel, and the guides for the valve rods are cast with it. The tender has inside bearings to match the engine. They are oiled from the top of the coping, access to which is obtained by walking along the foot-plate. Thus all risk of men leaning over to oil the boxes, and being knocked off by bridges, &c., is done away with. I must now apologise for filling up so much of your space, but trust this may be of use to your readers. The Granville, Northcote, and Salisbury are of the same dimensions, &c., as the Gladstone, and two more are being made.—A. A. C.

[57192.]—**Drills and Taps.**—

| in. | in. | in. | in. |
|---|---|---|---|
| 1/4 ........ | 3/16 | 3/4 ........ | 5/8 |
| 5/16 ........ | 1/4 | 7/8 ........ | 47/64 |
| 3/8 ........ | 19/64 | 1 ........ | 53/64 |
| 7/16 ........ | 11/32 | 1 1/8 ........ | 15/16 |
| 1/2 ........ | 13/32 | 1 1/4 ........ | 1 3/64 |
| 9/16 ........ | 15/32 | 1 3/8 ........ | 1 5/32 |
| 5/8 ........ | 33/64 | 1 1/2 ........ | 1 9/32 |
| 11/16 ........ | 37/64 | | |

(Martin's screw-cutting tables.)—R. N.

[57195.]—**Iron Rusting.**—Try white lead and tallow applied hot. This is easily removed.—Os.

[57195.]—**Iron Rusting.**—Linseed oil is sometimes used; but Buck and Hickman, the tool makers, employ a special transparent preparation, which would answer the requirements of the querist.—Bacchus.

[57204.]—**Sea-Water Aquarium.**—1. Sea-anemones are about the easiest things to keep. The common sort, *Actinia mesembryanthemum*, lives best. The "Plumose" (*S. dianthus*) are lovely creatures and live very happily; so do the "Daisies" (*Sagartia bellis*). Almost any sort except the "Dahlia Warttet," which requires more water than it is possible to allow it. For fishes the blennies and gobies are decidedly best; eels live very well (I have had one for two years), but are seldom seen, so don't do much good. For plants you ought only to have two sorts if you want to get on well; one is the "Sea lettuce" (*Ulva latissima*), and the other *Enteromorpha*. 2. You *can* keep the water for five years without changing; but in order to do so you must have very few animals in proportion to the volume of water, and keep the aquarium in a very dark place. I prefer myself to keep it in a place where one can *see* the creatures, and change the water pretty often. You needn't have real sea-water; but you can use Southall's aquarium sea-salt, which answers just as well. 3. There is not the slightest occasion for any zinc top, unless you want to prevent fishes from jumping out. 4. Any place will do to keep it in. I should recommend your dining-room window, or if you prefer it the hall; *not* in a conservatory. Now for useful hints. You must not let the sun shine on it too much; in the winter it does not matter, but in summer it must be covered up. Don't leave any scraps of meat (with which the creatures ought to be fed) in the water, or they will ruin the whole business. If the water looks muddy sometimes, syringe it with a glass syringe till it becomes clear. The anemones enjoy this process, and open wide generally while it is carried on. All the skins (which the anemones have a habit of casting) must be taken out as soon as discovered with a small net. More advice if you get into difficulties.—R. A. R. Bennett, Walton Manor Lodge, Oxford.

[57206.]—**Legal.**—If you did absolutely buy the ground, you can compel him to complete the sale; or if the value has increased, you can sue him for the difference by way of damages. The only question is, Did he stipulate for any particular sort of house? If he did not, of course, you can do as you like. Tender him the remainder of the money and take possession of the ground. If it has increased in value, of course, he will be glad to get it back, as he can get more money from someone else.—Os.

## UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

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56946. Clock Springs, 396.
56947. Rotary Hair Brush, 396.
56965. Blasting Powder, 397.
56982. Ball-room Floor, 397.

**The Whitworth Scholarships, 1885.**—The following is the list of successful candidates for the Whitworth Scholarships this year:—Thomas Clarkson, 20, engineer, Manchester, £200; Hugh O. Bennie, 20, engineer, Glasgow, £150; Robert H. Unsworth, 20, engineer, Pendleton, near Manchester, £150; Harold M. Martin, 21, engineer, Gateshead, £150; William T. Calderwood, 25, mechanical draughtsman, Glasgow, £150; John Richards, 22, blacksmith, Cardiff, £150; Ernest R. Dolby, 23, engineer, Leeds, £150; James Rorison, 21, engine fitter, Paisley, £150; Arthur J. Moulton, 20, engineer apprentice, Preston, £150; William McNeill, 22, mechanic, Birmingham, £100; George W. Moreton, 24, fitter, Crewe, £100; Stephen E. Mallinson, 24, assistant analyst, London, £100; Henry C. Jenkins, 23, engineer and millwright, London, £100; Robert Smith, 24, engineer, Glasgow, £100; Thomas W. Nash, 21, engineer, London, £100; Henry F. W. Burstall, 19, engineer apprentice, London, £100; Arthur J. Stopher, 22, mechanical engineer, Nottingham, £100; Sidney H. Wells, 19, marine engineer apprentice, London, £100; George Milnes, 24, fitter, Charlton, Kent, £100; Henry Begbey, 22, engineer, Old Charlton, Kent, £100; John Goodman, 23, engineer, Brighton, £100; Mark H. Crummie, 21, mechanical engineer, Hull, £100; Oliver Marsh, 22, fitter and turner, Crewe, £100; Thomas Galbraith, 23, pattern maker, Manchester, £100; Joseph H. Bowles, 23, engine fitter, Stratford, £100.—Calderwood and Richards were bracketed equal.

**New Fire-Alarm.**—With reference to Mr. Pritchett's electric fire-alarm, illustrated on page 495, we are informed that Messrs. J. T. Mayfield and Co., of 41, Queen Victoria-street, E.C., are the sole makers, and will be glad to show the instrument in action at any time at their show-rooms, 35a, Queen Victoria-street.

## QUERIES.

[57207.]—**Electric Lamp.**—I have got one of Swan's incandescent lamps. How am I to tell the number of c.p., as it is not marked?—it cost 5s. about three years ago.—Plumber.

[57208.]—**Speaking Tubes.**—Can any reader of this paper who has had experience in fixing long-distance speaking tubes, say if there is any difficulty in communicating through 300ft. of 1½in. lead pipe? I might say I shall have about six corners to turn.—J. B.

[57209.]—**Case-hardened Iron.**—Will any fellow-reader kindly let me know how I can case-harden iron studs in an ordinary smith's fire? What are the compounds, and how used?—Busby.

[57210.]—**Tar.**—To Mr. Allen and Others.—Stockholm tar, which is obtainable from trees, is of a brown colour; coal tar, which is of vegetable origin, is intensely black; this change in colour is effected by nature. What is the process? I wish, by copying nature, to turn Stockholm tar black, if this be possible.—Dandie Dinmont.

[57211.]—**Steam Launch.**—I want to build two of the above, suitable for single-cylinder engines, cylinders 5in. diameter, 6in. stroke; boiler, 4ft. 8in. long, by 2ft. 9in. diameter; fitted with 52 1¾in. tubes. Can any of "ours" give me the name of any work that would give me idea of best mould and size for such engine and boiler?—Carpenter.

[57212.]—**Co-ordinate Geometry.**—Would any of your readers be kind enough to inform me when the sectorial angle and radius vector are considered positive, and when negative? Also if the rectangular co-ordinates of A be 4, 4; of B 3, − 8, of C − 2, − 7, find the sines, cosines, and tangents of angle between the lines joining A and B, A and C.—E. S. L.

[57213.]—**Hydrostatics.**—I should be grateful if any reader of the "E. M." would give me the working necessary to solve the following:—If the surface of a detached sheet of ice, whose sp. gr. is 92, floats ½in. out of water; find the thickness of the ice?—Private Student.

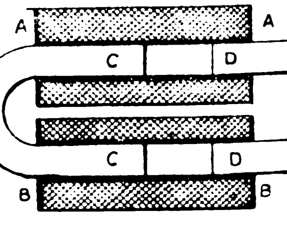
[57214.]—**Electric Bell.**—Will some kind reader of this valuable work inform me how much, and what size wire I should require for two iron cores, 3-16in. diameter, 1in. long, to work a 2in. gong, and oblige.—A Constant Reader.

[57215.]—**A Pottery Furnace for Experimental Work.**—Can any reader of the "E.M." give drawings and working details of a small furnace, suited for experiments on glazing and enamels, the total height being about 6ft. Such a furnace would be of value to many readers.—B. L. Pearson.

[57216.]—**Wheatstone Bridge.**—Will any one kindly give me a sketch of the connections in Messrs. Elliott Bros. new platinum rheostat, and say whether the 1-20ohms are added together, when the plugs are out as in the units?—H. S. H.

[57217.]—**Taxidermy.**—Can any reader of the "E.M." help me out of a difficulty? In preserving fresh-water fish, I fail to keep their colour; roach and bream for instance, turn dark, thereby losing their beauty! I use size made from parchment cuttings, applied hot.—Young Beginner.

[57218.]—**Electro-Magnetic Problem.**—Will any of your readers kindly work out the following problem, and show how it is done? A and B are two coils 24 centimètres long, each having 4,000 turns of covered copper wire, 1mm. diameter, amounting to 1,000 mètres. A horseshoe magnet of round soft iron, 36mm. diameter C, is fixed with its poles halfway into the two coils; a similar horseshoe magnet D is free to move into the other ends of the coils. What is the current in volts and ampères required to magnetise C to saturation (intensity of magnetic field 45)? Also what is the force in grammes exerted on each pole of the free magnet, when the distances between the poles of the two magnets are respectively 12, 9, 6, 3, 0, centimètres? Also is the current affected by the position of the free magnet when at rest?—Asterisk.



[57219.]—**Screw Cutting.**—Will any of my fellow-readers let me know if a screw chaser can be made from an ordinary tap, and how it is done, and if they can give me a table of the different wheels to put on the mandrel and the stud to produce the different number of threads per inch on a leading screw of four threads per inch?—Busby.

[57220.]—**Batteries.**—I am about to place a series of six gravity batteries in my laboratory. Will some correspondent describe the best method, also the correct method of attaching wires, &c.? I am getting the cells from London, and wish to know how to set them up for operation?—Western Youth.

[57221.]—**To Mr. Bottone.**—Please give me brief drawings of the ironwork of a Gramme dynamo, to light about 100 candle-power, also the amount of wire and sizes of same?—W. P. W.

[57222.]—**Lecture Illustration.**—I want to illustrate my lessons, given to a class of about 50 students, by means of the lantern and slides. The slides are photos taken from prints. I want information (1) Do mechanical subjects show up well on the screen? (2) What apparatus would be suitable, *i.e.*, for taking the photographs, and for projecting on screen? Would Lancaster's quarter-plate Instantograph be good enough for taking the photos?—KIPPO.

[57223.]—**Gas-Engine.**—To "INVICTA."—I made a gas-engine, 3¼in. bore, 6in. stroke, 2in. compressing chamber, explosion every second stroke, I ignite it with a red-hot pipe. I had many very good explosions, and had it running for three minutes, but cannot get it to run properly. Please will you state if it is really too little to make it work properly, and which is the smallest compressing engine working?—G. J.

[57224.]—**Prevention of Noise.**—The Scotch system of building houses in flats may have its advantages, but it has also its disadvantages, as I have found to my cost. I have just purchased a lathe and I also amuse myself with joiner work; but I am afraid I will have to stop these amusements, as the family beneath have sent up word that the noise is too great to be borne. I shall feel truly thankful if some of your correspondents can put me in the way to prevent the noise from travelling downwards.—SPES.

[57225.]—**Copper Bend.**—To "GLATTON."—It was not a band I inquired about, but a bend made in two halves, with seams at the side, say for a 4in. pipe. If "Glatton" can give me any hints how to make one I shall feel obliged? I thank him for the definite reply he has given me recently to my other query.—PLATE WORKER.

[57226.]—**5ft. Reflector.**—In a telescope whose 4½in. speculum is of 60in. focus, how far from the speculum must the 1in. plane mirror be placed? In a small book I have, the position of plane is given as "half the diameter of the tube from the principal focus," thus bringing the focus exactly in the opening in the side. Would not this be too near the small mirror to allow the use of negative eyepieces or a Barlow lens?—A. B. C.

[57227.]—**Cleaning Sextant.**—Would any fellow reader kindly say how I can clean or remove green scale or verdigris on sextant? It has not been in use for a year or two, and seems difficult to remove unless by dipping in acid, and that, of course removes the black varnish or skin. The green, of course, is the result of salt water. —BILL.

[57228.]—**Tinman's Piecework Prices.**—Can any reader inform me if there are any such published, or if I could obtain a list, either for London or Birmingham?—PLATE WORKER.

[57229.]—**Gold and the Mint.**—I am given to understand that the Mint Authorities are purchasers of gold. Do they buy it if of low quality, and would there be much risk in sending them a parcel from the country? To whom should such parcel be addressed? Do they charge for melting and assaying?—WESTERN.

[57230.]—**Cardew's Voltmeter.**—I wish to test E.M.F. of a Siemens D$^3$ (6,000c.) upright machine with above. Will some reader of "Ours" kindly say if entire current from dynamo should be passed through voltmeter, or should it be connected in a shunt circuit, and how? The voltmeter, with extra resistance, reads to 150 volts. The dynamo shows a current of about 34 ampères when tested with a Siemens dynamometer.—DON'T KNOW.

[57231.]—**A Six-Footed Pig.**—A friend of mine has a pig with six feet, the two extra ones branching off from the fetlock of the fore leg; they are fully developed. When the pig is killed I want to keep those feet, and I shall feel obliged if some correspondent will kindly tell me how I can preserve them?—C. D.

[57232.]—**Heating by Steam.**—Would some kind friend answer the following?—Wishing to heat a large building, 70ft. by 30ft., by steam-pipes, could we take steam from a Cornish boiler at any pressure, from 10lb. to 50lb., round the building, and bring the condensed water back into the same boiler by a small back-pressure valve at the front of the boiler? Or could we take the exhaust steam from a horizontal engine, with cylinder 11in. diameter by 24in., round the building and back into a well during the day, but would have to take steam from the boiler during the night? The exhaust pipe from the engine is 3in. diameter. As it would be a great distance round the building, would it be liable to increase the back pressure on the piston of the engine? Please give information as to size of pipes?—A. D.

[57233.]—**Fret Saw.**—Will any of "ours" kindly give me a few tips in the making of the above, which I would like to be worked by treadle? I am anxious to make it of wood, or at least as much of it as is possible. The fuller the details in the advice the better. What book on fret working and kindred woodworking would you advise an amateur to go in for? What ready-made fret machine of a reasonable price would be the best to buy?—JOB.

[57234.]—**Colour Lakes.**—Will "An Analytical Chemist," or some other chemical friend, kindly give a list of modern transparent colours, suitable for oil varnish in the same sense as red alkanet colour is transparent in oil?—T. WOOD.

[57235.]—**Thermometer.**—Will any of our scientific friends kindly inform me if we have at command, any thermometer or indicator of momentary changes of heat in vapour, &c., more sensitive and more convenient to read, than the clinical thermometer? I want to read the temperature of air, as it goes in and comes out of the human system.—T. WOOD.

[57236.]—**Adhesive Paste.**—Any hints on preparing a good adhesive paste for labels, &c., not to mould, same as "Gloy," would greatly oblige an old reader of "Ours." —A. W. G.

[57237.]—**Grooves of Pulleys.**—Could any of your readers give me a rule or method for cutting out the grooves in a pair of grooved gut pulleys, so that when the speed was changed, the band might always be tight—of course that is when the one has a greater diameter than the other?—BORDERER.

[57238.]—**Vacuum Tube Rotator.**—Could any friend of amateurs give instructions as to making a vacuum tube rotator, to work electrically?—W. P. W.

[57239.]—**Coil Regulator.**—Could any kind reader tell me how to make a regulator for regulating the power of shocks from a ¼in. spark coil?—W. P. W.

[57240.]—**Automatic Musical Instrument.**—I have obtained a copy of Mr. Wenham's specification, No. 5024, 1884. Theoretically the whole thing is apparently simple and clear but is it practically successful?—is it equal in effect, to say, the pianista? I opine from Mr. Wenham's description in No. 1061 (24516), that he has actually constructed one or more, and looking at the date of the complete specification, Nov., 1884, why is it not exhibited at the Inventions Exhibition, and shown in action? Perhaps Mr. Wenham will kindly answer these questions, and say where the instrument can be seen and heard.—B.

[57241.] — **Robinson's Patent Lubricating Bags.**—A patent has just been brought out in the shape of a lubricating bag. It is made of canvas and filled with the lubricant, which is a grease capable of becoming semi-liquid when coming into contact with heat. The bag is placed upon the bearing of plate rolls, or axles, &c., and as the bearing becomes heated by friction the grease leaks through the pores of the bag, and so lubricates the bearing. What I want is some one to tell me how to fill the bags quickly? The present mode of filling them is by hand, on the same principle as sausage making; that is to say, by putting the grease into a cylinder and forcing through a pipe into the bag. This is a very slow way of doing it, as the bags have to be cut the required size and then sewn; then the lubricant is put in the bag, and the hole left to fill the bag has to be sewn up, thus taking up a great deal of time and labour, which, I think, might be dispensed with in some way or other. I should be glad if "Invicta," or some other friend would enlighten me on the subject.—H. U.

[57242.]—**Chemical.**—To MR. GREY, F.C.S.—I propose studying the composition of Portland cement. Would you be kind enough to draw up a table or recommend a practical book, to include the quantitative estimation?—DAVID STEPHEN, Wellington Quay.

[57243.]—**Condenser.**—Will any of your readers kindly help me in making a good condenser for an engine of 8in. bore, 15in. stroke, to run at about 165 to 175 revolutions per minute, with the boiler pressure from 65 to 70lb. I have plenty of water, the river is a foot from engine. Will I get much power from it? A sketch, and size of condenser will oblige—F. A. M.

[57244.]—**Dentistry.**—Will some kind reader explain where I can get the necessary tools for making false teeth? Is the vulcanising process supposed to be better than plate work? Can a brother mechanic give a sketch of how to make a cheap vulcaniser? I wish to perfect myself in dentistry, and any hints as to books or classes would be gladly received.—MECHANIC.

[57245.]—**Compound Tandem Engines.**—Will "Invicta" kindly give a sketch and dimensions of a pair of compound tandem engines with outside pipe condenser, suitable for a boat about, say, 20ft. by 5ft., showing arrangement of valves and air pump?—R. N.

[57246.]—**Boiler.**—I have a steam boiler, and I want to know what pressure it will stand for working: size, 12½in. high by 6in. diameter, with firebox 5in. diameter by 6in. high, with 2¾in. brass tube carried up, all made of brass 1-16in. thick all over, and riveted vertically twice, and well riveted all round and inside, and soldered; water space all round ½in. Can anyone say if it will stand 100lb. working, and actual pressure, and how it is got at?—FERROTYPE.

[57247.]—**Tempering Twist Drills.**—Will any kind reader oblige by informing me how to temper twist drills and reamers? Also the best material to use for grinding steam and water-cocks?—W. THOMSON, Sukkur, Scinde.

[57248.]—**Speed of Launch.**—To "INVICTA" OR OTHERS.—In a small steam launch, say of 10ft. length, the paddles revolving 200 per minute, a speed of eight miles per hour is obtained. If the speed of the paddles be increased to 2,000 revolutions per minute, would there be any increase in speed, and if so, in what proportion? Also, what is the average number of revolutions of the screw propeller in small launches, and would an increase in the number of revolutions in the screw give greater results in speed than in the case of paddles, or would the water be churned into foam? I may say that if the speed of boat increased at all in proportion to the number of revolutions of propeller, I could obtain easily 5,000 per minute from a rotary engine of a new design, which has registered as many as 16,800 at 30lb. pressure, and which has the advantage of lightness, a 4½-h.p. only weighing (without flywheel) about 20lb.—SENSITIVE FUSE.

[57249.]—**Electro-Motor.**—I must apologise to Mr. Eugene Brown and Mr. S. Bottone for not clearly stating what I wished to do with my motor. I have a shunt-wound motor which I wish to be able to run in either direction, so I use two phosphor bronze plates as brushes touching the commutator tangentially. I can by this means reverse the direction of rotation by simply altering the direction of the current through the armature only, the brushes being always in the same position. What I want to know is whether, when the machine is running at full speed, I can reverse the direction of the current in the armature, and so the direction of the rotation of the machine, without damaging the machine in any way.—W. E. H.

[57250.]—**Coke Cracker.**—Will someone tell me how to make a simple one of above, for hand or power, of the simplest possible construction?—and greatly oblige—P. W. R.

[57251.]—**Agglomerate Blocks.**—A short time ago I made an oblong box, partitioned so as to form an electric battery of three cells. Having purchased three agglomerate blocks of the Leclanché pattern, I joined the cells in series and set them to work with bells, &c. In about four days two of the carbon sets fell to ashes, the remaining one is working by itself all right up to the present. The chemicals employed are common salt and water, same proportion as sal-ammoniac. If any of your readers would be good enough to say if I am right in supposing the carbons are not good, I would be much obliged.—F. E. MORGAN.

[57252.]—**Free Reeds.**—Many thanks to G. Fryer and "G. L. B." for their kind information respecting my query, but what I wanted was (I must say with all due respect to both Mr. F. and "G. L. B.") instructions how to make a tuning apparatus, and I will be much obliged to either for a sketch of the apparatus as used in organ factories? As to my private correspondence with Mr. F., I wish to say that I did intimate to him that I was not a competent tuner, and intended to purchase a chromatic scale of reeds, tuned to equal temperament, as a guide, but I fell out of work just at that time, which has prevented me from getting them. I thought it very ungentlemanly and against the rules of this valuable paper to mention my correspondence in the way he did, as I have spent most of my leisure hours for the last twelve months in learning how to tune reeds, unassisted by any practical tuner, and don't mean to give it up now. I have a good ear, and I don't see why I should not succeed with practice. I have got very valuable information from back vols. of the "E.M.," especially Vol. XXIII. on tuning. I believe if I could get two hours a day with a practical tuner for a week, it would about set me right; but as I cannot get it, I shall have to do the best I can. In conclusion, I wish to ask a few questions on tuning: 1st, In tuning or laying the bearings by fifths and octaves of a reed instrument, equal temperament, is it a rule to have all the fifths a slow wave flat? 2nd, What is the exact speed of wave, and is it to be the same speed in all the fifth intervals throughout the scales? 3rd, Is it right to tune fifths and octaves by a light pressure of wind? 4th, Why does a reed sound flatter in an instrument than out?—AMATEUR TUNER.

[57253.]—**Waterwheel.**—To "INVICTA."—Is 20lb. water pressure, from a pipe ⅜in. internal diameter, sufficient to drive a waterwheel to give 1-10h.p.? If so, I should esteem it a great favour if you would give me a sketch and dimensions of such a wheel, also any hints as to construction will oblige? There is no such thing described in any back numbers I have.—ROUGE GORGE.

[57254.]—**Photo. Chemigraphy.**—In a back number it states that the zinc plate for this process is to be coated mith a mixture of gum-arabic, water, grape sugar, bichromate of potassium, and a few drops of ammonia, and afterwards to be etched with strong solution of ferric perchloride. Will someone kindly give the actual formula, as the above directions are very vague?—GRATEGOSH.

[57255.]—**Storage Battery.**—I am about to make a storage battery of two cells each of eleven plates connected alternately. Will "Bunsen" or any other person kindly tell me (1) The best plan to keep the plates in position, and from contact? (2) How I am to tell when they are fully charged? (3) How many times before formation is completed? (4) How many 10 or 20c.p. Swan lamps it will light;—size of plates 5in. by 5in.?—W. LAURIE.

[57256.]—**Fees to Fire Brigade.**—What are the rules or by-laws referring to fees or expenses payable to the Metropolitan Fire Brigade? Is it true that if an engine arrives, or any fireman enters a house where there has been a slight fire, although now extinguished, the householder has to pay a certain considerable sum, which can be enforced by law?—FIRE.

[57257.]—**Equatorial Mounting.**—Can any of our astronomical readers refer me to a description sufficient to work from, of a simple, yet effectual, form of equatorial mounting, suitable for a 3in. refractor? It must not be too difficult to make. I have no doubt in some back number of the "E. M." there is such a description, but not very recently, and if I knew in which, could get it from the office.—LANDBIRD.

[57258.]—**Chemical.**—Would any of our chemical readers give some reliable method for the detection and separation of a mixture of not more than two acids and bases, to be selected from any of the following salts:—Benzoic, succinic, salicylic, citric, tartaric, oxalic, hydrocyanic, formic, and acetic acids, as required in the Advanced stage of practical organic chemistry, under the Science and Art Department, and oblige.—ORGANIC STUDENT.

[57259.]—**Making Patterns on Glass.**—Will some kind reader inform me how I can take patterns from prints, drawings, &c., and transfer, print, or draw them on glass? I saw the other day a magic lantern slide, which had the appearance of a steel-plate engraving, every line showing so plainly. Will some reader tell me how this was done, or any other information on making patterns on glass? I might say I don't want them to stand any length of time.—R. H. C.

[57260.]—**Flies.**—Will someone kindly say where there is a good account of the life-history of the common house-fly?—T. W.

[57261.]—**Cupola.**—Is it possible to build a furnace to melt about 12lb.? Would the pull of a chimney 40ft. do? I have experienced difficulty in getting good castings, and think ironfounders don't care about small jobs, and no doubt many of our readers think the same. I believe iron that has only been melted once turns out soft; is that so?—and is the hard stuff we often get hold of through old iron or the loam? If anyone could give a few hints, I should be very much obliged.—J. K.

[57262.]—**Quick-Drying Paints.**—I have lately made experiments with quick-drying paints, and have used spirits of wine and shellac? Can you recommend me any other varnish, equally good and cheap?—R. J. P.

[57263.]—**Chemical Action in Battery.**—What chemical action takes place in a battery of zinc and carbon with chloride of ammonium, also in one where manganese is used?—R. J. P.

[57264.]—**Blue Paint.**—Wanted, a good cerulean blue paint which will stand a good heat without blistering, turning black, or yet fading.—R. J. P.

[57265.]—**Bees.**—Having a large and light spare room in house, I propose keeping bees; will it be safe? Any information suitable for a beginner will be thankfully received.—R. PARKS.

[57266.]—**Sea Voyage.**—On account of ill-health, I have been advised to take a sea voyage. Can any brother reader inform me if it is possible to work, or partly work, a passage to Australia and back, as steward's or purser's assistant, or some similar capacity (age nearly 22) ?—Five Years' Sub.

[57267.]—**Live Spindle.**—Some months back a correspondent stated where in London, he had got small lengths of hydraulic tube, about ⅜in. outside diameter, suitable for live spindle. Will anyone kindly repeat the information, or state what number of "E. M." it appeared in ?—Dubious.

[57268.]—**Dyeing Fishing Baits.**—Will any of our readers (deep-sea fishers), inform me what is the best yellow to dye feathers with ? I have tried various dyes, but can't get them to stand the salt water. I would much rather have natural yellow feathers, if anyone could inform me where I could get them ; I have tried all places that were likely to have them, but could get none.—Joiner.

[57269.]—**Phosphorescence of Sea.**—I shall be obliged by some correspondent kindly explaining the cause of the phosphorescent appearance of the sea as observed in the following manner ? I was crossing the Channel by the 8 p.m. boat from Boulogne to Folkestone on July 9th, and when it became dark enough, about half past nine perhaps, noticed this condition which continued unaltered till the boat stopped in Folkestone Harbour. It did not cover the surface generally, but was evidently excited by the motion of the boat ; the phosphorescent parts being only the foam and crests of the waves thus produced, and consequently especially marked was it in the neighbourhood of the screw. It was well seen even in the smooth water of the harbour, and where the water was reflected from the wooden piers of the landing-stage it showed very beautifully. Seen in this way and so close to the shore, it occurred to me that the usual explanations of marine phosphorescence, viz., that it is due to certain animal organisms of peculiar species would hardly apply. Although new to me, not being aquatic in my habits, it is doubtless familiar enough to many others, and I should be pleased to learn the cause of the condition as thus seen ?—Landbird.

[57270.]—**30-Lighter Dynamo.**—Will "W. H. E." kindly inform me what current, and at what potential, his machine will work ; also, what speed to be given to armature ? I require it wound for 50 volts ; perhaps "W. H. E." will give me wire required, unless he has worked above for his potential.—Volta.

[57271.]—**Flageolet Tuning.**—Will some reader kindly inform me how to tune the French flageolet ?—R. E. H.

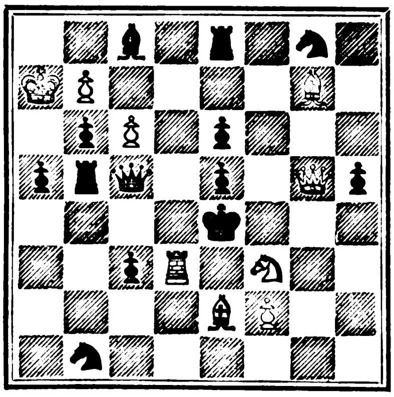
## CHESS.

◆

All Communications for this department must be addressed to J. Pierce, Langley House, Dorking.

PROBLEM DCCCCLII—"Patience."

*Black.*



*White.* [9+13

White to play and mate in three moves.

Solution to 949.

| *White.* | *Black.* |
|---|---|
| 1. Q-Kt sq | 1. Q-B 6 (a) |
| 2. Kt-R 6 | 2. Anything |
| 3. Q or R mates | |
| 2. K-R sq, &c. | (a) 1. Q-R 2 (b) |
| 2. Kt-B 2, &c. | (b) 1. P-Q 7 (c) |
| 2. Kt takes Kt, &c. | (c) 1. Kt-K 6 |

### NOTICES TO CORRESPONDENTS.

Correct solutions to 950 by E. S., B. Fison, Rev. W. Anderson (Old Romney), F. O'N. H. (a puzzle-headed conception, rather than a problem), R. A. Bennett, A. S. Olver (pitfalls). A. A. E. Lecluse (key move apparent, too many duals) and H. Culmer.

To 951 by E. S , R. A. Bennett (very neat), V. S. Pochin, H. Culmer, Streetgate, and A. S. Olver (don't like it).

To 949 by T. L. Robins.

E. S.—Notice was repeatedly given at the beginning of the tourney, that if solvers wished to score full marks, they must send full solutions, both of the two and three movers. The reason such are not printed is because of the space they would occupy.

B. F., V. S. Pochin, and A. A. E. Lecluse.—If in 950, 1. Kt-R 6, 1. Kt-K 6, 2. Q takes R P (ch), Kt-Kt 5 (ch).

T. L. Robins.—Your solution to 950 appears to fail if Black play 1. Kt-K 6. See notice below to Streetgate.

V. S. P.—You have overlooked in 949 that Black can check with R at Q Kt 3. We did not receive your solution to 948.

Streetgate.—The solution you sent was quite correct : the initials referred to another correspondent. Your elaborate solution of 950 appears to fail in this variation, 1. P-K 6, Kt-K 6 ; 2. Kt takes Kt, Q-Q R 4. And where is the mate ?

W. A. (Old Romney).—We will try to examine some of the problems without further delay ; but will you be kind enough to send the solutions given in the English Mechanic ?

## ANSWERS TO CORRESPONDENTS.

⁂ *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

### HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

⁂ Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, Aug. 12th, and unacknowledged elsewhere :—

G. E. Davies.—Rev. T. Calliphronas.—J. and H. Grace.—R. E. Phillips.—Gilford.—Mills Reading Society.—E. N. Grimwade.—F. H. Briggs.—R. R. R.—One in a Fix.—Pedlier.—W. H.—Transit.—C. R. K.—C. A. W.—J. Brierley.—Pump Patent.—George Smith.—G. Park. J. T. Strange.—S. Bottone.—J. E. Gore.—A. Evans.—Rev. J. Pearson.

F. G. Williams, Demerara. (The late Government was defeated by the united efforts of the Conservatives and the Irish party. It was, of course, in Mr. Gladstone's power to have advised the Queen to dissolve Parliament, and appeal to the country. Then, if the country had returned another Liberal majority, Mr. Gladstone would have resumed power. But he declined to take this course, because it would have been foolish to appeal to the present limited electorate, when so many more voters will be added to the register at the General Election, which must take place shortly. The Queen, therefore, sent for Lord Salisbury, and that statesman formed a Ministry, which retains power in the face of a Liberal majority by a sort of tacit understanding between the two parties that he shall be allowed to do so until the General Election determines which party the people really wish to take office. We cannot deal at length with political questions in these columns, and should recommend you to take in the *Weekly Times*, published at this office, which is the best English Liberal weekly newspaper, and in the columns of which we shall be glad, from time to time, to solve any difficulties that may occur to you in connection with social and political subjects.)—Trophy. (We cannot spare space for five problems a week.)—J. G. B. Yates. (We incline to your opinion that they were not cheques, but simply requests to pay ; but the question would admit of argument on the facts.)—Ebbw Vale. (You would gain the most useful information in connection with villa and cottage building by searching the volumes of the *Building News* ; but if you consult the Catalogue issued by Mr. Calvert, of Great Jackson-street, Manchester, you will find a list of books from which you can make your choice.)—J. Johnson. (The book that will apparently suit you is "Tall Chimney Construction," by R. M. and F. J. Bancroft, just published by John Calvert, Great Jackson-street, Manchester.)—A., Liverpool. (We must really refer you to a textbook. Try Mr. Sprague's "Electricity." The charge makes no difference in the weight of the jar. 2. We do not know of an electro-magnet or a magnet that will attract copper, tin, and brass.)—Jumbo. (Because very few were coined in that year.)—D. R. S. (It is a monthly, published at Boston, Mass., which draws liberally on our columns without acknowledgement.)—Copyist. (See indices. It is usually a lithographic ink, but you will find recipes in back numbers.)—Young Blacksmith. (We do not know of any.)—One in Despair. (The letter on p. 456, seems to meet your case exactly ; but if not, you will find many other hints in back volumes.)—W. Chapman. (You might try a decoction of green walnut shucks.)—Geo. Fleming, Philadelphia. (The price north of the Thames is 3s. 2d. per 1,000 cubic feet ; south, 2s. 10d. We believe there is no difficulty about hiring gas-stoves, and some companies urge their customers to hire them.)—E. Knight. (The stamp on the application for a patent is £1 ; 1s. is the cost of the stamp on the declaration before a magistrate, and a few pence for the printed forms. The "three guineas" you mention must be an agent's charge. He must be paid for his work, of course, and three guineas is little enough.)—Rapier. (Form A is the "application," and bears the stamp ; form B is the provisional specification, and two copies must be sent to the office with form A. Drawings are not necessary with provisional specifications, unless requisite to properly define the nature of the invention.)—Ferrotype. (If you cannot refer to recent back numbers, procure one of the cheap handbooks, but you had better stick to the dry-plates.)—N × X Zoo. (Nos. 633, 634, 640, price, post free, 7½d. Only some of the numbers from May to December, 1879.)—Ironmonger. (Yes, when the manganese is worn out. See "Recharging Leclanché Cells," pp. 21, 42, 121, 394, Vol. XL.)—E. G. C. (Procure catalogues from Longmans and Co., Macmillan and Co., Lockwood and Co.—Enghinheiro. (You were answered on p. v. July 17, under the signature "Engineer." You do not state what branch of engineering you wish to study ; but you will have no difficulty in Glasgow in finding suitable works.)—Tintern Abbey. (It is no infringement of a patent to make the article for experiment. You will find full details for making a phonograph in Vol. XXVII. p. 157.)—Pianessamo. (If you cannot refer to back volumes, obtain Babbington's little book on tuning pianofortes from L. U. Gill, 170, Strand.)—Nautilus, Gibraltar. (The Boyton dress was illustrated in No. 534 ; but we do not know where it can be obtained. It was made of indiarubber cloth, with air pockets so that it could be inflated.)—F. J. Stevens. (Brodie and Middleton, Long-acre, publish a work of the kind ; but most books on painting contain chapters on that branch.)—A. R. (Twelve of the numbers containing the letters of Mr. Wassell to which you refer are out of print ; but there are fourteen still in stock which the publisher will send post free on receipt of 2s. 11d.)—F. M. (If you only want a few, try and get them made by those who manufacture such articles. You must make a pattern first of all, and then cast a mould from that in plaster. Then you want a core, and a vulcanising apparatus. The rubber can be made "liquid" by dissolving in carbon bisulphide ; but it will be better to use the masticated rubber mixed with sulphur and force it into shape by the aid of steam pressure, which will vulcanise at the same time.)—Engineman. (Procure Mr. Calvert's catalogue of books on practical science, which will enable you to select those suited to your pocket. The address is Great Jackson-street, Manchester.)—New Reader. (As to the bells, procure the pamphlet advertised by Gent and Co., Leicester, on our front page. As to telephones, what sort are you going to use ?)—Clerk. (Rules for ascertaining the capacity of casks will be found in many of the textbooks ; but a discussion on the subject appeared in a back volume. Hurst's formula is capacity (in imperial gallons) equal $\cdot 0014162\ L\ (Dd + M^2)$, where $Dd$ are the diameters inside at the heads, M the diameter at the bunghole, and L the length, all in inches.)—A Constant Subscriber to the "E.M." (Let your wife get a bottle of sal volatile at the chemist's, and take a teaspoonful, in a wineglassful of tepid water when the flatulence troubles her.)—C. E., M. E. (Photo-lithography is considerably cheaper than lithography, and if you are, or employ, a good draughtsman, much more satisfactory. We fancy, however, what you really want is photo-zincography ; if so, write to Messrs. Hill and Co., 46, Essex-street, Strand ; if photo-lithography, write to Mr. Jas. Akerman, 6, Queen-square, Bloomsbury ; or Messrs. Whiteman and Bass, 236, High Holborn.)

**Wood Stains in a Dry Form.**—Andres (*Erfindungen und Erfahrungen*) gives the following formulæ for some wood stains which may be put up in a dry form, and when wanted for use may be readily dissolved in water :—Oak : Five kilos. of Cassel brown brown, 0·5 kilo. of potash, and 10 kilos. of rain water, boiled together for an hour, the whole strained through a linen cloth, and the clear, dark-coloured liquid boiled to a syrupy consistency. Walnut : A decoction of Cassel brown, 3 kilos. ; potash, 0·3 kilo. ; and water, 7 kilos. ; the whole strained through linen, and during evaporation to syrup, 2·5 kilos. of extract of logwood added. Mahogany : A decoction of extract of Brazil wood, 3 kilos. ; potash, 0·25 kilo. ; and water, 3 kilos. ; to which, before evaporating to syrup, 150gr. of eosine are added. Ebony : Five kilos. of extract of logwood boiled with 11 kilos. of water, and, when near the syrupy state, 300gr. of iron nitrate added ; evaporated to syrup under constant stirring. All the above stains are brought into a dry condition by running the respective syrups into trays of sheet iron, with low rims, in which the syrup hardens, and is afterwards broken up and ground.

**Every Workman** connected with the Building Trades requiring a Situation should advertise in "THE BUILDING NEWS," published every FRIDAY, price Fourpence, at 332, Strand, London, W.C.

"THE BUILDING NEWS" is the Principal Journal representing Architects and Builders, and has the largest circulation of any Professional Journal in the kingdom.

Every Workman should insist on seeing "THE BUILDING NEWS" every week at his Club or Coffee House. He will find more "Lists of Tenders" for new work in it every week than in any similar paper, and can thus judge where work is likely to be had. He is also specially invited to make use of "Intercommunication" if he wants to know anything about his trade ; to write to the Editor if he has any suggestions to make, and to advertise in the paper when he wants work.

The charge for Advertisements for Situations is One Shilling for Twenty-four Words, and Sixpence for every Eight Words after.

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Subscribers receiving their copies direct from the office are requested to observe that the last number of the term for which their subscription is paid will be forwarded to them in a PINK Wrapper, as an intimation that a fresh remittance is necessary, if it is desired to continue the Subscription.

**Holloway's Pills.**—These Pills cleanse the vital fluid from all contaminations, and by that means strengthen and invigorate the whole system, healthily stimulate the sluggish organs, repress over-excited action, and establish order of circulation and secretion throughout every part of the body. The balsamic nature of Holloway's Pills exercises marvellous power in giving tone to debilitated and nervous constitutions.

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Messrs. JAMES W. QUEEN and Co., of 924, Chestnut-street, Philadelphia, are authorised to receive subscriptions for the United States for the ENGLISH MECHANIC, at the rate of 3 dols. 25c. gold, or Thirteen Shillings per annum, post free The copies will be forwarded direct by mail from the publishing office in London. All subscriptions will commence with the number first issued after the receipt of the subscription. If back numbers are required to complete volumes, they must be paid for at the rate of 4d. each copy, to cover extra postage.

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Indexes for Vols. I., VI., VII., VIII., and IX., 2d. each. Post free 2½d. each. Indexes to Vol. XI. and to subsequent vols., 3d. each, or post free, 3½d. Cases for binding, 1s. 6d. each.

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⁂ It must be borne in mind that no Displayed advertisements can appear in the "Sixpenny Sale Column." All advertisements must be prepaid; no reduction is made on repeated insertions; and in cases where the amount sent exceeds One Shilling, the publisher would be grateful if a P.O.O. could be sent, and not stamps. Stamps, however (preferably halfpenny stamps), may be sent where it is inconvenient to obtain P.O.O's.

The address is included as part of the advertisement, and charged for.

Advertisements *must* reach the office by 1 p.m. on Wednesday, to insure insertion in the following Friday's number.

## OUR EXCHANGE COLUMN.

*The charge for Exchange Notices is 3d. for the first 24 words, and 3d. for every succeeding 8 words.*

**Good Value Offered** (cash or instruments) for all kinds of sound or repairable Scientific Appliances.—CAPLATZI, Science Depot, Chenies-street, near British Museum. Established 1862.

Handsome **Pipe Organ**, 7 stops, 1½ octave pedals, hand and foot blower; suit chapel; room wanted. Exchange American Organ or Piano.—WALES, Hemsworth, Yorkshire.

Wanted, **Anvil**, about 2cwt. Will give Bench Drilling Stand and 12 drills up to 1¼in., will drill at any angle; well-made tool.—Address, 128, Barkerend-road, Bradford.

Wanted, **Lists**, Engineering, Architectural, and Scientific Books; Civil Engineer's "Proceedings," early vols., "Engineering," any vols. Exchange Instruments or cash.—Z. C., 62, Loddiges-road, Hackney.

Two Double-Cell **Batteries**, Quart of rich Silver Solution, Piece of Fine Silver, and written instructions, or shown (genuine), for small Dynamo.—CATON, 60, Ludgate-hill, City (third floor).

Wanted, Jones's Seventy Candle-Power **Dynamo** CASTINGS. Exchange for Gent's Silver Studs, Sleeve Links, Breast Pin, or Lady's Brooch and Earrings, to the value of twenty shillings.—TRAVERS, 11, Wills-street, Lozells, Birmingham.

Four-Guinea **Chemical Case** (Stratham's), not used. Exchange for Engineering Works, Drawing Instruments, or anything to help in Whitworth Competition.—HAWKINS, 42, Upper Hanover-street, Sheffield.

Small Compound **Microscope**, and quantity of Fishing Tackle, in exchange for Telescope or offers.—SMITH, 156, Bond-street, Macclesfield.

Wanted, ½-plate **Instantograph**, or other good Tourist's Portable Camera, Exchange (£10) 1-1 plate Portrait Lens, lake scene back-grounds, &c.—CLARK, Photographer, Pandanarm, Forfar.

**Harmonium**, in good condition, value £3. Will exchange for good Bicycle, its value, or what offers.—ABRAHAM AUTY, Emley, via Wakefield.

Mechanical **Orguinette**, in good condition, cost 56s. What offers to the value of £2?—Mr. JOHN AUTY, Emley, via Wakefield.

**Reflecting Telescope**, 8in. glass speculum, iron tube, on strong equatoreal stand, with screw motion.

**Bunsen Battery**, 20 cells, and Electric Lamp, by Browning; Magic Lantern, 3½ condenser, limelight, and gas bag. Exchange for 4½in. or 5in. screw-cutting Lathe, or offers.—J. TURPIN, Drighlington, near Bradford, Yorks.

**Lathe**, 22in. gap bed, 2½ centres, chucks and tools, on polished bench, with six drawers and treadle under, all complete. Exchange lady's Gold Watch.—J. TURPIN, Drighlington, near Bradford, Yorks.

**Lathe Heads**, heavy 3in. back-geared, screw-cutting, head and poppet, strong, 2ft. 6in. bed, new. Exchange.—BLANCHARD, 29, Earl-street, Lisson-grove, London.

Good treadle **Lathe**, 2 flywheels, double crank shaft &c., for folding double-slide Camera, or Photographic Accessories.—BELLIS, 14, Oldbury-road, Smethwick.

Superior **Lathe**, 5in. centre, with slide-rest, by Milnes, Bradford, including tools and appliances. Offers requested, or exchange 5in. or "Facile" Bicycle.—F. UNDERWOOD, Beverley.

What offers for the following articles?—5in. **Slide-rest**, Guitar, two splendid Fern Cases; also superior Lathe and tools.—F. UNDERWOOD, Beverley.

Valuable **Foot Lathe** for sale, as am giving up turning, 4in. centre cylinder mandrel, brass bushes, massive standards, flywheel alone worth £2, with several tools and appliances. Exchange musical box with accompaniment, small engine and boiler (no rubbish), or offers exchanged to £10.—W. EVANS, 9, Friargate, Derby.

Good exchange in **Telephone Apparatus** for half-plate Le Merveilleux camera and stand.—W. J. ROBERTS, Mold.

Last 72 parts of "**English Mechanic**," quite clean, and four parts of "Amature Work." What offers?—Above.

Folding **Pocket Camera and Lens** for 3¼ plates. Exchange for dynamo, gas bags, or lantern.—JONES, 98, Packington-street, London.

Have a really good **Bench Lathe** to dispose of, complete, 4in. centre, 3in. bed; offers in musical box, small engine and boiler.—W. EVANS, Friargate, Derby.

Very good 49in. **Bicycle**, roller bearings, good condition, approval. Exchange engine and boiler; offers.—L. DAVIS, 79, London-road, Derby.

A 52in. **Bicycle**, with bag, &c., nearly new, Æolus ball bearings, light and strong. Offers. May be viewed in London on application to A. G. S., Chattan, Axminster.

**Sewing Machine**, the improved Singer, treadle, with accessories, new, recently cost £5 5s. Will exchange to value.—GOODYEAR, New-road, Spalding.

Wanted, second-hand horizontal or vertical **Tubular** BOILER, horizontal preferred. Exchange for plain Vertical Boiler. Wanted immediately.—Apply, BRADSHAW AND CO., Enniskillen.

One H.-P. **Vertical Engine**, new, turned flywheel, disc, crank, £5; Booth's, 30s.; Mitre machine (new). What offers?—W. HIGSON, Levenshulme, Manchester.

Wanted, offers for 6 pairs prize-bred **Pigeons**, with pigeon house; also 6 good cross-bred Hens and black Hamburg cock.—LOCKYER, Merstham, Redhill, Surrey.

Wanted, **Gas Bags, Theatrical Light Boxes**. Exchange good tools or jewellery.—67, Thomas-street, Aston-road, Birmingham.

52in. Coventry **Bicycle**, ball bearings, hollow forks, cradle spring, suspension saddle, nearly new. Offers.—J. OLIVE, Middle Wall, Whitstable.

Double **Dark Slides**, mahogany, best quality, ¼, ½, and 1-1 plate. What offers? Cash or exchange.—F. MOORE, 1, Naas-road, Wood green, W.

**Carte-de-Visite Camera**, walnut dark slide, good lens, with chemical printing frame, dishes, measure, all complete for taking photographs. Offers.—F. MOORE.

**Printing Frames**, polished pine, ¼-plates, ½-plates, 1-1 plates, 12 by 10, 13 by 12, 18 by 16, &c. Offers. Also portable tripod stands.—F. MOORE.

**Magic Lantern Slides**, 24 Christie's Old Organ, 50 Nile Expedition, 7 Grace Darling, 7 Raikes, 6 Drunken Geese, 10 History of Coal, &c. Plain and coloured. Offers.—F. MOORE.

**Views** in France, Spain, Germany Austria, Italy, Russia, Holland, Belgium, Mediterranean, Egypt, Palestine, America, South and North, and all principal Cities in the Globe. Plain and coloured. Offers.—F. MOORE.

**Magic Lanterns** and 12 Slides, 36 subjects. No. 1, 4s.; usual price, 7s. 6d. No. 2, 5s. 6d. No. 3, 7s. No. 4, 9s. 6d. Offers.—F. MOORE, 1, Naas-road, Wood-green, N.

## THE SIXPENNY SALE COLUMN.

*Advertisements are inserted in this column at the rate of 6d. for the first 16 words, and 6d. for every succeeding 8 words.*

**Motor Castings**, materials for Electric Bells, Batteries, Galvanometers, Intensity Coils, Microphones.—KING, MENDHAM, and Co., Bristol.

**Insulated Wire Table**, showing size, weight, resistance per foot, feet per ohm, &c., price 3d.—KING, MENDHAM, and Co., Bristol.

**Standard Ohm**, in box, copper poles, guaranteed correct to ten thousandth of ohm, 21s.—KING, MENDHAM, and Co., Bristol.

**Wimshurst Influence Machine**.—Sole Manufacturers of Improved Pattern. Numerous testimonials as to thorough efficiency.—KING, MENDHAM, and Co., Bristol.

**Galvanometer Cards**, improved for tangent and ordinary combined, 2½in., 8d.; 4in., 10d.; 6in., 1s.; post free—As above.

Write for **King, Mendham, and Co.'s** large new and reduced Price List, post free 4 stamps.

**Trouser Lengths**, 5s. each. Cheap Cloth for Ladies Dresses, Mantles, Boys' Suits.—HEWITT, 37, Winfield Mount, Leeds. Patterns free.

**Electric Depot**, 10, Deansgate, Manchester.—Electric Breast Pins, 25s. Electric Bells, 4s. Induction Coils, 8s.—MILLAR, Proprietor.

New Illustrated Price List of **Screws, Bolts, and** NUTS for Model Work, drawn to actual size, sent on receipt of stamp.—MORRIS COHEN, 132, Kirkgate, Leeds.

**Do we get Heat from the Sun?** No! How the Body is warmed. Spontaneous Combustion accounted for Eight reasons, showing the fallacy of this popular delusion. By R. HUMPHREYS. Stamps 1½d.—11, Cambria street, King's-road, Fulham, S.W.

**Old Scientific Instruments**, Broken Model Engines, &c. For estimate of cost for repairing, relacquering, &c., send particulars to H. F. LOVEGROVE, Optical Works, Slough, who makes this class of work a speciality.

**Vermilion**, best, 2s. 4d. lb.—PINNELL BROTHERS, 214, Whitechapel-road, London, E.

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Tudsbury and Sons' Improved "High-tension" **Wimshurst Machine**, with their new Compound Ebonite Plates.—Edwinstowe, Newark.

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**Microscope Objectives,** 1in., ¼in., English lenses, cheap.—W. Butler, 44, Elsden-road, Bruce Grove, Tottenham, N.

Two H.-P. **Launch Boiler,** new, cheap.—RESIDE, Brighouse, Yorks.

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5½in. back-geared **Lathe,** 5ft. bed, turned flywheel, roller, treadle motion.—Reside, Brighouse,

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Half-Horse **Engine,** vertical, copper boiler, working order, £5 15s.—E. V., 95, Wirtemburg-street, Clapham.

Vertical **Engine** for sale, no worse than new, 1½ horse-power, price £4 15s.—Apply, J. H. Evans, 30, Trealaw-road, Trealaw, near Pontypridd, Glam.

**Microscopic Glass Slides,** 6s. Cells, 14s. per gross.—H. Howard, 7, Chichester-terrace, Shepherd's Bush, W.

**Thin Covers.**—Squares, 3s.; Circles, 4s. 6d. per ounce. Troughs, Stage Plates, and Microscopic Materials.—As above.

**Gas Engine,** ½ h.p., in first-class working order. Can be seen at work. Price £22.—T. Evans, 61, Denbigh-street, S.W.

Small **Dynamo** for sale, little used. Also a Magneto —A. C. Hervey, Portchester, Fareham, Hants.

## Wanted.

Agents Wanted.—Morgan's celebrated Improved Scale Preventing Compound. Nothing better or cheaper.—W. H. Morgan, Engineer, Gloucester.

Old Microscopes.—Send rough sketch, with dimensions state, and price, to J. Mayall, Junior, 224, Regent-street, London, W.

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Wanted, Steam Launch, about 16ft., or Steam Canoe; must be good, and a bargain, cash.—Fire Brigade, Pontypool.

Wanted, Root's Blower, small size. State price, size, and condition.—H. Allison, Harris-street, Bradford, Yorks.

## Addresses.

All desirous of making a cheap Engine Oil (935°), splendid Lubricator, communicate with J. M., 6, Hamlet-street, Bootle, Liverpool.

Will makers of "Invicta's" Gas Generator communicate with W. J. Barry, Broadisland, Ballycarry, Co. Antrim, Ireland?

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Scientific Instrument Maker seeks Situation as Assistant to scientific gentleman, in laboratory, or in any place of trust; at present engaged in optical trade.—Address, 99, Northcote-road, Wandsworth Common, S.W.

Mechanic seeks Situation; accustomed to eyelet-making machinery.—J. W., 333, Halifax-road, Rochdale.

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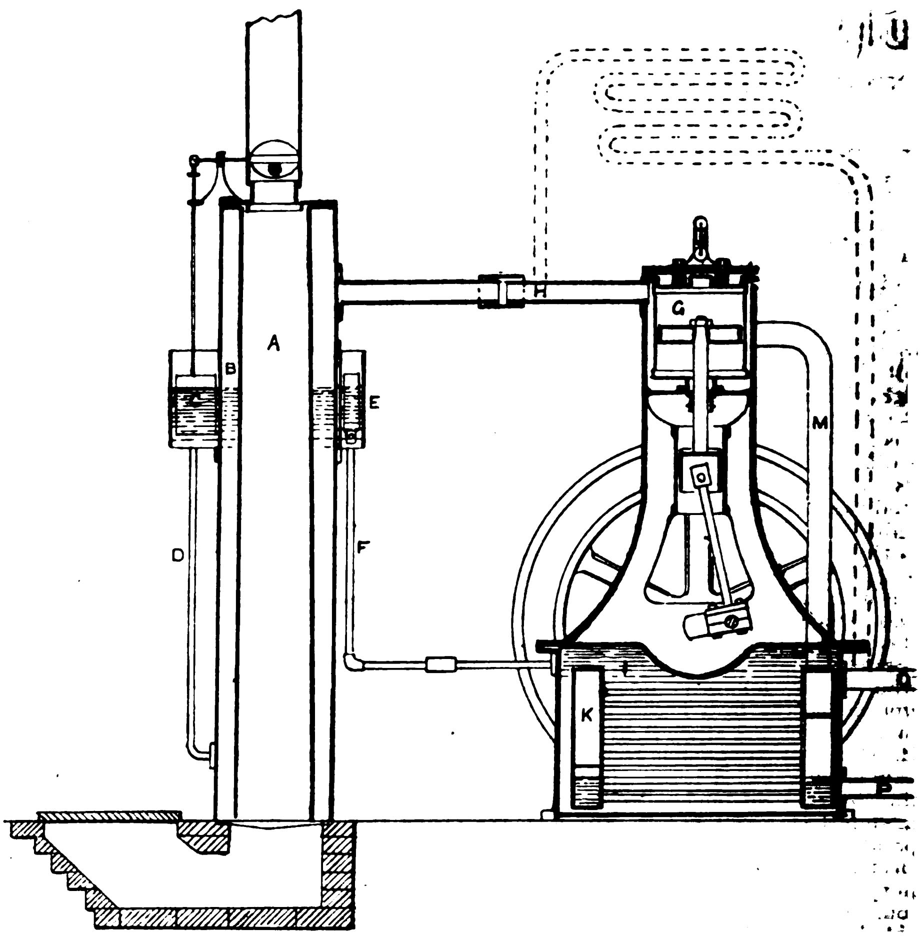
*FRIDAY, AUGUST* 21, 1885.

# PRIVATE INSTALLATIONS OF ELECTRIC LIGHT.

THE simplest arrangements for using the electric light in houses are those in which batteries and incandescent lamps are connected up in separate circuits, each with its own switch; but for reasons which are by this time tolerably well known only those with long purses can afford this method of lighting, and they will not be bothered with the trouble and mess of batteries. The secondary battery, charged by a dynamo, is a different arrangement altogether, and has its advantages; but those who desire to study economy while enjoying the electric light, prefer to take the current as cheaply as they can get it from the dynamo, and pass it direct through the lamps. The late Sir W. Siemens did good service a few years ago by putting up an installation of the electric light at his country seat, though possibly the great majority of those who have followed in his footsteps were influenced in a higher degree by the success which was attained by Mr. Octavius E. Coope at Berechurch Hall. There are now many so-called private installations of the electric light, and not a few amateurs having steam or other power at their disposal have utilised it for the production of electric light in their homes, for special purposes if not for general use. Although some use small arc lamps, which are invaluable in certain circumstances, it is generally conceded that the incandescent lamp is the only one that is really adapted for what may be termed "domestic" illumination. At the meeting of the Institution of Mechanical Engineers, held the other week at Lincoln, Mr. Ralph H. C. Nevile read a paper in which he gave an interesting account of the manner in which he lit up his residence, Wellingore Hall, Grantham. It seems that he had a 6 h.-p. portable engine about ten years old that had been used for pumping and for driving a saw, which he determined to utilise for his purpose, although it had one of the old-fashioned governors with heavy balls, and consequently promised to give trouble. The wiring of the house was put into the hands of a firm of electrical engineers, and a Siemens compound shunt wound dynamo was obtained, and placed with the engine in a shed about 180 yards from the point where the cables enter the house. The total number of lamps in fifty rooms and offices is 125, but the maximum number required at one time, except for purposes of experiment, has never exceeded fifty. All the main wires or leads are of sufficient size to allow of the number of lamps being increased to 200. The dynamo is driven direct from the flywheel of the engine by a 4in. linked leather belt, which from the absence of laces or joins is well adapted to the work. From the dynamo the current is led to a set of switches, whence it can be distributed into five circuits—the first exciting the F.M.'s of the dynamo; the second taking current to the engine-shed and carpenter's shop adjoining; the third goes to a schoolhouse near; the fourth goes by an overhead cable to the hall, a branch being taken off to light the stables; and the fifth supplies current to a number of lamps (100) which are fixed on a board for purposes of experiment. The last-mentioned circuit is also intended for use in charging secondary batteries which Mr. Nevile hopes to try before long. The switches are of the two-way type, so that the current can be sent to the leads direct, or can be passed through an Ayrton and Perry spring ammeter, by which the amount of current in use on any given circuit can be ascertained. The current for the house circuit is taken by an insulated cable of fourteen No. 16 wires from the dynamo to the roof of the shed, where it joins a bare cable of the same size, which is suspended on poles and led to the main cable in the house, which has nineteen No. 14 wires. This large cable has been fitted in order that a greater number of lamps may be employed if deemed desirable at some future time: it passes into the middle of the house, throwing off branches on its way, and then connects to a smaller cable, which is in turn connected to a still smaller one, until the end of the house is reached. Fusible cut-outs are provided at the junctions of all the branches with the mains, and most of the switches used have fusible plugs, and are of the quick-breaking type, which cannot be left in such a position as to form an arc. The lamps themselves are mostly 20 candle-power Edison and Swan, of 100 volts; but in some places two 50 volt 10-candle lamps in series are used instead, as, for instance, in passages, which are thus better illuminated by the greater diffusion of the light. Chandeliers with incandescent lamps are used in parts—for instance, in the chapel; but, as a rule, the lamps are attached to the wire-ends, or carried on the old gas brackets. In his private workshop Mr. Nevile has a few lamps attached to flexible wires, which he finds very convenient when working at the lathe. So far the general arrangements, which are just what would be adopted by any firm of electrical engineers engaged to make the installation; but now we come to the main difficulty of all electric light installations on the comparatively small scale, and, for that matter, of all in which the prime mover is not more than sufficient, and is not controlled by the devices which have been introduced for producing perfectly steady action. As might be expected, Mr. Nevile found that his engine, while quite up to the work required of it, had a governor which was utterly unsuitable, for the inertia of the heavy balls is so considerable that the position remains the same during considerable variations of speed; so much so, in fact, that although an adjustable resistance had been introduced into the circuit exciting the field magnets, it was found impossible to keep the electro-motive force to the point required. Mr. Nevile, early in his experience, seems to have "touched the point," for he not only discovered that perfectly steady motion was requisite, but also that each dynamo ought to be specially wound for the potential desired and for the external resistance between the lamps and the dynamo; in other words, that the machinery employed should be accommodated to the conditions. All sorts of schemes have been devised to simplify installations of electric light; but as those who have been engaged in the work know, it is not an easy matter to make the actions of the drivers altogether harmonious with the conditions required by the driven. Thus, the main leads to Mr. Nevile's house, having a resistance of about ·2 ohm, there is a loss of about 12 volts of E.M.F. when 60 ampères are passing along them between the terminals of the dynamo and the house; whereas when only one or two ampères is the quantity of current, the loss is practically *nil*. If, then, the E.M.F. is constant at the dynamo, it falls at the house as the lights are turned on. This difficulty is supposed to be met by the use of an isochronous governor and a compound wound dynamo; but, as pointed out above, each dynamo, to give the best results, ought to be wound specially for the work it has to do. Consequently reserve machines are not competent to undertake the work of an installation unless the number of lamps are reduced or increased to suit the machines. But the question is, how to illuminate a country house by electricity with the same convenience that gas now affords, and it is obvious that the number of lamps in use cannot always be adapted to the conditions required by the machines, and certainly it is impossible to alter the latter to suit the conditions of the illumination. If secondary batteries are interposed, there is the disadvantage that in the case of compound wound dynamos the current may flow back and reverse the polarity of the machine if the engine is slowed down before the connection is broken. The plain shunt-wound dynamo is free from that objection; but even in that case, when more lamps are added to the circuit the electro-motive force falls just when it should rise. Mr. Nevile having seen the Richardson electric regulator at work, determined to try it on his engine, although the latter was of a type which does not readily lend itself to the introduction of the necessary valve. The Richardson regulator can be seen at the Inventions applied to a semi-fixed compound engine by Robey and Co., Stand 433, and is designed to maintain either a constant current or a constant electro-motive force, irrespective of variations in boiler pressure or work done. It is obvious that in country districts, and many other places, it would cost rather too much to devote as much attention to the engine as is done by the driver of an express locomotive; and it is, therefore, practically impossible to keep the boiler pressure steady, while even if that could be achieved the variations in the work would still necessitate some sort of "regulator." The Richardson regulator consists of a double solenoid magnet, placed vertically, and wound with insulated copper wire; a double core works within the solenoid, and the crosspiece connecting the cores is attached to a lever, the short arm of which presses upon the spindle of a double-beat Cornish valve controlling the admission of steam to the chest. The speed of the engine is by this means regulated by the conditions of the circuit. For incandescent lamps in parallel the wire on the bobbins is placed in shunt circuit between main leads, the size being adjusted to the electro-motive force which it is desired to maintain between the mains, so that the cores are kept suspended within the solenoids. As the resistance of the solenoids is fixed, any increase of electro-motive force causes an increased current to flow through them, and the cores are immediately attracted by an increased force, and thus, acting through the lever, close, or partially close, the valve until the electro-motive force has been reduced to its normal amount. The arrangement is superior to an automatic expansion gear, because, with the latter, when but a few lights are on, the steam is cut off so early in the stroke, that unless the flywheel is exceptionally heavy, a fluctuation in the light can be seen at every revolution, somewhat similar to the unpleasant bobbing in electric lamps worked by a gas-engine. The Richardson regulater was set to work at Mr. Nevile's last January, and the improvement produced by it was remarkable, the lamps remaining fairly steady without sudden alterations of brightness and dulness in their incandescence; but it was found that with any considerable variation of boiler pressure or of load the electro-motive force in the mains varied more than was considered conducive to long life in the lamps. By augmenting or diminishing the weight suspended from the core-bars, it was found the electro-motive force could be brought back to its normal amount, and Mr. Nevile adopted the plan of fixing an upright cylinder in direct communication with the boiler, and making its piston rod press upwards on the core-bars. When the load varied considerably—say, from one lamp to a a hundred—even this plan was not successful, or rather not sufficiently so for Mr. Nevile, who modified the arrangement by causing the piston-rod to act upon a lever, and introduced a second cylinder supplied with steam from the chest, the piston-rod of the latter acting upon the same lever, but on the other side of the fulcrum. The resultant effect of the differential power of the two cylinders can be easily adjusted by the means provided, and the number of lamps can now be varied from one to one hundred, and the boiler-pressure from 30lb. to 60lb. with very slight variation of electro-motive force in the mains. Mr. Nevile's experience with the Richardson electric regulator satisfactorily establishes the utility of that invention, which has, we believe, been severely tested at the works of Robey and Co., Lincoln. In the discussion which followed the reading of the paper Mr. Crompton expressed an opinion that electric force was not practically applicable, for by improper packing throttle-valve spindles might offer from 30 to 40lb. resistance to movement; but, be that as it may, others besides Mr. Richardson have been moving in this direction, and it will be a triumph for both mechanician and electrician to make the electric current regulate itself, whether the actual movements of the steam-valve are produced by steam or hydraulic power, or are produced as well as controlled by the electric current. For the successful installation of electric light for domestic purposes in isolated examples, it will be seen that many points have to be studied; but with such experimenters as Mr. Nevile we are likely to reach much nearer perfection than we are by the help of limited liability companies.

## THE DAVEY "SAFE" DOMESTIC STEAM MOTOR.

THE "low pressure" steam engine recently patented by Mr. Henry Davey, of Leeds, which has attracted much attention in consequence of its complete immunity from risk of explosion, is illustrated and described in the following. The motor is shown in action in the West Annexe at the Inventions, stand 1,195; but as manufactured is more compact than appears in the illustration, which is expanded to show the parts clearly. The invention includes low pressure steam boiler, engine, and condenser, specially suitable for electric lighting in private houses and for working domestic machinery, where it is important to provide against all risk of explosion. The boiler is self-feeding in respect of fuel and water, and is in the form of an upright vessel having a central space for the fuel and an annular space for the water surrounding the fuel space. Communicating with the water space of the boiler there are two float chambers, one having a float for regulating the supply of feed water, and the other a float for regulating a damper in the chimney. The latter float chamber communicates by a pipe with the lower part of the boiler and is open to the atmosphere. While the pressure in the boiler is equal to that of the atmosphere the float is kept up, and the damper which is connected to the float is closed or nearly so. When the pressure in the boiler falls below that of the atmosphere, the water in the float chamber being pressed into the boiler descends, and the float also descending opens the damper. The float in the chamber for regulating the feed water supply in descending opens a valve admitting water to the boiler. The fuel chamber has, at its bottom, fire bars, on which the fire is lighted, the chamber being then filled up with fuel which descends as that below burns away, fresh fuel being added from time to time if desired. By this arrangement, the necessity for frequent stoking is avoided, the fire burning for a considerable time without attention. Connected with the boiler a low pressure engine is arranged to work with steam at or below the atmospheric pressure. It has an inverted steam cylinder by preference made of bronze or gun metal to avoid the necessity for lubrication. This cylinder is inclosed in a steam jacket mounted on a framing, the base of which constitutes a surface condenser consisting of a number of horizontal tubes surrounded by water. The water space is connected by a pipe to the feed water float chamber. There is also a pipe supplying cold water at the bottom, and a pipe leading off hot water from the top. These pipes communicate respectively with the lower and upper parts of a tank, so that when the engine is at work, the water circulates through the condenser and the tank until the water becomes too much heated for circulation. The tubes of the surface condenser connect two end chambers from which an air-pump draws the water of condensation and such air as may accompany it, discharging into the water space of the condenser or into the circulating tank. By this arrangement, the same water may be used over and over again for steam, and, as the cylinder of the engine requires no lubrication, no lubricant can get into the boiler to interfere with its action. The pump might, however, if desired, discharge into a drain. The drawing shows in longitudinal section, partly in elevation, a boiler and engine according to the invention. A is the fuel chamber and B the water chamber of the boiler, C is the float for regulating the damper, and D the pipe connecting the float chamber to the bottom of the boiler; E is the float chamber for the feed water, and F the pipe connecting it with the condenser chamber; G is the steam cylinder, and H the steam pipe connecting the cylinder jacket with the boiler; I is the condenser chamber, and K the condenser; M is the exhaust pipe of the engine leading to the tubes of the condenser K. An air-pump is attached to the side of the condenser; O and P are the circulating pipes communicating with the tank, which it is unnecessary to show.



## THE INTERNATIONAL INVENTIONS EXHIBITION.—XVI.

### Indiarubber, Guttapercha, &c.

INDIARUBBER and guttapercha are properly ranked amongst the most remarkable products of nature, though they owe much of their reputation for utility to the art of man. Rubber or caoutchouc is the inspissated juice of a variety of plants, which, as a rule, grow in countries where the mean temperature is as high as 80° Fahr., and the best qualities are obtained from the species of Hevea, the most important of which is the Hevea Brasiliensis, which flourishes in the dense forests on the banks of the Amazon. The milky juice of these trees is rapidly coagulated by exposure to the air, and when dried over a wood fire is known in commerce as bottle or ball rubber, according to the method adopted in preparing it for market. The best is known as Para rubber, and is obtained from species of Hevea; but the fact is that, although botanists and travellers have found several species of trees which yield caoutchouc, nothing is definitely known as to the range of rubber-bearing trees. Caoutchouc is obtained in Brazil from the *Manihot gladiovii*, from the *Castilloa elastica* in parts of Central America, and in the eastern hemisphere from the *Ficus elastica*, the *Urceola elastica*, and the *Landolphia Kirkii*, which latter probably extends throughout the whole of tropical Africa. Guttapercha is also a milky kind of juice yielded by trees of the natural order Sapotaceæ, and is of more recent introduction to the arts than caoutchouc, which it closely resembles in some respects. Caoutchouc and guttapercha have both been found of great value in the industries and arts, as well in their natural state as when manufactured; but so far as rubber is concerned, it is chiefly when the inventor. has played his part that its great usefulness is seen. The exhibit of the Indiarubber, Guttapercha, and Telegraph Works Co., which forms a prominent object in the East Quadrant of the Inventions Exhibition, shows in an excellent manner what can be done with caoutchouc and guttapercha, for besides samples of the raw materials from Borneo, Africa, and Peru, we have specimens of the numerous useful articles which can be manufactured from these natural products through the discoveries of Goodyear in the United States and Hancock in this country. The remarkable, not to say extraordinary results which follow the mixing of the rubber with sulphur, and the subjection of the compound to heat and pressure, rank amongst the most important discoveries of the century The manufactured material is so hard that it can be used in the shape of pumps and air-vessels for acid and other liquors; and by a simple alteration in the processes can be employed also for making driving belts, in which the maximum of flexibility and durability are required. A belt shown by the company has two plies of some cotton or flax fabric completely buried in caoutchouc, and although it is 320ft. long and 18in. wide, it weighs only five hundredweight. Belts of that kind are used more extensively in America than in this country, where the older fashioned leather belt still holds the first place. Among substitutes for rubber, the vulcanised fibre of Mosses and Mitchell, Chiswell-street, E.C., has come into somewhat extended use. It is made both hard and flexible, as a substitute in the one case for metal, vulcanite, ebonite, ivory, &c., and in the other for rubber, leather, gutta-percha, &c. A. H. Huth, of Ennismore-gardens, S.W., exhibits a number of articles in "imperishable rubber," the method of preparing which is, however, not described. Judging by the smell, camphor enters into the manufacture, and if we may accept the statements of the labels, the process is an improvement, for ¾in. hose, capable of withstanding 300lb. pressure, is priced at 6d. a foot, while valves tested to 22 tons are marked "about 3s. 6d. per lb." In this group (XXI.) we find an exhibit of linoleum, with paper foundation, for damp walls, and specimens of the manufactures of the British Xylonite Company, including xylonite and celluloid in sheets, rods, and tubes, and sundry applications of this very useful discovery, in the shape of facing for piano keys, knife handles, surgical instruments, &c.

### Leather, &c.

The group devoted to leather, &c. (XX.), though the number of exhibits is small, is attractive from the public point of view, for Woollams and Co., of High-street, Marylebone, exhibit their embossed, painted, and lacquered leather wall-hangings, screens, &c.; tergorine, an artificial leather for the same purposes, both of which are inodorous, washable, and non-poisonous—that is, they are free from arsenical colours. Jeffrey and Co., of Essex-road, also exhibit specimens of embossed leather, gilded and hand-painted, for hangings and mural decoration; their leather papers are an attractive feature of this part of the exhibition. Both firms sell the material plain, prepared for painting, so that "artists" can put their own work on their own walls. S. E. Norris and Co., of High-street, Shadwell, have a fine exhibit of leather, mostly in the shape of belts and bands, and have adopted the praiseworthy plan of labelling each exhibit with a ticket which refers to a book of photographs, woodcuts, &c., showing the processes undergone by the respective samples, and the machines employed in the work. Specimens of double leather belts are shown in considerable variety, and sewn on different plans with hemp, hide, flat copper wire, &c.; bucket leathers and rings for hydraulic rams are also shown. But the greatest novelty at this stand is Sapworth's patent wood-link belting, in which the belt is made up of a number of pieces of wood, faced with leather on the pulley side, and connected together by iron pins. It is constructed on the same plan as the leather link belts, but the links are larger. Belts can be made of any length, and up to 6ft. in width; but they are somewhat heavier than double leather belts, though the cost is only about half. A belt of this construction is easily joined up at any link by the insertion of one rivet or pin, but it is not quite clear how "increased frictional hold" is obtained. A compound material which is said to possess the qualities both of leather and indiarubber is exhibited by the Dermatine Syndicate, William-street, Camberwell, S.E. At a guess, it might be said to be a preparation of casein, and it certainly seems well adapted for the outer soles of boots, as shown at the stand. It is said to be perfectly waterproof, unaffected by climatic changes, to be acid, oil, and grease proof, and capable of withstanding high temperatures—some specimens of it more than 300° Fahr. E. Wilson, of Exeter, exhibits a patent striking and scouring machine for hides, which is said to do the work of six or eight skilled men, the drum being capable of being raised, lowered, or revolved during the processes. W. Warwick, of Bolton, Lancashire, exhibits a glossing machine, in which the rubber is of glass; and Carpenter Brothers, of Wellington-street, S.E., exhibit a cutting machine on the principle of the bookbinder's plough. Altogether, the group devoted to leather is scarcely worthy of this exhibition. The group devoted to Clothing is also small and insignificant, and some of the stands might have been with advantage included under the head of leather, &c.—for instance, the ingenious machines for making boots shown by the Northamptonshire and Leicestershire Boot and Shoe Machinery Co., Leicester, and by Salmon and Co., Kettering. In the group named Clothing we find a "permanent accordion pleating machine" entered in the catalogue; while Turner and Sons, of Redditch, show their wire-drawing apparatus for the production of pins and needles. Sewing machines also fall into this group, for Bradbury and Co., of Oldham, exhibit their rotary shuttle machine, an ingenious device, which carries far more cotton than the spools or the old bobbins, and is also fitted with a rotary pedal, which is much approved by those who have to work a sewing machine all day long. Thomas and Co., of Holborn Viaduct, exhibit several improvements and new devices in connection with sewing machines, including their patent machine for sewing corrugated metal round the lining of ventilated helmets, a two-needle machine for glove making, a button-hole machine, and their waxed-thread machine for harness and similarly heavy work which requires the use of a waxed-thread. For some reason or other we will not attempt to explain, a patent oscillating motion devised by Mr. Warwick, of Hilton-street, Manchester, is exhibited in this group. It consists of a disc grooved in its periphery, and set at an angle on the axle or shaft; a roller running in the groove imparts an oscillatory motion to anything to which it may be attached.

### Aeronautics.

The group devoted to aëronautics, which is located in the East Avenue, is a practical failure, for it contains only a few models which have any even the slightest pretensions for navigating the atmosphere, and is so small in itself that the authorities have placed the chimney-climbing device (a mechanical arrangement for raising a cage by clasping the shaft) of Mr. P. L. Gray, Ratho, N.B., in the group. Lieut.-Col. Hime, of Weymouth, shows a working model of his wave-winged propeller, which is similar in principle to that exhibited in the Naval Architecture department, and is intended to show the propelling effect of wave-motion in wings. Mr. Thomas Moy, 8, Quality-court, E.C., shows a photograph of his aërial machine, which was tried in 1879, and did actually raise itself from the ground. The total weight was 216lb.; the three horse-power engine and boiler weighed 80lb., the cylinders being 2⅛in. by 3in.; the area of the revolving planes was 40 sq. ft., and of the two fixed planes 114 sq. ft. Mr. S. H. Hollands, of New Brompton, exhibits a direct high-pressure twin steam fan "avitor," which makes 1,500 revolutions and weighs only 6½oz., its maximum power being 1,100 ft.-lb. It consists in the arrangement of propeller blades on a vertical spindle, and probably represents in principle his aëro-dynamometer, a machine designed to gauge relative wind-pressure, vertically and horizontally, on inclined aëro-planes, the model of which has been removed to Chatham for experiment by Major Templar. C. G. Spencer, of Ringcroft-street, N., exhibits "improvements in the construction of balloons and aëronautical apparatus," which consist in the use of asbestos cloth, which, being fireproof, allows of the use of the old hot-air arrangement continuously applied by means of a "furnace" carried in the car. Altogether, these smaller groups of the exhibition help only to swell the size of the catalogue, as by a better arrangement they could have been easily introduced into other groups.

## THE INTERNATIONAL INVENTIONS EXHIBITION AWARDS.

THE awards of medals and diplomas to the exhibitors at the "Inventions" were published in the *Gazette* last week. Altogether 235 gold medals, 438 silver medals, 515 bronze medals, and 24 diplomas of honour have been awarded. It is needless to say that there is the usual amount of dissatisfaction; but the following selected list will be of interest to our readers:—

#### GOLD MEDALS.

**Beck, R., and J., microscopic and other optical apparatus.**
**Bell, John and Co., treatment of asbestos.**
**Benson, J. W., improvements in machine-made watches.**
Bessemer, Sir H., Bessemer iron and steel.
**British Gas Engine and Engineering Company, Limited, gas engines.**
Cardew, Capt., voltmeter.
**Common, A. A., celestial photographs.**
Coventry Machinist Company, cycles.
Crompton, R. E., and Co., improvement in electric lighting appliances.
Crookes, William, radiometers, &c.
Crossley Brothers, gas engines.
Evans, J. H., ornamental turning lathes, counting apparatus, excellence and accuracy of workmanship and cheapness.
Fletcher, Thomas, gas fires and furnaces.
Holtzapffel and Co., excellence of exhibit, good workmanship and accuracy, as evidenced by work done in lathes, &c., for turning, carving, &c., in wood and ivory.
Jenkin, late Prof. Fleeming, telpherage.
Joy, D., valve gear.
Maddox, Dr., replacing collodion by gelatine in the emulsion process of photography.
Phosphor Bronze Company, phosphor bronze alloys.
Planté, G. (France) secondary battery and scientific research.
Shaw, Professor W. S. Hele, sphere and roller mechanism for transmission of power.
Shaw, Professor, W. S. Hele, improved integrators.
Stanley, W. F., improvements in philosophical instruments.
Surrey Machinist Company, cycles.
Swan, J. W., incandescent lamps.
Swan, J. W., part taken by him in the invention of carbon printing.
Vacuum Brake Company, vacuum automatic continuous brake, with universal coupling.
Varley, S. A., designing the first self-exciting dynamo machine.
Webb, Francis William, exhibit of railway plant.
Westinghouse Brake Company, Limited, automatic air brake and passenger communication for railway trains.
Wilde, Henry, discovery of the indefinite increase of the magnetic and electric forces from quantities indefinitely small.

The following gold medals have been awarded by the Society of Arts on the recommendation of the juries:—

Sir Henry Bessemer, F.R.S., for the invention of Bessemer steel.
Percy Gilchrist, for the Thomas-Gilchrist basic process of steel-making.
Hathorn, Davey, and Co., for their domestic motor.
Samson Fox, for the invention of corrugated iron flues for steam boilers.
Crossley Brothers, for the "Otto" gas engine.
Ralph Tweddell, for his system of applying hydraulic power to the working of machine tools, and for the riveting and other machines which he has invented in connection with that system.
Badische Anilin und Soda Fabrik, for their improvements in the manufacture of colouring matters, and intermediate products from coal tar.
William Crookes, F.R.S., for his improvements in apparatus for the production of high vacua, and for his invention of the radiometer.

#### SILVER MEDALS.

Bailey, W. H., and Co., hydraulic hauling engine.
Bower, George, process for rendering iron rustless.
Bower, George, regenerative gas burner.
Brailsford, T. R., tide gauge.
Brin Frères, improvements in the production of oxygen and nitrogen gases.
Cunyngham, E. H., calculating machine.
Dixon, T., improvements in slide rules.
Ellis and Co., "Facile" bicycle.
Gerard and Co., Limited, lamps and dynamos.
Gillott, Joseph and Sons, specimens exhibiting processes in the manufacture of steel pens.
Glover, W. T., and Co., cables.
Gülcher Electric Light and Power Company, Limited, electric lighting apparatus.
Harrison, Cox-Walker and Co., electrical exhibit.
Jenkin, late Prof., system of gearing.
Jordan, J. B., sunshine recorder.
Kendall, J. A., gas battery.
Marion and Co., photographic apparatus.
Salomons, Sir David, electrical appliances and philosophical instruments.
Selig, Sonnenthal, and Co., turret head lathe.
Steward, J. H., optical apparatus.
Traill, W. A., electric tramway.
Trouvé, G., electrical appliances.
Voss, R., induction machine.
Ward, P., illuminating apparatus for surgical purposes.
Warnerke, L., progress in connection with film negative for photography.
Wenham Patent Gas Lamp Company, Limited, regenerative gas burner.
Wilson, W. J., harmonograph.
Wimshurst, James, induction machine.
Zuccato and Wolff, trypograph or multiple writer.

#### BRONZE MEDALS.

Albo-Carbon Light Company, albo-carbon light apparatus.
Allin, S. S., signal wire compensator.
Baker, C., student's microscopic apparatus.
Dale, H. and E. J., electrical exhibit.
Frost, A. J., transit instruments.
Gant, R. B., electrical exhibit.
Harling, W. H., improvements in mathematical instruments.
Irish, W. H., electrical exhibit.
Lee, R. A., electrical exhibit.
Mosses and Mitchell, vulcanised fibre.
Richardson, Dr. B. W., apparatus for extinction of life.
Rogers, Francis M., electrical exhibit.
Ross, Lieut.-Col. W. A., improvements in blowpipe analysis.
Sands and Hunter, adaptation of various improvements to photographic apparatus.
Spiller, A., gelatino-chloride of silver transparencies, developed with hydroxylamine.
Story, J. H., jaw-chuck for lathes.
Stott, J. and Co., gas governor for service pipes.
Thornthwaite, Horne, and Wood, improved limelight apparatus and photographic apparatus.
Thorpe, H., electrical exhibit.

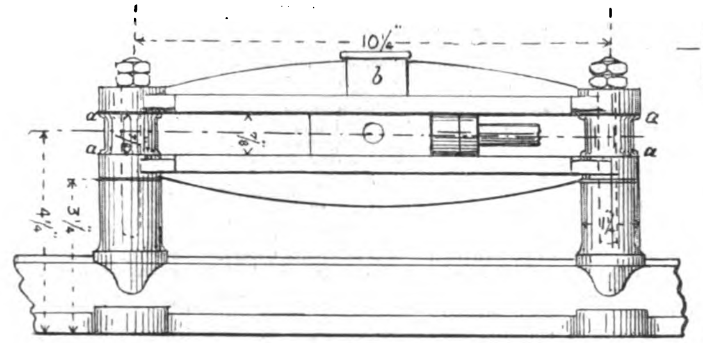
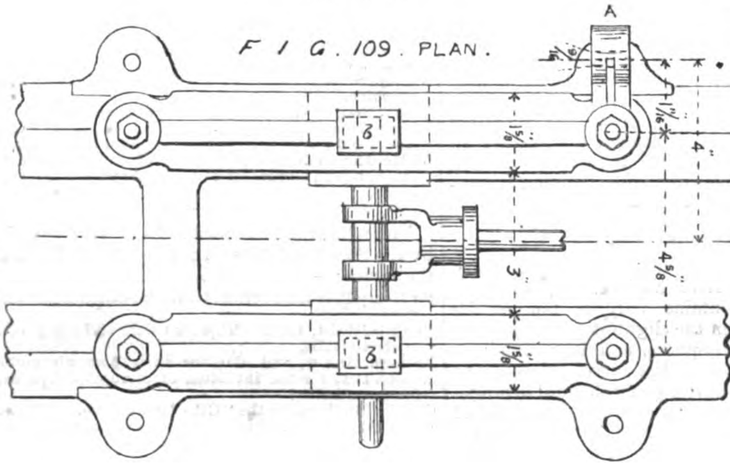


FIG. 109. ELEVATION

FIG. 109. PLAN.



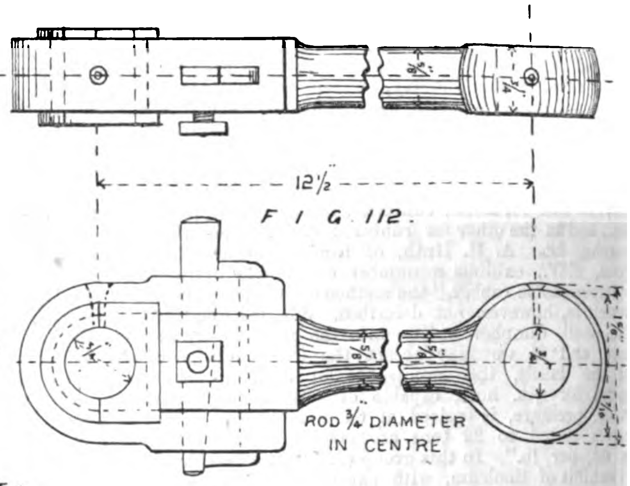


FIG. 112.

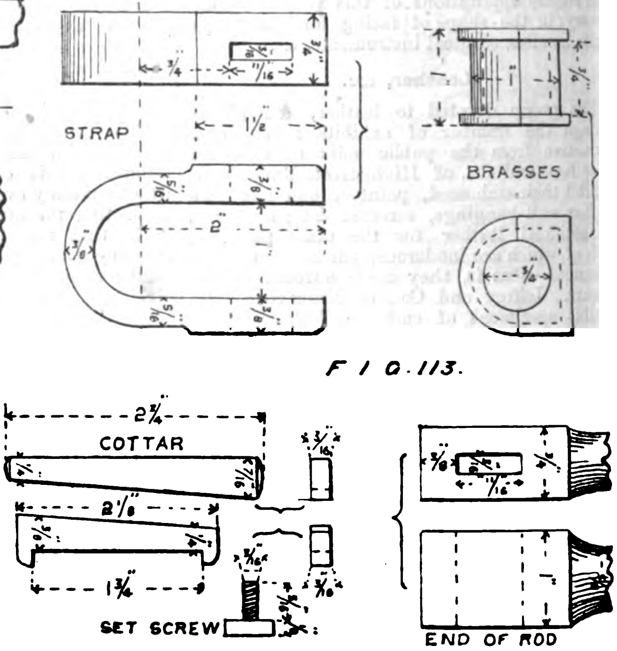


FIG. 113.

FIG. 110.

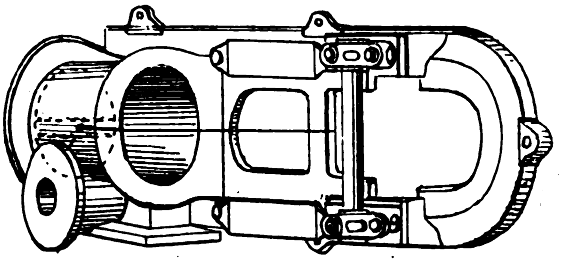
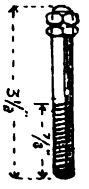


FIG. 111.



# ENGINE-MAKING AT HOME—IX.

## Slide Blocks and Connecting Rod.

TAKE now the four guide bars and file their faces true. The greater the accuracy attained here the better, and it will be comparatively easy to get these true, since we can use them as surface plates for mutual trial. First, file all four as carefully as possible with the aid of a straightedge, then try them each one in succession upon each of the others, until all are alike interchangeable and in contact everywhere. This can only be ensured by scraping; but, as their surfaces are small, it will be a moderately easy task. The faces of the bosses (Fig. 109, *a*, *a*, *a*, *a*) will be filed at the same time level with the bearing surfaces, while the bosses upon the back will be filed parallel with the first, to a thickness of $\frac{9}{16}$in., the uniformity of the thickness being gauged with calipers from faces *a*, *a*. The sides must be filed straight and parallel to $1\frac{5}{8}$in., and equidistant from the sides of the $1\frac{1}{4}$in. bosses at the ends. A $\frac{3}{8}$in. hole will be marked and drilled in the centre of each boss, the centres measuring $10\frac{1}{4}$in. between, lengthways, the holes to take $\frac{3}{8}$in. tight-fitting turned studs. We may note that all bolts and studs in engine work should be tight fitting, since the continual vibration would cause displacement of the parts in cored holes and slack-fitting bolts.

It is now necessary to set the bottom bars parallel, both with the bore of the cylinder and at their exact distance below the central line of the piston rod—viz., $\frac{7}{16}$in.; that is, of course, equal to half the thickness of the slipper. There are two ways of doing this. One is to strain a chalk line through the centre of the cylinder, extending from a cross strip of wood at the back end, thence to the centre of the crank shaft bearing, and to measure from this line downwards to the faces of the slide bars, employing straightedge and level for the purpose, and sideways to their edges (Fig. 110). The other way, and one which is easily adopted with so small an engine, is to use the accurately turned piston and piston rod, fitting closely in the corresponding bored parts, together with the slipper blocks, as a means of testing the linear setting of the guide bars.

We shall already have levelled the tops of the bosses which sustain the slide bars by means of the spirit level, Article VI., page 294, so that presumably they are all in the same plane relatively to one another; and the bosses upon the guide bars, being filed parallel to the calipers, the slippers ought, when the bars are laid in place, to bear equally and evenly all along, as the piston rod, having the piston attached to it in the cylinder, is drawn along through the gland and cover. But if the fit in the latter is good, some slight variation in the slide blocks and their bars will almost certainly be perceptible to sight or touch. This will be corrected in respect of the higher parts by reducing the bed bosses, or those upon the back of the slide bars. If unfortunately either of the bosses have been filed too low, a bit of packing must be introduced—a thin bit of zinc, or tin, or paper. The edges of the slippers will indicate the positions of the inner edges of the guide bars. When the positions of these are finally set, then, from their drilled holes, the positions of the stud holes in the bosses of the bed will be marked and drilled to $\frac{5}{16}$in., and tapped with $\frac{3}{8}$in. taps.

The four distance pieces (Fig. 109) will now be turned on both faces to $\frac{1}{4}$in. thickness, and drilled to $\frac{3}{8}$in. diameter upon the face plate. The one marked A will be rechucked at right angles to the drilled $\frac{3}{8}$in. hole, and to the centre of the slide-valve rod, $1\frac{1}{8}$in. away from the centre of the slide block, and a $\frac{9}{16}$in. hole drilled to take the bush for the valve rod. Then the studs (Fig. 111), $3\frac{1}{2}$in. long, being screwed into the tapped holes in the bosses on the bed, the slide bars and distance blocks will all be screwed down, lock nuts being used, and the slippers tried along. A little easing of the bosses may, notwithstanding all our care, be necessary in order to insure freedom of movement between the slide blocks and the bars throughout their length. A $\frac{1}{4}$in. hole will be drilled in the centre of each oil-cup, and the brass covers, *b*, *b*, filed to fit over them.

Fig. 112 shows the connecting rod with a gib and cottar joint at the crank end, and a plain bored hole at the end next the piston rod, and this involves a careful bit of fitting up, the details of which will not, however, cause any real difficulty after what we have said of the other parts. There are at least half-a-dozen ways in which the ends of the connecting rod might be fitted. If we wanted to be very exact in taking into consideration the future wear of the brasses we should adopt one of those arrangements by which, though the brasses would wear, the distance apart of the centres should remain constant. With our arrangement the rod will become slightly shorter in length each time the cottar is tightened up, because there is no compensatory joint at the piston-rod end. But we can afford to neglect this in the present instance, and to employ a plain bored hole only for the cross-head pin.

Fig. 112 shows the connecting rod fitted up, but the brasses, the strap, the gib and cottar, and the end of the rod are shown separately from each other in Fig. 113, dimensioned to their finished sizes. The brasses we have already as rough castings, and now require the forgings. A bit of 1in. square bar; hammered out at the ends where the section is required of an oblong shape, and roughly rounded along the shank, and about 13¼in. length, will do for the actual rod. But the strap, gib, and cottar will be more suitably forged out of steel as being stiffer, and taking finer surfaces.

The rough forging of the rod is first chalked, and a longitudinal centre line marked upon it, and equi-distant from this centre line the width of the cottared end = 1in. is marked and filed parallel. Upon each face so filed, one other centre line is marked and popped, and equidistantly from these last lines, and at right angles with the faces first obtained, the rod is filed to ¾in. in thickness. The centre of the cross-head journal is marked at the opposite end, and at a distance of 12in. from this centre the rod is marked off and filed square across. Lastly, through this square end a cottar way to the dimensions of Fig. 113 is drilled and filed, and a set screw made and tapped in.

The strap brought to the dimensions in the same figure has its cottar-way also drilled and filed to the dimensions there given. The gib and cottar need no comment. The brasses are filed between the shoulders of their flanges to fit within the strap, and also in their joints, but they are not bored at present. The brasses may be made a close fit in the joint, or else left a trifle open, and a strip of leather introduced so that they can be tightened up at a future time without taking them out for the purpose of refitting. When they are now fitted into place, the strap will be slipped over the end of the rod, the gib put in, then the cottar driven home, and the set screw tightened against it.

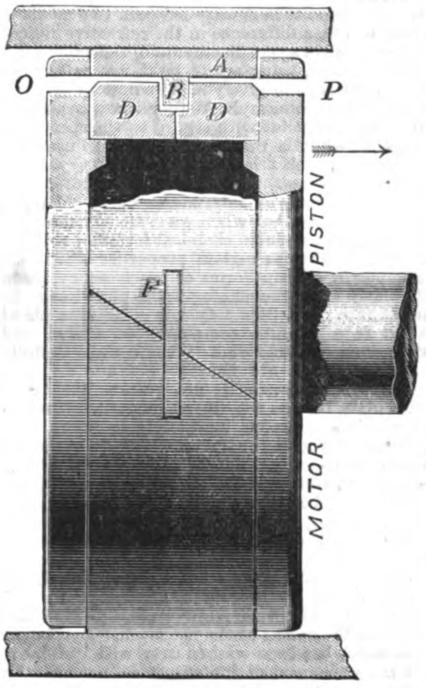
Before boring the brasses and the hole for the cross-head journal, we shall be cautious to check the exact centres, since if the brasses are out of truth, the centre at the opposite end of the rod alone can be readjusted. A circle ¾in. diameter will be struck upon the brasses, and one ¾in. diameter for the cross-head pin, their centres being 12¼in. apart. The brasses are better bored in place, but as this involves the possession of a lathe with a gap, they can be also bored when taken out and clipped in the dogs of the face-plate, care being taken to preserve their joints flush as though in their places before boring and facing. The opposite end of the rod will best be drilled in the lathe by means of a drill fixed in the slide-rest, while the eye of the rod is centred on the face-plate. Properly, this end also should be fitted with brasses and a cottar or a set block; but its wear is much less in amount than that of the crank bearing, and if it becomes slack in time, it is easily rebushed.

It only remains to remove the strap and its attachments, centre the rod in the lathe truly with the filed portions, turn it to the dimensions, and file and polish it with emery. The rounded end will be filed up neatly, oil-holes drilled, one for each bearing, and, if desired, small lubricators screwed into them.

## BRANDON'S PISTON PACKING.*

THE piston packing illustrated herewith is the outcome of the efforts of a practical and experienced mechanic to overcome difficulties that had come under his observation in machinery in his charge. Investigations and experiments on piston packing rings had satisfied him that when a piston moves forward, the inertia of the ring, and also the friction between the ring and cylinder, tend to make the ring bear tight against the rear flange of the piston, leaving a slight opening between the packing ring and the front flange of the piston. From this it will be understood that in pistons having packing rings cut for expansion, made in the usual way, when acting as pumping or compressing pistons, the working fluid will get on the inside of the rings, forcing them radially against the cylinder with a force equal to that of the pressure of the working fluid acting on the whole inside surface of the ring. He also found, by experiment, that a certain amount of the fluid under pressure creeps in between the rings and cylinder, tending to force the rings off their seat, this force being equal to about one-half of that of the fluid under pressure acting on the whole inside surface of the ring. As a result of his investigations and experiments, Mr. Brandon finally constructed the piston packing shown, the theory and operation of which may be understood from the following description:—The engraving represents a piston partly in section, in which A is the main packing ring cut for expansion, and a piece set in to break joint in the usual way, as shown at F. D, D may be regarded as part of the body of the piston, made in two parts, as shown, or in one part, or solid with the piston heads, as may seem advisable. B is a small ring fitted in the groove in the central part of the body of the piston, D, D. The ring B is cut for expansion, and a piece set in to break joint in the usual way. It is made to bear against the outer ring A the same as a packing ring bears against the cylinder. O and P represent two of several holes in the flanges, as shown. Now, assume the piston to be moving forward as from left to right in the engraving, and that it is used for a steam engine. The outer ring A will take the position in which it is shown. The steam pressure, being behind the piston, will pass in through the holes O, between the ring A and body D, forcing ring B against the forward side of groove in D, D. It may be seen that the pressure of the steam forcing the ring radially against the cylinder is limited to that of the inside surface of ring B and that part of ring A lying between ring B and the rear flange of piston, leaving that part of ring A lying between ring B and the front flange of piston relieved from internal pressure.

Assume the piston is used for a pump. Then as the pressure is in front of the piston it will pass through the holes P, or between the front flange and the ring A, forcing the small ring B against the rear side of the groove in D, D. Now it may be seen that when it is used for a forcing piston the pressure on the inside of the ring, forcing the ring to the cylinder, is limited to that of the inside surface of the ring B, and that part of the inside surface of the ring A lying between B and the front flange of the piston, leaving that part of ring A lying between ring B and the rear flange of the piston relieved of internal pressure through the holes O. The ring A is fitted in the usual way between the flanges of the piston, and B in the groove, the spaces on the side being left open so as to more easily understand the working from the engraving. The construction is not, of course, limited to that shown, which is intended to explain the principle involved. The aim is to provide a piston that shall be self-packing against pressure, but in which the pressure shall be so balanced as to permit neither the forcing the rings outwardly so hard as to rapidly wear out the rings and cylinder, nor the forcing them inwardly so as to permit the fluid to pass by them. Mr. Brandon has submitted the results of a large number of experiments he made in determining the proper proportions to secure the desired ends to Professor Robinson, who finds them to be in accordance with theory and with experiments which he has made. Packing made as described has been in use for, we believe, a year or more, with little or no wear of parts, and showing direct saving in power required to operate. The address of the inventor is James Brandon, 233, Tenth Avenue, New York.



IT is stated that in the German army salicylic suet is now used universally for foot-sores, sores from riding, &c., and is found much more satisfactory than the salicylic powder which was formerly used. The salicylic suet consists of 2 parts of pure salicylic acid, with 98 parts of the best mutton suet.—*Lancet.*

## ALKALOIDS AS DISEASE PRODUCERS.*

ALKALOIDS as agents in the causation of symptons of disease have grown into great prominence during the past few years. The interest that attaches to "cadaveric alkaloids" is both pharmacological and forensic. Perhaps no one has done more for the advancement of our knowledge of ptomaines than Professor Brieger, who has recently published "Weitere Untersuchungen über Ptomaine." As far back as 1866 Dupré and Bence Jones noted the presence of alkaloid-like substances in all the organs, tissues, and fluids of human and animal bodies. Owing to the flourescent appearance of the solutions of this alkaloid in weak sulphuric acid, the name of "quinoidin" was given to it. Nevertheless, Dupré and Jones did not succeed in obtaining ponderable quantities of the pure substance. In 1869 Sonnenschein and Zulzer obtained from a maceration of muscle an alkaloid having the property of dilating the pupils of rabbits and dogs. When injected into the jugular vein of rabbits, it increased the number of beats of the heart, and in two animals completely stopped the peristaltic action of the intestines. Rörsch and Fassbender found in 1871 in the liver, spleen, and kidneys, by the Otto-Stass method, a body having alkaloidal properties. It was a tasteless, uncrystallisable substance, and gave, with phospho-molybolic acid, a precipitate, which by warming and the addition of ammonia assumed an intensely blue colour. In the same year Schwanert extracted from the putrefying intestines, liver, and spleen of a child that died suddenly a peculiar-smelling fluid body that dissolved in ether. On the supposition that this was an alkaloid formed during putrefaction, Schwanert analysed the completely putrefied abdominal organs of a male corpse, and obtained a golden oil that smelt of propylamine, had a somewhat bitter taste, and gradually evaporated. The hydrochlorate of this body gave various reactions like those of alkaloids, but its toxicology was not investigated. L. Leibermann extracted from a putrefying stomach a coniine-like substance, which was taken up by ether from either alkaline or acid solutions. This substance had no poisonous properties. Traces of arsenic were found in the same stomach. In a trial for murder by poisoning, held at Brunswick in 1874, the expert in chemistry discovered, besides arsenic, a coniine-like base that Otto regarded as a ptomaine. It did not give the characteristics of nicotin, though resembling it in some respects. It was deadly poisonous, and killed a frog and a pigeon very rapidly. A similar kind of alkaloid was detected by Brouardel and Boutmy in the corpse of a woman who had died with symptoms of cholera, and who had partaken of a stuffed goose with ten other individuals. The base was also detected in the remains of the unwholesome goose. The substance was volatile, smelt strongly of mice's urine, and gave several reactions like those of coniine, though it differed in remaining colourless with muriatic acid, and could not be oxidised into butyric acid. It proved poisonous to frogs. In the cadaver resulting from prussic acid, and also in another due to charcoal fumes, the same authors discovered an alkaloid having a likeness to veratrin. Somewhat similar substances were also found in a body dead from arsenic, in one that had laid in water eighteen months, and in another that had succumbed from asphyxia. Wolkenhaar, again, extracted from the intestines of a woman who died from the excessive use of alcohol an alkaloid-like body having many features in common with nicotin; it was not toxic in its action. Morriggia and Battistina stated that dead bodies yielded much larger quantities of poison eighty days after burial in warm summer weather than when they were investigated in a shorter time after interment. These statements were made as the result of physiological experiments on frogs and rabbits. Extracts of the putrid tissues were made with pure or acidulated water, ether, ethyl-alcohol, or amyl-alcohol, and injected into the animals mentioned. Falling off in the number of heart-beats, loss of motility and sensation, and stoppage of the heart in systole were the phenomena noted.

The name of Selmi stands out most prominently in this field of work. It was he, if we mistake not, who first coined the word "ptomaine," which indicated the cadaveric origin of the alkaloids. It is now known that bodies undistinguishable from those discovered in the cadaver occur under many other circumstances. We may refer our readers to the article by Dr. Wolfenden, published in the *Lancet* of 1883, Vol. II., p. 852. The investigations of Guareschi and Mosso may also be mentioned (the *Lancet*, Vol. I., p. 827, 1883). Brieger lays much stress on the following propositions: That in the different stages of decomposition in the human body different basic products are formed; that many ptomaines disappear, their place being taken by others; and that certain bases, though present in spare quantities at the beginning of decomposition, gradually acquire a greater prominence as other basic substances disappear. A certain analogy exists between the above-mentioned changes and those met with in the putrefaction of albumen. Nencki has shown that for the formation of indol a certain temperature is necessary; whilst the production of phenol, according to Baumann and Brieger, is independent of temperature. Odermatt has proved for indol what Brieger has for phenol—that it disappears completely to make place for other aromatic products. In the course of putrefaction, cholin, which is probably derived from lecithin, is perhaps the first alkaloidal substance to make its appearance. On the third day what Brieger has called "neuridin" ($C_5H_{14}N_2$) can be found. Neuridin forms with picric acid a picrate which crystallises in feather-like masses of needles, which are almost insoluble in cold water and very difficult of solution in hot water. Neuridin is always found in company with cholin, but the latter gradually diminishes in quantity, whilst the former increases day by day. The fact that in slow putrefaction of human organs so strongly poisonous ptomaines can be shown to exist during the first few days deserves attention. About the time of the disappearance of cholin may be reckoned as the period when strong toxic products are developed. It is not known whether trimethylamin results from the decomposition of cholin or neuridin, but both these bodies contain its elements. Brieger refers to the appearance of a ptomaine on the seventh day which has hitherto been unknown. One of his observations showed that this new base was present even on the third day, though in very minute traces. With platinum salts, the new base formed dark red masses which were composed of needles mixed up with spangles and spicules. The purified crystals were of a somewhat brighter colour, and were found by Dr. Hirschwald to be about two millimètres in length, and to belong to the rhombic system of crystals. The crystals proved with polarised light to be doubly refracting. The base also forms a beautiful double salt with gold. This new diamin ($C_5H_{16}N_2$) is termed "cadaverin," and boils at a temperature of 115° to 120° C.; unpleasant its odour is, reminding one of coniine. A third diamin has also been differentiated, having the composition of a butylendiamin ($C_4H_{12}N_2$), but its reactions prove it to be a secondary diamin. The absurd name of "putrescin" is given to this substance, which may be detected on the fourth day of natural putrefaction, but is not present in large quantities until a week later. A fourth diamin, called "saprin," has also been isolated from the products of decomposition of human organs. Neuridin, cadaverin, putrescin, and saprin are physiologically almost harmless; cholin in large quantities produces physiological effects, like those of muscarin; whilst trimethylamin must also be given in large quantities in order to cause toxic effects. Brieger has, however, found two powerfully poisonous ptomaines in the cadaver. These poisons existed in large quantities on the fourteenth and twenty-first days of decomposition. One of these bodies is named "mydalein"; it exercises marked effects on the various functions of the body, increasing the nasal and lachrymal secretions, dilating the pupil, stopping the heart and breathing, and causing paralysis and death. Brieger has also investigated the nature of the products resulting from the action of bacilli in various media. He has separated highly poisonous bases from cultivations of the Koch-Eberth bacillus of typhoid fever. Intense salivation, diarrhœa, and paralysis were some of the toxic effects produced by these poisons.

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* From the *American Machinist.*

From the *Lancet.*

## PHOTOGRAPHY AND THE SPECTROSCOPE.—III.[*]

By Capt. Abney.

IN my last lecture, I left off with the use of the slit in the spectroscope, and I showed you, I think, that under certain circumstances the slit which had the form of a ring was useful, having previously demonstrated that it was not necessary that the slit should be straight, but that it was most convenient that it should be so. I will next deal with the subject of the prism. We know that prisms are employed to separate the different coloured rays, as each colour is differently refracted as it passes through the prism, and it is this difference in the index of refraction between the red ray and the violet ray which gives the amount of dispersion in forming the visible spectrum. Of course, if we go beyond the violet, there are invisible rays, while again below the red there are also dark rays, which also have their indices of refraction, but I wish to show you the influence that the material of the prism itself has on the dispersion of the visible spectrum. I have here a prism of 60° built up of six or seven different triangles of glass. It is apparently homogeneous, but when we pass light through it we shall find that it is anything but homogeneous; in other words, the different portions are differently refractive. The different portions of the prism are all glass, as I have said, but of different densities, and the denser the glass, the more are rays refracted, and the greater dispersion between the red and violet there is. (A slice of light was passed through this built-up prism, and the different spectra thrown on the screen.) You will notice, by the spectra on the screen, that the length of the top spectrum between the red and violet is much smaller than that of the bottom spectrum. The glass which gives the dispersion to the latter is much denser glass than that which gives it to the former. Practically speaking, therefore, we may say the denser the glass the greater refraction, and the greater dispersion there is. For most purposes in spectroscopy, it is as well to use as dense a glass as possible in order to get the maximum amount of dispersion. I will now combine three prisms together, two of a light glass, and one of a denser, and we get a combination, in which, although the main beam will pass straight on to the screen, yet the presence of dispersion is also shown by the formation of a spectrum. This is an example of what is called a direct vision prism. The spectrum is given by the differences of the refractive indices for each ray in the two kinds of glass. For some purposes this kind of compound prism is very useful, and particularly for lecture experiments, but, as a rule, for photographic purposes I should not recommend it, on account of the internal reflections which take place between the different surfaces of the glass, though they are cemented together. You must recollect, wherever there is a difference in density between two media—in other words, a difference in the refractive indices—there is always a certain amount of reflection, and those reflections, being white light, are rather apt to fog the plate, and give you false notions of what you get in the photograph. We come now to a much more important point with regard to the spectrum, and that is, what is the best material to use. In those prisms which I have already shown you the material was glass. Now glass is, comparatively speaking, a mixture of materials, and has no definite chemical formula; but when we come to a material which has some definite chemical formula, we find that, as a rule, it has certain properties which are invaluable in certain forms of spectroscopy, more particularly when the photographic plate has to be brought into requisition. Quartz is an example of this; it is a definite compound of silicon and oxygen, and we find that it has certain definite advantages which are not to be found in glass prisms. The dispersion is not quite so great as it is with glass, but, on the other hand, it lets through rays which are cut off completely by glass, as I hope to show you on the screen. This quartz prism has very well-worked faces, and we will send a beam of light through it, and then proceed to investigate its behaviour. (Spectrum thrown on screen.) I may further say, in reference to this, that the condenser in that lamp is quartz, the lens is quartz, and the prism itself is quartz, so that we are dealing with nothing but quartz? Now, the question comes, Is there any advantage to photographers in using such a material as quartz? Let us first see the extent of the spectrum. By placing a card which has been washed over with quinine in the ultra-violet part of the spectrum, you are able to see these ultra-violet rays glowing with a pale blue light, and you will notice to what a great length these rays reach beyond the ordinary visible point of the spectrum. Now, by placing a piece of glass in front of the slit, you will see that the ultra-violet spectrum is very much shortened; in other words, the glass has absorbed these rays. I may repeat the experiment with a card which has been brushed over with paraffin oil, and the same result holds good. I have here a photograph of the electric arc taken in another manner, to which I shall have to direct your attention presently. The sight in this case has to pass through no glass whatever. The spectrum was taken by a diffraction apparatus; for the top part of the spectrum a glass was interposed in front of the slit, and we see the difference there is in the spectra, owing to the use of glass in one case, and not in the other. The glass apparently cuts off many useful rays; but I will now draw your attention to the solar spectrum taken in the same way, in which there has been a glass placed in front of the slit for one spectrum, and not in the other. Both spectra, practically, reach the same limits. We now can answer as to whether it would be advisable for photographers to use quartz lenses for ordinary photographic purposes or not. Recollect that every ray of light you saw fluoresce on the screen is useful for photographers when they are using a light such as we have in the electric light. You will see, then, from that, if the electric arc light was usually employed, all those rays which are cut off by the glass could not be utilised by them, and, therefore, there would be so much power wasted. Now photographers, as a rule, do not work with the electric light, but with sunlight; we have seen that in the solar spectrum taken under similar conditions the glass practically cuts off none of the ultra-violet rays; the atmosphere of the earth, or of the sun, or both, cuts off the extreme ultra-violet rays before the light reaches us. We therefore come to the conclusion that, so far as photographic work with sunlight is concerned, there would be no advantage in using a quartz lens over the ordinary photographic lens. Some years ago, Mr. Claudet made an agate lens, which he considered would give him greater advantages over the ordinary photographic lens, simply because he could utilise the ultra-violet rays, but I think you will see from this there is no advantage in using such a lens. Remember, however, if you are photographing the spectrum of the electric light, or using it for illuminating a sitter, there is a very great advantage in using quartz. We may use another definite chemical compound in the shape of Iceland spar. I have here a very beautifully worked prism of Iceland spar, which has a definite composition of calcium and carbon, and I dare say that we shall reach very nearly to the same ray limit as we did in the quartz experiment. Iceland spar holds an intermediate position between quartz and glass. It was with such a prism as that that Dr. Huggins took his famous star spectra, and I thought it might interest you to throw one or two of these on the screen. They are very small, but the definition is very beautiful. Many of the black lines in these spectra indicate, probably, hydrogen. It remains to be seen whether Dr. Huggins has attained any advantage in using Iceland spar instead of glass, for if the ultra-violet stellar light is absorbed, as with sunlight, no advantage would be gained. I may mention that he gives the composition of the stars by reference to the spectral lines of well-known elements. One more point is this: Would it be advantageous to use a mirror instead of a lens? There is a great deal to be said about this, particularly in spectroscopy, where we have to examine everything minutely. The material we utilise most easily in the case of a mirror is silver: that is to say, we get a glass mirror, and silver it on the front surface. Now, the question is, does the silver reflect every ray in the same way that quartz would transmit it? Here I have a photograph which should give an answer to that question. The bottom half of the spectrum was taken as reflected from a quartz surface, the top half of the spectrum was reflected from a silver surface, and you will see that at one certain part of the latter the rays are very nearly absent, though beyond that again they are present. Where those rays are wanting is just at the end of the solar spectrum, and therefore, when using sunlight, it is no great advantage to use a quartz reflector over a silver reflector. In spectroscopy it is necessary to know exactly the qualities of all the substances with which you are dealing. One question in photography and in spectroscopy is, what width of slit you would use—what slice of light would you allow to pass through? Here, let me give you a demonstration. In the centre of this black disc there is a fine line of light, and there is a micrometer screw by which we can tell how many thousandths of an inch wide it is. As a rule, about $\frac{1}{600}$in. is the dimension used for ordinary work. I have been referring to the photographs of two spectra on the same plate, and I must show you how it is managed. For this purpose, it is necessary to have an adjunct to the slit, and that is a shutter, which is able to cut off half the slit at one time, and afterwards leave that part open, and close the other half already used. By this means we can get one spectrum adjacent to another. In comparing spectra of different metals with each other, we are able to tell whether we have any two lines coincident one with the other. Photographic spectroscopy is the easiest thing in the world when you know how to do it, but it requires a deal of patience to learn every dodge. As a rule a photographer is a patient man; indeed, there ought to be no class of men who have more patience than photographers; hence spectroscopy should not be difficult to them. Here is another piece of apparatus which is very useful in the spectroscope. It is an apparatus by which you can take a great many spectra on one plate. I need not enter into its details; it is simply a dark slide, which by a rack and pinion motion can be raised, so that the plate gives a fresh surface at each exposure. The only light accessible to the plate comes through an opening of about three-quarters of an inch wide, cut longitudinally in the shade. By this method we can get about sixteen different spectra of different materials on the same plate. Here is another piece of apparatus which is also useful in investigations with photography. It is a slide in which you can expose plates in different gases or liquids—that is to say, in water, in alcohol, in nitrogen, and so on. It is essentially a glass cell which slips into a dark slide especially adapted for it; on the top there is an air-tight junction, which is screwed down, and there are two little tubes, through which you can fill the cell with gas or water, or whatever other material you wish to use. This is very useful in investigating the behaviour of different sensitive salts under different conditions of moisture, pressure, &c. This cell has been used in a great many hundred experiments, and I hope it will be used in a great many more. Those who are going in for spectroscopy should not be without such an apparatus as this, for I do not believe much real investigation can be done without something of the kind. The sensitive salt of silver acts differently when isolated from its atmospheric surroundings, and the only way to ascertain how it does so is to expose it with other surroundings, and to differentiate the results one from another. There is no such thing as a perfect vacuum; you cannot say you expose a plate in vacuo, and, for this reason, I say you have to differentiate between the different media in which you expose a plate, in order to get at the true result which would happen supposing you could expose the plate in vacuo. You saw last time how you could combine a spectrum, by means of a lens, to form white light. Now, I want to show you that it is not impossible to develop a plate in white light. I expose a plate behind a negative to the electric light, and in the cell which is placed in the patch of white light is some developing solution (which is quite colourless). The plate is dipped into it. The image comes out into it, although exposed to white light, without fog, which was supposed to be an impossibility. I have another plate placed behind the same negative. I expose half of that plate for half a minute to the white light on the screen, and the other half to apparent darkness, but in the same position on the screen, for a couple of minutes. The plate on development shows that the half which was exposed to what was presumably white light gives no image, while the half exposed in the dark shows a perfect picture. I daresay many of you have guessed my trick, for it is merely a trick; but for those who have not, I will show you how it is done. It is perfectly easy, by mixing two elements of light of different refrangibility, to produce a colour which, at all events, to our eyes, is a white light. But you must not take it for granted that wherever you can see white light you can photograph with it, because it is quite possible you may not. It is only a trick, but some of these tricks bear fruit in a very practical manner. I will reform white light again, and we will examine it by means of the colour-chart I showed you last time. You will see that when the red is placed in the white light there is blackness—no colour whatever—the yellow looks bright, as does the blue, all the other colours are gone except some few, which are of a nondescript colour. The meaning of it is this: we have simply a combination of yellow and blue, which gives us the appearance of white light. (The blue and yellow rays were shown to be coming through two slits placed at the focussing screen of the camera.) The blue has no power of acting on the iodide or chloride of silver, neither has the yellow, and, therefore, the white light which is made by the combination of those two colours is powerless to act on films made of such materials as those. We can also produce a white light, practically, by a red and green, and if we examine this (which is a very good imitation of white light) in the same way, you will not see the whole series of colours in the colour chart any better than you did before. The red comes out perfectly, but the blue is no longer visible; the blue becomes green, and the violet becomes red; the yellow is also not intense. This is because we have only two colours present, viz., the red and the green. The apparent darkness to which we exposed the one-half of the plate was in reality the dark ultra-violet light, and I need say no more regarding that. I told you last time that this was a very interesting way of studying the spectrum. You see how, by combining two lights together, you may have a light which is perfectly safe for certain salts of silver. On the screen is the spectrum taken on the three ordinary salts of silver—chloride, iodide, and bromide. The iodide stops exactly at the violet. Below that light we have no action whatever, and we, therefore, may expose an iodide plate with impunity to any rays below the the violet. A bromide plate, you see, is sensitive down as far as the yellow, and, therefore, it would be impossible to develop a bromide plate in such a light as I showed you just now, whereas iodide is perfectly capable of being developed in such white light; the chloride again stopped very nearly with the limits of violet, so that it would be safe to develop a chloride plate in such a light.

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[*] The substance of the Cantor Lectures delivered before the Society of Arts.

## LAYING OUT SHEET IRON AND BOILER WORK.*

ORDINARILY, a boiler-maker can get along with a knowledge of the first four rules of arithmetic, but I would suggest that with these you acquire a thorough knowledge of square root, as this may be of some advantage to you at some time in your practice. I have had occasion to know this to be true from my own experience. Ability to calculate in decimals is also of great importance, as will readily be seen on looking at the multiplication of fractions; as, for instance, let it be required to multiply 37¼ by 38¾. By the decimal method, these become 37·25, multiplied by 38·75, and the operation becomes one of simple multiplication. The calculation of the circumference from the diameter of a circle is one of the first, simplest, and most essential points in laying out work. In my own practice, I have followed the rule: "As 7 is to 22, so is the diameter to the circumference." In other words, three and one-seventh times the diameter are equal to the circumference. Example:

Diameter, 42in.
3⅐
126
6
132 circumference.

In the books usually sold as assistants to boiler-makers and others, the decimal 3·1416 is given, but the results are so near the 3⅐ theory, and the latter is so much simpler, that I have invariably used it. Taking the other as an example, we have

3·1416
Multiplied by diameter, 42
62832
125664
Equal to 131·9472 .

We here have a difference of

$\frac{428}{10000}$ $\frac{52\frac{1}{2}}{1000}$ $\frac{5\frac{1}{4}}{100}$

or a little over $\frac{1}{20}$th of an inch, and if you look on your rule for the last-named distance, your eyes will be keener than mine if you find it. The rules given, no matter which you use, apply to the circumference of a circle without regard to thickness of plate. If you want to make a large and small course, such as boilers are usually made of, there would necessarily be quite a difference in the length between the inner and outer courses, and to get this you would add three thicknesses of plate to obtain the distance from centre to centre of holes for the length of large course, making it, if of ¼in. plate, 132¾in., and subtract three thicknesses to obtain the distance from centre to centre of holes in the small course, which would leave the latter 131¼in.—a difference of 1½in. this case. In $\frac{5}{16}$in. iron I have allowed a difference of 2in. between the large and small courses, adding 1in. for large and subtracting the same quantity for small. In ⅜in. plate I allow six and a-half thicknesses, and $\frac{7}{16}$in. and over I allow seven thicknesses of plate between the large and small courses. In ¼in. iron, and under, six thicknesses are the standard used by me, and I have found good results from their use. These figures do not make any allowance for laps, which must be added to the length already given, as I have stated the distance only between the centres of holes. In single-riveted work, three times the diameter of rivet equals the distance from centre to centre; twice the thickness of plate is supposed to equal the diameter of rivet; and one and one-half times the diameter of rivet is the lap, or distance from caulking edge to centre of hole. In the rule last given, I say twice the thickness of plate is supposed to equal diameter of rivet. In these days of heavy plate the diameter of rivet, if carried out in this proportion, would, in many cases, prove injurious; as, for instance, a ¾in. shell would require a rivet 1½in. in diameter, and three diameters of that equals 4½in. between centres of rivets. I can fancy the smiles on some faces as they think of caulking that distance, and making tight work to carry a pressure of 150 pounds to the square inch. Tight work can and has been made by this method, but the practice of engineers and boiler-makers at present is to use smaller rivets and reduce the distance between centres, at the same time taking into consideration that the greater the number of holes the more the plate is weakened. While on the subject of calculation, I would also say that in figuring up the circumference by the 3⅐ rule, where there is a fraction left, as, for instance, ⅐ of 44, which equals 6²⁄₇, my practice is to call the fraction ²⁄₈ or ¼, which can be found on any rule, while the ⅐th of an inch is never met with on the 24in. rules used by boiler-makers.

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* Abridged from an article by G. Marshall in the *American Machinist.*

## EVOLUTION IN THE VEGETABLE KINGDOM.*

THE law of biologic evolution (for it is no longer a mere "doctrine") may be regarded as fairly established, no large and respectable body of scientific men being any longer found to oppose it when stated in its most general form, while difference of opinion and discussion have narrowed down to the more special aspects and minor details. In the animal kingdom, where organisation is generally so high and structure so definite, great progress has been made in discovering the particular lines along which development has taken place, and something like a true genealogy of the existing types has been worked out. The law of phytogeny is abundantly established by palæontology and surprisingly confirmed by embryological ontogeny.

In the vegetable kingdom this last important class of evidence is almost wholly wanting, and palæontological evidence, owing to the lower structural rank of plants, is far less complete and convincing than in the animal.

It is proposed in this article briefly to inquire what vegetable palæontology has to present in favour of evolution in plants. The subject may be considered under three somewhat distinct points of view, the historical, the geological, and the botanical.

### I. Historical View.

It is a common observation that botany is far behind zoology in supporting advanced biological theories. This is still more strikingly true of the study of extinct than of that of living forms, for not only were the ancients wholly unacquainted with any form of vegetable petrifaction, although familiar with fossil shells, madrepores, and other animal remains, but when at last the era of science dawned toward the close of the eighteenth century Blumenbach had for many years been sounding the key-note of palæontological truth in the animal kingdom before Schlotheim took up the refrain in favour of plants.

When we consider the present state of knowledge respecting the geological strata of the earth's crust, we can scarcely realise that but two generations ago comparatively nothing was known on this subject. Geology was not yet born. The investigators of the last century were really not discussing the geologic age of fossil remains. With those who studied fossil plants the assumption was universal that they were plants that grew somewhere in the world only a few thousand years ago at most, plants such as either grew then in the countries where their remains were found, or in other countries from which they had been brought by one agency or another, generally that of the Flood, or else, as some finally conceived, had been destroyed by these agencies, so as to have no exact living representatives.

In the year 1804 appeared Baron von Schlotheim's "Flora der Vorwelt," as it is now universally quoted, although the author himself merely entitled it a "description of remarkable plant impressions and petrifactions—a contribution to the flora of the former (or primeval) world." To us this seems modest enough, but, in view of the history of palæontology, the second part of this title amounted to a bold declaration, and accordingly we find him defending it in his introduction by these words: "The petrifactions which so early engaged the attention of investigators, and which, without doubt, afforded one of the first incentives to the founding of mineral collections and to the earnest study of mineralogy and geology, have, as is well known, since Walch began to arrange them systematically, been for a long time, as well in as out of Germany, almost wholly neglected. They were content to regard them as incontestable proofs of the Deluge, which closed all further investigation until they were at last compelled to explain their occurrence through other great natural operations which had probably been going on earlier and more universally than the flood described in the Bible, and influencing the formation of the upper strata of the earth's crust; and more recent observations and investigations have even led us to the very probable supposition that they may be the remains of an earlier so-called pre-Adamitic creation, the originals of which are now no longer to be found. * * * In the continued investigation of this subject this opinion, with certain restrictions, has, in fact, gained a high degree of probability with the author of the present work, so that he ventures to announce his treatise as a contribution to the flora of the ancient world (Vorwelt)." Since its introduction by Schlotheim this expression, "Flora der Vorwelt," has been applied to nearly all the German works on fossil plants, and "Beitrage zur Flora der Vorwelt" still continue to appear.

This work was followed, though sixteen years later, by his "Petrefactenkunde," and also by Count Sternberg's important "attempt at a geognostico-botanical presentation of the flora of the ancient world." These men were the pioneers of vegetable palæontology. It was reserved for Adolphe Brongniart to become its true founder. Brongniart's paper on the classification and distribution of fossil plants, which was published in the memoirs of the Paris Museum of Natural History in 1822, showed that he had already been some time at work, and after six years of nearly complete silence he at length came forward, in 1828, with his epoch-making works on the history of fossil plants—the "Prodrome" and the "Histoire des Végétaux Fossils"—which, taken together, as was the design, form the solid basis upon which the science has been erected.

Brongniart's fundamental conception was that fossil plants were none the less plants, and that so fast as they really became known they should be placed in their proper position in the vegetable series and made to form an integral part of the science of botany. In his classification he therefore had due respect for the natural system as then understood, but he nevertheless felt that geognostic considerations must be taken into the account, and he saw with almost prophetic vision that in passing up through the geologic series higher and higher forms of vegetable life presented themselves Although unable to understand the complete continuity in the series, as modern evolution postulates, and although affected by the Cuvierian idea of successive destructions and re-creations, still he insisted that each successive creation was superior to the one it had replaced, and that there had thus been, as it were, a steady progress from the lowest to the highest forms of vegetation. He divided the geologic series into four great periods, the first extending through the Carboniferous and corresponding to the modern Palæozoic, the second embracing the Grès bigarré, or Buntersandstein, only, the third seeming to include the rest of the Trias, the Jurassic, and the Cretaceous, and the fourth completing the series. The table which he gives on p. 219 of the "Prodrome" is designed to show the development of the higher types of vegetation in successively higher strata, and in discussing it he remarks that "in the first period there exist hardly anything but cryptogams, plants having a more simple structure than that of the following classes. In the second period the number of the two following classes become proportionately greater. During the third period it is the gymnosperms which specially predominate. This class of plants may be considered *intermediate between the cryptogams and the true phanerogams* (dicotyledons) which preponderate during the fourth period." The words italicised in the liberal translation here made are scarcely less than a prophecy, and one whose fulfilment is only now being tardily granted by systematic botanists.

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* By Lester F. Ward, A.M., in the *American Naturalist.*

As the result of his prolonged studies, Brongniart finally arrived at the following remarkable classification of plants, as drawn up on page 11 of the "Prodome" and repeated on page 20 of the "Histoire:"—I. Agams. II. Cellular cryptogams. III. Vascular cryptogams. IV. Gymnospermous phanerogams. V. Monocotyledonous angiospermous phanerogams. VI. Dicotyledonous angiospermous phanerogams.

In the present state of botanical science Brongniart's "agams" would probably all be relegated to his second group, or cellular cryptogams, but in other respects this classification is pre-eminently sound, and seems likely to be vindicated by the future progress of science.

It will thus be seen that Brongniart founded the science of vegetable palæontology firmly upon the law of progressive development, and there can be little doubt that if his influence could have been felt by botanists as it was by vegetable palæontologists in general, botany might have advanced *pari passu* with zoology. But Brongniart was far in advance of his time, and his views were destined to meet with violent opposition. His method was, with few exceptions, adopted by subsequent palæobotanists, but never by botanists proper.

(*To be continued.*)

**Science and Art Examinations, 1885.**—The following are the successful candidates for Royal Exhibitions, National Scholarships, and Free Studentships in 1885:—William Burton, 22, science teacher, Manchester, National Scholarship; Philip L. Gray, 19, assistant master, Southampton, National Scholarship; Charles Lang, 22, engineer, Johnstone, N.B., National Scholarship; Thomas Clarkson, 20, engineer, Pendleton, Manchester, National Scholarship; Harry E. Hadley, 18, student, Worcester, Royal Exhibition; William Scudamore, 16, student, Northampton, National Scholarship; Frederic W. Lanchester, 16, architect's assistant, Southampton, National Scholarship; Thomas H. Holland, 16, student, Helston, National Scholarship; Harold E. Hay, 14, student, Manchester, National Scholarship; William Blackmore, 18, student, Sheffield, National Scholarship; Hugh O. Bennie, 20, engineer, Glasgow, Royal Exhibition; William Kelsall, 17, student, Bradford, National Scholarship; Henry Sowerbutts, 17, student, Manchester, National Scholarship; Frederick Chattaway, 24, chemist, Birmingham, National Scholarship; James Young, 23, shoemaker, Belfast, Royal Exhibition; Arthur J. Moulton, 20, engineer's apprentice, Preston, Royal Exhibition; Harold C. Coote, 17, student, London, Royal Exhibition; Robert H. Unsworth, 20, engineer, Pendleton, Manchester, Royal Exhibition; Sidney H. Woolhouse, 15, student, Weaste, Manchester, Royal Exhibition; David Wilkinson, 21, agent, Preston, Free Studentship; Henry P. Motteram, 19, student, Small Heath, Birmingham, Free Studentship; Albert E. Briscoe, 17, machinist, Birmingham, Free Studentship; Orlando J. Preston, 16, student, Bristol, Free Studentship; James McKenzie, 20, engineer, Glasgow, Free Studentship; Philip C. Coultas, 18, student, Bristol, Free Studentship.

# SCIENTIFIC NEWS.

THE death is announced of Thomas Box, the author of, amongst others, those well-known works, "A Practical Treatise on Heat," and "A Practical Treatise on Mill-Gearing, Wheels, Shafts, Riggers," &c. Mr. Box was, we believe, in his sixty-fifth year.

Many will regret to hear of the death of the well-known antiquary, William John Thoms, F.S.A., at the age of 82. Mr. Thoms was well known in literary circles, and more widely by his work on the "Longevity of Man." Within recent years he has seen reason to modify his opinion that cases of centenarianism are very rare, and many friends will regret that he did not live to refute his opinions in his own person.

In No. 2,676 of the *Astronomische Nachrichten* Dr. Lamb has a note of an investigation of the annular parallax of a small star in Draco, to which attention was attracted by its large proper motion. It is a double star, numbered 2,398 in Struve's Catalogue, and its components have magnitudes, respectively, of 8·2 and 8·7. According to Dr. Lamb, the annual parallax of the principal star amounts to ·34″.

On any Tuesday, Thursday, or Saturday, until the end of September, those who have archæological tastes may visit the rooms of the Royal Archæological Society, Oxford-mansions, Regent-circus, and see the large and interesting collection of antiquities which Mr. W. M. Flinders Petrie has discovered and brought from Egypt—from the Nebireh mound, which is the site of the famous Greek city, Naucratis. An iron foundry appears to have been discovered, and a number of tools of various kinds, besides that novelty in archæological "finds"—fishhooks. The iron foundry would appear to have been at work in the sixth century before Christ.

A royal charter has been granted to the Entomological Society of London, which was founded in 1833.

It is stated that Prof. Huxley, P.R.S., will continue to act as Dean of the Normal School of Science and Royal School of Mines, South Kensington, by special request.

The *Athenæum* says:—"A good deal of surprise has been excited in the scientific world by the action of the Science and Art Department in relation to the chair of biology vacant at the School of Science at South Kensington, by Prof. Huxley's resignation. This professorship was recently put on a firm footing by a Treasury minute, and, being worth £800 a year, might be considered one of the few prizes open to biologists. The Treasury minute, too, in fixing the salary, spoke of the desirability of encouraging original research; but such encouragement as this chair gave has disappeared, for the appointment has been summarily suppressed. The salary of Mr. Howes, Prof. Huxley's assistant, has been raised from £200 to £600 a year; but this is scarcely considered compensation for the abolition of the professorship."

The report of Drs. Klein and Gibbes on the alleged discovery that cholera is due to Koch's comma bacillus will be withheld until the conclusions of the committee appointed by the Secretary of State for India are also ready.

The autumn meeting of the Iron and Steel Institute will be held at Glasgow from the 1st to the 5th of September. The programme contains a series of ten papers bearing upon almost every subject of current interest to iron metallurgists, the more notable being on the "Rise and Progress of the Scotch Steel Trade," by Mr. Riley, and on the "Present Position and Prospects of Processes for the Recovery of Tar and Ammonia from Blast Furnaces," by Mr. William Jones, both of Glasgow. A committee composed of over 200 gentlemen engaged more or less intimately in the manufacturing industries of the west of Scotland has been formed in Glasgow for the reception and entertainment of the Institute, and excursions have been arranged to all the leading works and places of interest in the neighbourhood during the five days of the meeting. The 4th of September is to be entirely devoted to an excursion to Inverary Castle, the Duke of Argyll's seat, while on the following day an excursion will be made to the works of the Forth Bridge, which will terminate the week's proceedings.

M. Hippolyte Fontaine says he is quite convinced that in the present state of knowledge regarding the construction of electrical machines, it is practically impossible to transmit 100 h.p. with a single generator dynamo through a resistance of 100 ohms even for one hour. The Creil experiments of M. Marcel Deprez cannot, therefore, in his opinion, be carried out under the conditions laid down. They are as impossible to realise as would be a steam-engine working at a pressure of 500 atmospheres.

The Rhode Island Electric Power Company, operating under the Daft system, are running a 10 h.p. generator at Providence, and furnishing power for the forges and atmospheric hammer in the engine works of the Harris-Corliss Company, the Rhode Island Printing Company, and the Hope Glass-Cutting Works, and in each case giving absolute satisfaction. They are making preparations to put in a 50 h.p. generator.

Prof. William A. Anthony, of Cornell University, Ithaca, New York, has constructed the largest galvanometer in the world. There are four circles, each two mètres in diameter. Dr. Guyter and several electrical engineers are engaged in testing, by the aid of the galvanometer, the strength of the current of a powerful dynamo run at 1,200 revolutions in a minute.

At the meeting of the French Association held at Grenoble M. Chauveau said that there was much reason to regard with interest the researches of Dr. Ferran on cholera inoculation—an opinion which derives such importance as it possesses from the fact that M. Chauveau is recognised as an authority on pathogenic microbes. M. de Mortillet discussed the question of tertiary man, and stated that the problem was not to discover the prototype of existing man, but only an ancestral form—a predecessor of the man of historical times. To the question, Do there exist in the tertiary strata objects which imply the existence of an intelligent being? M. de Mortillet replies in the affirmative. He declares that there is sufficient evidence to show that animals less intelligent than man, but more intelligent than existing apes, lived during the tertiary period. The anthropethique, or ape-man, was an ancestral form of historic man, whose skeleton has not yet been discovered. The almost unanimous opinion of the meeting was that there can no longer be any doubt of the existence of ancestrel man in the tertiary period.

Baron Leon de Lenval, of Nice, has offered a prize of 3,000 francs (£120) for the best easily-carried instrument for the improvement of hearing in cases of partial deafness. The instrument is to be constructed on the principle of the microphone, and must be completely finished and sent in before the end of 1887. The award will be made at the International Congress for Otology, held in September, 1888, at Brussels.

Prof. Lustig, of Hanover, in the course of investigations having for their object the discovery of the pathogenic microbe of contagious pneumonia of bovine animals, has isolated, in pure cultures, four varieties. One is a bacillus that liquefies gelatine and forms at the confines of the liquefied area pulverulent masses of a whitish-grey colour. The liquefied gelatine varies in tint dependent upon the proportion in which the other varieties of microbes are present. The second microbe is a micrococcus which does not liquefy gelatine, and forms at the surface a deposit something like the white of an egg in appearance; the gelatine is gradually absorbed as this cultivation proceeds. The third is also a micrococcus, very like the preceding, only that it forms golden-coloured clusters. The fourth is micrococcal in form, and appears as coloured heaps of a yellowish-orange tint, having a waxy look on the surface of the gelatine. It does not liquefy the medium, and grows better on potatoes. Inoculations made on a heifer gave mostly negative results.

**Artificial Honey.**—One of the latest American novelties is artificial honey—that is, honey adulterated with a syrup manufactured from maize, the method being as yet a secret. Experiments on the subject show, however, that if wheat or maize starch (not potato starch) be treated with oxalic acid, or any other powerful organic acid, a syrup is produced which in a certain concentration, and after standing two or three weeks, exactly resembles in taste and appearance an old honey.

# LETTERS TO THE EDITOR.

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[*We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.*]

*All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

*All Cheques and Post-office Orders to be made payable to* J. Passmore Edwards.

⁂ *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

◆

## DOUBLE STARS.

[24627.]—Clouds having prevailed for some time after Mr. Sadler's letter (24474, p. 488) was published, I have been unable to look again at the double in Corona Borealis, and, when it cleared, the star was hidden before dark among the top branches of a tree whose trunk is only 13ft. from my telescope in a W.S.W. direction. I am inclined, however, to believe it is no other than Σ. 1959, though I cannot account for the difference in magnitude. My declination circle was right, but my reading was wrong.

I have looked at the stars Mr. Sadler kindly gave in the same letter, but in such conditions of air that to obtain a disc I have had to reduce my aperture down to 6in., and even then the stars were far from being steady and clear; it is, therefore, with the greatest diffidence I give the following results, which are the mean of three nights: B.A.C. 6959 (A.C. 17) Pos. = 260° 44 Cygni (A.C. 18) 300° 60 Cygni (OΣ. 426) 150° P xxi. 215 Cygni (β. 167) 80° 75 Cygni (A.C. 20) 208°. I feel that to deal successfully with such stars very good air is absolutely necessary, especially when a reflecting telescope is used, as even then there is always, in a more or less marked degree, a certain measure of scattered light around the minute central disc which must hide or extinguish such small stars as Struve's 11th mag. I hope Mr. Sadler will say as soon as possible how far I am wrong, as I intend to observe these stars again.

I may say I have given Mr. Burnham (letter 24591) the trouble of looking for the double in Corona Borealis. He will see by a subsequent letter of mine that the first position given was wrong. What is the mag. of β. 54 in Σ. scale? I find it easy, especially with high powers.

August 14. **C. M. Gaudibert.**

## PLACES OF STARS—36 OPHIUCHI—SIZE OF BEER AND MÄDLER'S TELESCOPE.

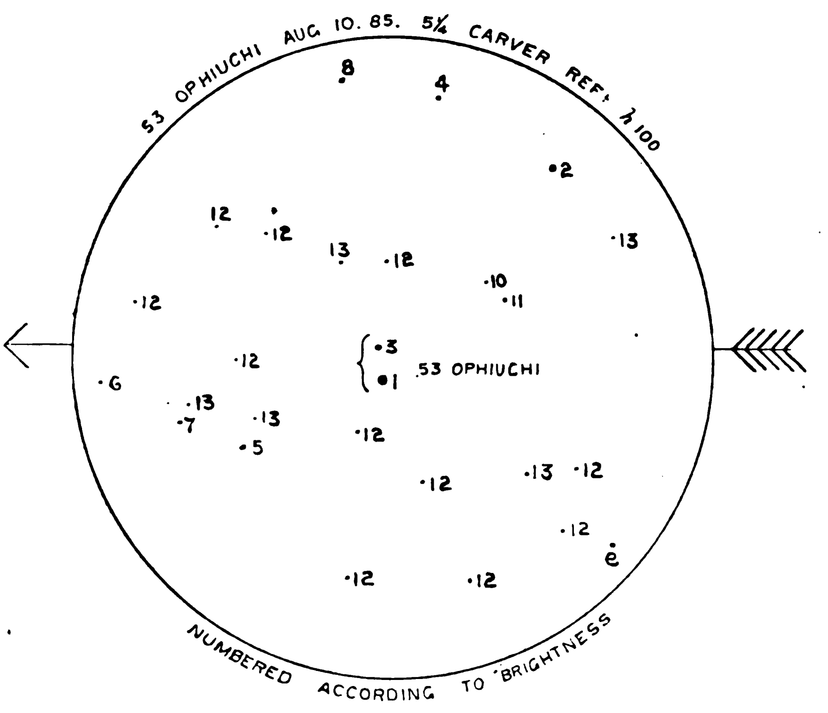
[24628.]—The following are the places for January 1st, 1885, of the objects referred to by Mr. Ruthven (query 57186, page 507):—

| | H. | M. | S. | ° | ′ | ″ | |
|---|---|---|---|---|---|---|---|
| T. Coronæ | 15 | 54 | 41·6 | + 26 | 14 | 48 | (Greenwich 9-year Cat.) |
| B.A.C. 6624 | 19 | 15 | 7·3 | + 40 | 8 | 55 | (B.A.C.) |
| B.A.C. 7001 | 20 | 14 | 46·3 | + 38 | 38 | 40 | „ |
| B.A.C. 7219 | 20 | 43 | 23·6 | + 45 | 6 | 27 | „ |
| Σ Neb. 6 | 18 | 6 | 31·3 | + 6 | 49 | 42 | (Schultz) |
| H. 5122 | 19 | 16 | 44·7 | − 18 | 13 | 8 | (Œltzen-Arg. S.) |
| β 142 | 19 | 21 | 47·0 | − 12 | 22 | 16 | (Schjellerup) |
| H. 1470 | 19 | 59 | 30·2 | + 37 | 59 | 58 | (Lalande) |
| Birm. 658 | 23 | 55 | 23·9 | + 59 | 42 | 55 | (Œltzen-Arg. N.) |

I think myself it is a pity that the R.A.'s, in the fourth edition of "Cel. Objects" are not given to the nearest second of time, as they were in the third; or, at least, to the nearest tenth of a minute. The supposed variability of the components of 36 Ophiuchi, alluded to by Mr. Numsen (letter 24492, page 518), rests only on the estimates of Smyth, which are utterly at variance with those of other observers (Herschel at the Cape, Dawes, &c.) at the same epochs. I regret to be obliged to contradict Mr. W. C. Rogers (letter 24596, page 519) as to the aperture of the telescope mounted by W. Beer in his villa near Berlin, and which was employed in making the drawings of Mars given in No. 191 of the '*Astronomische Nachrichten.* It was a refractor of 3¾in. aperture, not 3in., and of 54in. focus, mounted equatorially, and driven by clockwork. **H. Sadler.**

## 53 OPHIUCHI.

[24629.]—As there has been some correspondence of late in "Ours" as to the stars visible in the field with 53 Ophiuchi, I send a rough sketch of the field with a power of 100 on my 5¼ Calver. I may add that these are numbered according to their brightness; but there are a great number of smaller stars which can only be glimpsed in the field. I may also say that I have no means of determining the exact distances or positions. The sketch was made by eye alone, and, of course, at the telescope. My mirror is not in first-rate order, or I could possibly have steadily held others which were only glimpsed.


53 OPHIUCHI AUG 10. 85. 5¼ CARVER REF. λ100
8
4
2
12
12
13
12
13
10
11
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3
1
53 OPHIUCHI
6
12
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12
12
e
12
12
NUMBERED ACCORDING TO BRIGHTNESS

Norwich, Aug. 12. **Easy.**

## 36 OPHIUCHI.

[24630.]—With reference to Mr. Numsen's remarks about 36 Ophiuchi (letter (24592), I quote the following from my little book ("Southern Stellar Objects"): "Both yellow, and almost exactly equal. The *f* star, if anything, rather the brighter of the two. In the field *n.p.* is a 7½m. or 8m. star, to which I see a faint *comes* to the south, 3m., 1875. Smyth says: 'The principal star is thought to be variable, though I have always seen it as now registered' (4½m., 6½m.), and he calls the companion to 7½m. 'a most minute *comes*,' whose existence Sir John Herschel first pointed out to him. In a large field, with 36 Ophiuchi, is the star 30 Scorpii. Between the two, Smyth (Cel. Cycle) notes a 14m. star. Close to the place indicated by Smyth (in a diagram) I see steadily with 3in. a small star; other faint stars in the field."

The above observations were made in Northern India. I think it very probable that one of the components of 36 is really variable. It will be seen that Mr. Numsen's observation differs from mine with regard to their relative brightness.

**J. E. Gore.**

## THE DAYLIGHT OCCULTATION OF ALDEBARAN.

[24631.]—I am very unwilling to enter into a controversy on scientific details; but Mr. Peek's letter of August 7th requires a reply, and with that I trust the correspondence on the subject may cease.

Mr. Peek says he is aware that "the times of immersion and emersion will vary perceptibly at places in different geographical positions," and he adds, that it is this very difference in time from Greenwich, obtained by observation, which is so valuable to the traveller in enabling him to compute his longitude."

But Mr. Peek ought to be aware that the amount of this "difference in time from Greenwich" thus obtained from observation depends on two things, and not on one only. It depends, first, on the difference of longitude, we admit; but it depends, secondly, on the difference of latitude as well. The difference of longitude and latitude between two places causes the moon to occupy a different position in reference to the star as seen from each place; and this difference (due to the moon's parallax) causes also a difference in the times of immersion and emersion. Nothing but a separate calculation for each place can determine its amount, and to do this expeditiously is the object of the "partially-graphic method of eclipses and occultations" which I have submitted to your readers.

If Mr. Peek is still unconvinced, I have done with him; but with reference to the last paragraph in his letter, allow me to say that though I do not lay claim to any very unusual acquaintance with the science of astronomy, this, at least, is one branch of it, in which I do claim to be thoroughly versed; nor does this statement depend simply on my own *ipse dixit*, but my position in the mathematical tripos at Cambridge in 1848 in the opinion of most people would justify the assertion.

**James Pearson, M.A., F.R.A.S.**

Fleetwood Vicarage, Aug. 14.

## THE CASSEGRAIN.

[24632.]—In thanking "Orderic Vital" for his reply, I should like to carry the problem somewhat farther if he would deal with it in the manner suggested, the ultimate object being to obtain the equivalent Newtonian focus of any given Gregorian or Cassegrain. Let me put the matter in the shape of four propositions, so as to render my meaning clear.

1. If the solar foci of the two mirrors are known, the focus of the small mirror for the vergent rays from the great mirror can be directly determined.

2. If the two mirrors are so matched as to be free from aberration for parallel rays, they can only produce a perfect (stellar) image at the final focus when placed a certain definite distance apart.

3. The distance apart of the mirrors being thus a fixed quantity, the position of the final focus will also be fixed.

4. The position of the final focus being fixed, the equivalent Newtonian focal length can be absolutely determined from the focal lengths and positions of the mirrors and their foci.

As regards proposition No. 2, the formulæ of "Orderic Vital" and Dr. Royston-Pigott are rendered more complicated by the assumed variability of the distance C E in Fig. 2, page 380, whereas, if I am not mistaken, *no variation is possible* when we are dealing with parallel rays and curves so matched as to be free from aberration. It would follow from this that Dr. R.-P.'s table giving the variation in position of final focus due to variations in the separation of the mirrors is only true for parallel rays when aberration is neglected; but for near objects is approximately correct. I say approximately, because it would seem that if the mirrors are figured so as to be true for the parallel rays of celestial objects, they cannot be true for the diverging rays from terrestrial ones; and though by varying their distance apart we may bring the rays more accurately into focus, we cannot, of course, alter the curves of the mirrors themselves to correct the aberration produced by this change in their relative positions. Coming to proposition No. 4, I showed in a former volume of the "E. M." that we could obtain the (approximate) equivalent Newtonian focal length by the formula there given —viz.: $N = \frac{F}{f}(F \pm f + \Delta)$, the positive sign being used for the Gregorian and the negative for the Cassegrain. In this F and $f$ are the foci of the mirrors, and Δ the distance of the final focus behind the vertex of the large mirror.

In these formulæ (deduced from a diagram) the points C and E of Fig. 2 on p. 380 were taken as coincident—that is to say, the difference between the solar focus and the focus for the vergent rays actually received by the small mirror was neglected. I presume, however, that by substituting the actual for the solar focus (as regards the *f* in the formulæ), the result would be exact instead of approximate.

The several steps for determining N would, therefore, be as follows:—From F and *f*, the solar foci, determine the focus of *f* for vergent rays; call it $f^1$ for distinction. Then $F + f^1$ will be the distance apart of the mirrors. Having the distance of the mirrors apart, fix the position of the final focus by "Orderic Vital's" rule on p. 519. This point being fixed, we also know its distance △ behind the great mirror, and have, therefore, all the elements for determining N.

In many respects this method of dealing with the problem seems simpler than the treatment of either "Orderic Vital" or Dr. Royston-Pigott, and for a non-mathematician like myself would be easier to use in any given case.

As to the two parabolic mirrors with foci coincident, they would merely serve as light collectors, and not as image-formers; but we may go a step further. Suppose while the vertex of the small mirrors remains in the same position relatively to the large one that its curve gradually changes from a parabola to an ellipse, then the infinite distance at which the parabolic curve would (theoretically) form an image becomes continually reduced till the point is reached where the second focus of the ellipse is situated, which is conjugate to the focus that coincides with the focus of the large mirror, and at this point an image is formed free from aberration.

But (and this is the point I am driving at) if such is the case, it is essential that one focus of the ellipse should coincide with the focus of the large mirror, a condition which Dr. Royston-Pigott expressly stated was non-essential.

Of course the distance from vertex of small mirror to the common focus of the two will not be the same as if the small mirror were subjected to parallel rays, and in that respect it differs from the parabolic small mirror first referred to. In this instance I use the Gregorian as an illustration; but, *mutatis mutandis*, the same reasoning would apply to a Cassegrain.

**A. S. L.**

## THIGH-BONE OF A SAURIAN—"SAURIAN" WATER LIZARD, OR CROCODILE.

[24633.]—In the Natural History Museum, South Kensington, there is a thigh-bone of crocodile (recent) not much larger than a goose leg bone, or as near 7in. long as may be seen. This bone belonged to a crocodile measuring 18ft. from nose to tail, and seems out of all proportion for walking purposes, especially for turning round sharp corners with so long a body, yet better adapted to propel through or under water. Now, in the same glass case is a fossil thigh-bone of a giant saurian 7ft. long, perhaps more, and thick in proportion. This belonged to a fearful creation 216ft. in length. Where is the thoroughfare in London wide enough to allow this immense crocodile to turn down a side street? I suppose his mouth or jaw would be 30ft. long, and his girth 60ft. round; and all this came out of an egg. Haeckel did not believe in a miraculous creation (special); but was not this saurian a distinct creation, now fortunately extinct as a dead leaf separated from the tree? What tree? The visible Universe. Haeckel took the envelope off Nature, and laid bare the secret of the continuation of Life (what I should term the origin of life) in a more certain manner than any other physiologist, for he went to the centre, the inside of the egg, to discover the reason why.

In his diagram, he places the centre in a mass of protoplasm, not in the middle, but in a hemisphere or upper part; and in this centre in the process of evolution he finds a kernel, and in this kernel a seed, all of which presently resolve themselves into centres having kernels and seeds to develop, until the whole mass is filled to repletion, after which changes take place in the primary formation of bodies, which ultimately become changed into different forms of vegetable and animal life. This appears to me most miraculous, for while the mass is sustaining itself by drawing in the outer surrounding substance, the centre is evolving from itself, and is thus the origin of life in the individual.

I do not attempt to account for the great saurian's thigh-bone, and neither do I think it necessary to knowledge to study these alone, because the truth is more likely to be found in minutiæ. "Perfection is made up of imperfections." The largest skeleton I have any recollection of was that of a whale (rorqual), about forty years back, when I took 300 youngsters in and out of its vertebrate form. The last I heard of it was its sale to a Russian, who took it home with him. By way of contrast, a skeleton of a mouse was perched by the side of one of the ribs.

There are still some large fish (cetacei) left, and little minnows as well, who manage to live as in antediluvial times, when some of the cave men carved their likeness on horns, teeth, &c. Were they white or black men, or when did they begin to change colour?

**Fiddler.**

## SULPHATE OF SODA IN DANIELL'S BATTERY.

[24634.]—In the letter which you did me the favour of inserting last week on this subject, I see that I spoke of the transmission of molecules of $SO_3$ from the sulphate of copper to the zinc. Your chemical readers would at once perceive that I ought to have said $SO_4$, this being the "radical" alike of sulphuric acid, $H_2SO_4$, and of the three salts with which we are at present concerned, formed by substituting copper, zinc, and sodium respectively for the hydrogen of the acid.

Perhaps my comparison of the strength of the current when the dilute acid and the sulphate of soda were respectively used was not quite conclusive, as I used a galvanometer of high resistance.

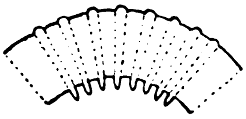
**Abner E. Brown.**

Wadenhoe, Oundle.

## A CURIOUS STOVE.

[24635.]—Stove pipes of this description (letter 24604), are very common, not only in Switzerland, but also in Germany and France. The form of the convolutions varies according to the fancy of the workman and the space at disposal, the object being to economise fuel by securing as much heating surface as possible inside the room. The bends are made in a very ingenious way; but though resembling at first sight the "lobster-back," as stated, they are found on closer inspection to differ widely from it, each quadrant consisting of a single piece of sheet iron, whereas the "lobster-back" is made up of separate segments seamed or soldered together.

The annexed rough sketch shows one of these bends in section, by which it will be seen that a length of pipe is drawn into this shape by means of a series of corrugations, which are wide and shallow on the outside, but deep and narrow on the inner side of the bend. I have not been able to obtain bends of this make in England, the nearest thing to be had being the so-called "circular stove-pipe elbow," which is made in two pieces, and is in all respects inferior to those in question. There should, however, be no difficulty in obtaining them from abroad, seeing that they are an article in common use, and, therefore, kept in stock by such houses as ordinarily deal in metal ware. I happened to be in Switzerland last week, and whilst looking over the premises of the well-known iron merchants, Rauch and Cie, at Fribourg, saw large quantities of these bends stacked in one of their warehouses. From memory I should say that the smallest was about 10c.m., or nearly 4in., though smaller sizes than this are frequently seen in use in connection with rain-water pipes, &c.



At the Paris Exhibition of 1878 numerous specimens of pipe bends made in this way, out of iron, zinc, and copper, from 1½in. diameter and upwards, were shown by various makers in classes 27 and 43.

**R. T. Lewis.**

## AN ADJUSTABLE OBJECT-GLASS FOR TELESCOPES.—II.

[24636.]—In the telescope spoken of in the last letter on the subject, the aperture is 3½in., and the focal length about 44. On trial, however, I find that on ordinary nights the best aperture is 3in. I had supposed that as the spherical aberration might be so very accurately corrected by adjustment of the distance between the lenses, we might use a larger aperture. But, as "Prismatique" suggested at the time, although we may by this method make the aberration to be absolutely zero for any proposed line of the spectrum, we cannot do so for all of them simultaneously (see note), so that in the correction for spherical aberration there will always be something analogous to the secondary spectrum in colour correction. And to this may be added that the lateral spherical aberration varies for a given value of *f* as the cube of the aperture, so that the necessarily uncorrected aberration increases rapidly as the aperture does. Hence, we must look upon this part of the experiment as unsuccessful, in that it is not worth while to depart from the usual relation for the sake of any advantage that may be obtained on exceptional evenings.

Moreover, there seems to be some other and less obvious cause, for, on looking with full aperture on bright objects—Jupiter, Arcturus, &c.—there is a small amount of glare or diffused light surrounding the object; and this in the case of the moon tends to slightly impair the definition, in that the diffused light which would arise from a given part of it, if detached from the rest, spreads itself over the surface of the whole, to the detriment of definition.

But on contracting the aperture to 3in., the glare above mentioned entirely disappears, and the view of the moon, for crispness and clearness of detail, was quite exquisite. The appearance of Jupiter, too, was very good. Saturn I have not seen; but "Prismatique" tells me that when he was trying it the shadow of the rings on the planet was well seen, as also Ball's division of the rings, all round.

On Aug. 14 the evening was a little hazy, just such a one as is favourable to definition, and with full aperture the star discs were remarkably neat and well-defined, and the optical appendages generally remarkably small. I hope on another occasion to say something of the performance on close doubles.

Note.—This may throw some light upon what Mr. Franks observes: that very large telescopes will not bear such deep eyepieces as moderate-sized ones will. For the circle of least spherical aberration varying as $\frac{y^3}{f^2}$, and in similar telescopes *y* varying as *f*, the circle varies as *y*, or, therefore, as *f*. In the same way the circle of chromatic aberration varies as aperture, and, therefore, in similar telescopes it varies as their focal length. This being the case, then, with both aberrations, there will be an indistinctness prepared in proportion to the magnifying power. In fact, it is impossible to magnify without producing indistinctness, and so the magnified object is never so distinct as the object itself. As for the reason why very small telescopes will not bear a high power, it appears to be an accident attaching to each particular instrument. If I remember rightly, "F.R.A.S." told us that opticians did not generally take near so much care in the making of terrestrial as they do for celestial instruments. Hence they have more imperfections, and will not bear so much magnifying.

**W. G. Penny.**

(*To be continued.*)

## MICROSCOPIC.

[24637.]—It is very easy to make glass globules for microscopic use of ordinary glass; Mr. Hooke's "Venice glass" is not at all essential. The difficulty is in using them as microscopes; for, made in the manner described by "F.R.A.S." (of which I was previously aware), they are of such small focal length that the magnifying power is very great. I have mounted some, varying from 1-80in. to 1-100in. focal length, giving powers of 800 to 1,000 diameters. But, besides the instrumental difficulty of focal adjustment for such small lenses (which I have surmounted), the light of so small a pencil of rays is quite inadequate, except with what I may call "violent" illumination. I could see with scarcely any definition an object with the 1-100in., except when it was turned against the sky in the neighbourhood of the sun, or in the opportunity of a setting sun, against the sun itself. Then, however, with its magnifying power of 1,000 diameters I found the definition did not fail.

But lenses by melting glass may be made to much better purpose of more useful focal lengths—not globular—but double convex lenses, in the following manner, which, I believe, is new, or was so when I first made them, say 30 or 40 years ago. Take a bit of fine binding wire, iron (not brass or copper), make, by twisting it round a taper wire for mandrel, a nicely circular loop; flatten it so that the loop is all in one true plane. The loop may vary in diameter from any desired smallness up to ½in. (which is nearly the largest size my glass-melting apparatus will conveniently manage). Place a square piece of glass—thicker or thinner, according as it is desired to have a lens of more or less convexity, but large enough to completely cover the loop. Then, holding it in a suitable blowpipe plane (which should be a vertical, not a horizontal one), the glass assumes in melting a doubly-convex lenticular form. A form, moreover, in which the spherical aberration of a globule tends to be corrected, and a larger proportion of the field is flatter than it is with an ordinary double convex lens. What the exact curve may be, I am not mathematician enough to say. "Catenary" suggests itself. But the factors, gravity, the viscosity of the glass in its approach, still considerably distant from fluidity, with a tendency to "wet" and adhere aggressively to the iron wire, are obscure, and were said by a competent mathematician, of whom I formerly inquired, to be very complicated and beyond his calculation.

Such lenses are made in a few minutes, and perform most admirably when a suitable instrumental apparatus is used. Of such, I have made perhaps fifty or more different forms; and among them the very one which "F.R.A.S." suggests as an application to my V-microscope of a glass lens. I did not, by the way, at all pretend to have discovered the microscopic qualification of a water globule;

but to have contrived a very simple and ready mode of practically applying them.

If "F.R.A.S." will do me the favour to inform me of his address, it would give me pleasure to send him some specimens of these melted glass lenses. And if he, or any other of your correspondents, could define the curvature which, under the circumstances, the glass will assume, I should be grateful for the information.

**J. Hippesley.**

Stoneaston Park, Aug. 15.

## THE MIDLAND 19in. CYLINDER EXPRESS ENGINES.

[24638.]—I am sorry still to see unfavourable accounts of the new Midland express engines with 19in. cylinders. When I left England at the end of last March, I hoped and believed that the little preliminary troubles which appeared to have attended the introduction of these fine engines had been surmounted. I forwarded to you on Feb. 14th, and you were good enough to publish, the result of an experimental trip privately undertaken by myself, to test the accuracy of the allegations so persistently made that the 19in. engine could not keep time between St. Pancras and Leicester with trains of 12 coaches, but had to take a pilot with a train of that length, although the pilot herself could have drawn the train with ease in time. You will remember that the train (Scotch express) was taken by No. 1,675, the engine specially singled out and denounced as incapable, and that the load of 12 coaches was taken to Leicester, in spite of rain, a greasy rail, a fresh side wind, and an extra slowing at Market Harborough, in 3min. 5sec. under time—i.e., in 2h. 3min. 55sec. I gave the detail of the run.

Now that did not look like failure. Nor do the two following runs with the fast Nottingham expresses between Kentish Town and Kettering, both ways:—

| Miles from St. Pancras. | No. 1,668. 9 Coaches. | |
|---|---|---|
| 1¾ | Kentish Town (dep.) ........ | 12.29½ |
| 3½ | Finchley (pass.) ........ | 12.33 |
| 7 | Hendon „ ........ | 12.37½ |
| 12½ | Elstree „ ........ | 12.43¾ |
| 15¼ | Radlett „ ........ | 12.46$\frac{7}{12}$ |
| 20 | St. Albans „ ........ | 12.51½ |
| 24¾ | Harpenden „ ........ | 12.56¾ |
| 27¼ | Chiltern „ ........ | 12.59½ |
| 30¼ | Luton „ ........ | 1. 2⅓ |
| 32¼ | Leagrave „ ........ | 1. 5¼ |
| 37¼ | Harlington „ ........ | 1. 9½ |
| 40¼ | Flitwick „ ........ | 1.11¾ |
| 41¾ | Ampthill „ ........ | 1.13½ |
| 49 | Mile-Post „ ........ | 1.19$\frac{5}{12}$ |
| 49¾ | Bedford (slack) ........ | 1.21 |
| 53 | Oakley (pass.) ........ | 1.25½ |
| 56¾ | Sharnbrook St. „ ........ | 1.29¾ |
| 59¾ | Sharnbrook Summit ........ | 1.33¾ |
| 62¾ | Irchester (pass.) ........ | 1.36¼ |
| 65¼ | Wellingborough „ ........ | 1.38¼ |
| 68¼ | Finedon „ ........ | 1.42 |
| 69½ | Isham „ ........ | 1.43 |
| 72¼ | Kettering (arr.) ........ | 1.46½ |

| No. 1,667. 10 Coaches. | |
|---|---|
| Kettering (dep.) .......... | 4.37½ |
| Isham (pass.) .......... | 4.42 |
| Finedon „ .......... | 4.43¼ |
| Wellingborough „ .......... | 4.46⅔ |
| Irchester „ .......... | 4.49⅔ |
| Sharnbrook Summit „ .......... | 4.53⅚ |
| Oakley „ .......... | 5. 0⅙ |
| Bedford (slack) .......... | 5. 3½ |
| Ampthill (pass.) .......... | 5.15 |
| Harlington „ .......... | 5 20 |
| Leagrave „ .......... | 5.25½ |
| Luton „ .......... | 5 28 |
| Chiltern „ .......... | 5.31 |
| Harpenden „ .......... | 5.33⅓ |
| St. Albans „ .......... | 5.38½ |
| Radlett „ .......... | 5.42¾ |
| Elstree „ .......... | 5.46 |
| Hendon „ .......... | 5.51¼ |
| Finchley „ .......... | 5.54¼ |
| Kentish Town (arr.) .......... | 5.57 |

The station times are given above to the nearest fraction of a second. All the times of passing mile-posts, &c., were carefully taken by me with an improved chronograph. It will be seen that the run from Kentish Town to Kettering, 70½ miles, occupied just 77 minutes, being slightly faster than that made by the celebrated Leeds expresses on the Great Northern in 1880. The average speed was 55 miles an hour, including starting and stopping. Some of the intermediate distances and times are very remarkable. The length of 58 miles from the 13th to the 71st mile post was covered in exactly one hour. This included the ascents of the long branches of 1 in 176 (passing St. Albans), and 1 in 120 to Sharnbrook Summit. The 17 miles from Leagrave to Bradford—slackening to 10 miles an hour through the latter station and yard—was done in 15¾ minutes, and the 16 miles from the 33rd to the 49th mile post in 13min. 50sec. Also, in descending banks of 1 in 120 and 1 in 200, a mile was several times run in slightly under 48 seconds, equivalent to speeds of a little over 75 miles an hour, the two fastest miles being done in 47·2 seconds each, or at the rate of about 76 miles an hour; this with a train weighing above 100 tons, exclusive of engine and tender. I do not think I can be wrong in characterising this as a remarkable and admirable performance. The "up" journey was a little slower, the average speed being 53, but with an extra coach and less favourable weather. I should mention that the down train was stopped by signal near Camden-road, therefore was 3½ minutes late in leaving Kentish Town; it reached Kettering half a minute early.

It may be said that the trains were comparatively light; but, even so, the speed over such a heavy road is quite exceptional. The allegation has been put forth that the 19in. engines were designed to run the Scotch expresses and to take twenty coaches up the Desborough bank without a pilot. That may be so, and some colour is given to the statement by the fact of Nos. 1,675 and 1,676 having been fitted with the Westinghouse brake for this purpose. Still, I cannot understand why, in that case, they should have been given boilers so much smaller than the other express engines; for it can hardly be contended that an engine is rendered stronger by decreasing her boiler power. If, however, on the other hand, these engines were designed specially for the lighter and faster Nottingham expresses—on which they have hitherto been almost exclusively employed—then it might be that the smaller boiler with larger cylinders is intended to secure more expansive working on those swift, light trains; to get, in fact, the advantages offered by the compound principle, as suggested some time ago by Mr. Stretton. Thus regarded, the engines would not be failures even if they could not run the slow, but far heavier, Scotch expresses. Nevertheless, I have shown already that they can keep time with twelve coaches, and even make up several minutes.

As I do not profess to champion these engines against others, but merely to record their actual work—having been specially enabled to observe it—I think it only right to add that while the down run with No. 1,668 is the best I registered, I have had several equal to that of No. 1,667, and some even quicker. For example, with No. 1,337, one of the 18in. cylinder 7ft. coupled (1,327 class), I have done the Kettering to Kentish Town journey in 78 minutes, and with No. 1,570, one of the 6ft. 9in. coupled (1,562 class), in 78½ minutes, as against 79 minutes with No. 1,667. But in those cases the trains were much lighter, being six coaches in the one case and seven in the other, while No. 1,667 had ten on; also, with the down train, No. 816, one of the 800 rebuilt class, took ten coaches from Kentish Town to Kettering in 79 minutes. I may add that No. 829 took a Scotch express of sixteen coaches from Leicester to Kentish Town (where it was stopped by signal) in 1h. 59min., notwithstanding that it was slackened by signal to 10 or 15 miles an hour at Market Harborough and Wellingborough, beside the usual slowing to 10 miles an hour through Bedford. These are all very fine specimens of express locomotive work.

**C. Rous-Marten, F.R.G.S.**

Wellington, New Zealand.

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[24639.]—These engines, it seems to me, are undeservedly praised. Twice within the last three months, at the same place—i.e., Aldersgate-street Station, and at the same time, about 5 or 5.30 p.m., have these engines, which have been landed to the skies almost, broken down and blocked the traffic for the rest of the evening. Not having my memo. book by me at present I cannot give the exact dates, but most probably some readers of the "E. M." who travel into the City by the Great Northern and Midland railways must have been inconvenienced as well as myself.

I was rather surprised no account of either of these was given in our pages. The first I believe to have been caused by a broken crank axle (as usual). I should be glad, also, if some correspondent could inform me why the North London and Metropolitan trains are the only ones which do not start with a terrific jerk? The North London are especially prominent in this, as they often start quite imperceptibly, and glide smoothly off; while the Great Northern (at King's Cross, suburban especially) almost throw the unwary passenger across the carriage. I hope for a solution of this, which is a mystery at present to **Shylock.**

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[24640.]—I observe with surprise the remarks contained in a letter in your last issue signed "Express," respecting the performances of the 1675 class of Midland engines. At all events, "Express's" disparagement of this class is in direct contradiction to the testimony of several Midland drivers with whom I have conversed on the subject, and all of whom speak in the highest possible terms of the work done by these engines. To a certain extent I can confirm what they say, having several times travelled in trains drawn by these engines lately. The run from Leicester to London is a very trying, long run, and in the words of Mr. Foxwell, in his very interesting little book entitled "Express Trains," "the average of 47 miles per hour attained over these steep ups and downs by the Scotch express, with its heavy train, is a first-rate performance."

Now, I travelled on the 3rd August last by the up day Scotch express from Leicester to London; the time taken was 119 minutes—an average of 50 miles per hour. The train was an unusually heavy one, and the engine was No. 1675, the very one alluded to so unfavourably by "Express" in his letter.

In the face of a fact like this it is difficult to believe that the performances of these engines can be so very unsatisfactory. I should be much obliged if Mr. Macmuir would favour us with a few particulars of the new 9ft. engine referred to in his reply in 57182.

**E. W. Sims.**

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[24641.]—The professional earnings of Mr. Bob Sawyer at Bath could have been put in a wine-glass and covered with a strawberry leaf. The coal saved by the express compounds could, I believe, be stowed away in a receptacle of yet smaller dimensions. That the daily time sheets might rise up in judgment and condemn the compounds need not for one moment be doubted; but that the coal sheet would prove such a veritable *pièce de conviction* as the May sheet for the London engines, now recently issued, could never have been anticipated. The figures are as follows:—

| Number. | Name. | Coal per mile. lb. | Class. |
|---|---|---|---|
| 2184 | Reynard........ | 30· 2 | Precedent. |
| 477 | Caractacus...... | 31·50 | „ |
| 2191 | Snowdon ...... | 31·58 | „ |
| 871 | Proserpine...... | 33· 2 | „ |
| 1170 | General ........ | 33· 6 | „ |
| 872 | Wizard ........ | 33· 8 | „ |
| 366 | City of Chicago. | 35· 6 | Compound. |
| 310 | Sarmatian ...... | 39· 4 | „ |

These two compounds are the only ones stationed at the London end, and work in the same link as the Precedents quoted above. The bulk of the compounds are at Crewe; but I am told they work chiefly in a link by themselves, and therefore invidious comparisons are not suggested. From the official pamphlet descriptive of the L. and N.W. exhibits at the Exhibition we learn that the compounds were "expressly designed," *inter alia*, for "the greater economy in the consumption of fuel." Having regard to the figures quoted above, one would scarcely have thought it. Perhaps, though, the other compounds are not such gluttons as "Sarmatian."

Whether, in point of logic, one would be justified in inferring that the other (small) compounds, if worked in the same link as the London Precedents and under similar conditions, would give equally deplorable results, need not now be gone into. In coal, oil, &c., "Sarmatian" costs the company between three and four shillings per 100 miles more than "Reynard," and at the same time is equally inferior to the latter in speed power.

In justice to the big compounds, it is only fair to mention that they take, unaided, heavy trains, which otherwise might have to be divided, and thus save expense indirectly; but this is accounted for by their greater weight and higher steam pressure. A Precedent, under similar conditions, would do as much as a big compound with ease.

With reference to the letter of "Express" (24618), I am quite aware that Mid. 1675 has failed with the Scotch express. At first the slide bar was fixed too tightly, and on one or two other occasions the heating was attributable to experiments with a different kind of oil. Failures from such causes as these in no way affect my previous statement that these engines "are, or will be, amongst the finest in the kingdom." Their running is excellent; I have averaged nearly 54 miles an hour between Kettering and Kentish Town with the Leeds express, and 1675 has run the Scotchman from Leicester in two hours. Larger tenders are being built for them at Derby, and drivers will then be able to do the London-Leicester run even better than at present, without fear of scarcity of water. The coal consumption of 1667, 1668, and 1673 for the last three months averages 26lb. per mile. If engines which can run at such high speeds and with such a coal consumption, notwithstanding Midland gradients, are not amongst the finest in the kingdom I should like to know what are.

**Kappa.**

August 17.

### THE COMPOUND LOCOMOTIVES.

[24642.]—We have been lately hearing a good deal said about the faults of the L.N.W. compounds, stating their large coal consumption, and their inability to run down hill freely at high speeds. But I hardly think correspondents do these engines justice; they do not seem to consider the years it has taken to attain the present state of perfection. In the design of the ordinary two-cylinder engine there are numerous little details conducive to good working which can only be obtained by experience. Now in such a departure from the ordinary system as that made by Mr. Webb—there being hardly any previous practice in this direction to guide him —I think, taking all things into consideration, he has produced a wonderful engine. I also have reason to believe that the Dreadnought class are in every way an improvement on the older ones, being able to run down hill freely, and, moreover, having a moderate coal consumption. Now as to another point: I believe that the coal consumption on these engines depends a good deal on the drivers. For instance, only the other day I heard of one of these engines, whose name I could mention, in which the coal consumed was only 27lb. per mile, whereas another engine of the same class, I was told, consumed 30lb. per mile; both these engines were of the earlier type.

One more point and I close. I notice that all the correspondents talk about the L.N.W. compounds; none ever discuss the merits of the engines introduced by Mr. Worsdell on the Gt. Eastern Ry. Can any of our readers come forward and give us some information about these, as to what is their coal consumption, whether they run freely, are troubled with excessive back pressure, or what not? Any details of running would be very interesting, I am sure. **Adiabatic.**

### L. & N.W. COMPOUNDS.

[24643.]—I was informed a few days ago that two drivers, who had spoken their minds in answer to inquiries respecting the above, had each been put back to shunting at Crewe, thus proving the statement made by "Kappa" in "Ours" of the 31st ult. **W. H.**

[We trust our correspondent is mistaken. The heads of departments of a great company like the London and North-Western Company would, we hope, hardly try to stifle free discussion in this way. Such attempts would be as futile as they would be unworthy.—Ed.]

### TRAIN SPEEDS.

[24644.]—Noticing "D. A. P.'s" interesting letter (24582), respecting train speeds, I shall be glad if he will kindly inform me whether it is correct that a train leaves Grantham about 4.17 p.m., and reaches King's-cross in 118 minutes, which gives an average speed of over 53 miles per hour. This he does not seem to have noticed in his tables; but, if correct, must be the most remarkable run known. **C. R. K.**

### THE BINEGAR ACCIDENT.

[24645.]—On Friday, 1st inst., a fatal collision occurred at Binegar Station on the Somerset and Dorset Joint Railway. The line is single, with a loop or double line at the station, and consequently facing points. The points and signals were interlocked, but in order to make necessary alterations, the locking-gear had been taken out. The signalman by mistake pulled a wrong lever, and the approaching passenger train was turned into the loop-line, and came into collision with a goods train. An inquest has been held, and a verdict of Manslaughter returned against the signalman.

In reading carefully over the report of the proceedings, it will at once be noticed that most important information relating to regulations for working points when interlocking is out of order were not produced.

It will be remembered that after the Desford Junction accident, Major Marindin reported "that he had stated in a report upon a previous accident that whenever the interlocking affecting a facing-point connection is out of order, a man should be stationed actually at the points in order that he may keep the signalman informed of the position in which they are lying. He therefore urged the company to lose no time in issuing some regulations to insure the safe working of the traffic."

In pursuance of that recommendation, the Clearing House Committee of Superintendents drew up proper regulations, which came into force on the various lines October, November, and December, 1883, as mentioned (Vol. XXXVIII. p. 266).

The Rule 149A adopted by the company's parties to the Railway Clearing System says: "When the interlocking of any lever-frame, or any facing-point, bolt, or bar is out of order, or when any point or signal lever is defective, a competent man must be appointed to act under the instructions of the signalman. When there are facing-points, this extra hand-signalman must, before signalling a train forward, *inform the signalman the position of such points*, and satisfy himself that they are open for the proper line. There is no doubt that the signalman by mistake pulled over the wrong lever; but it will at once be seen that if the rule had been carried out, and a man appointed at the facing-points, the error would have instantly been detected.

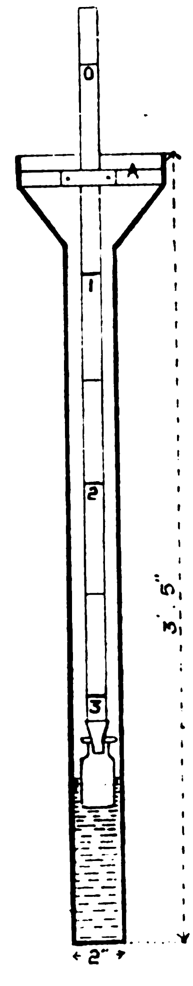
Nothing can be more dangerous than to interfere with or take away the security of the interlocking system without appointing a man or other means to provide for safety. The signalman made the actual mistake, and for that he will take his trial at Taunton in November; but a much more serious error was made by the official who decided to remove the interlocking without carrying out the instructions contained in the rules, and, as it is now given in evidence, *without* the signalman knowing that the safety of the interlocking had been interfered with.

**Clement E. Stretton, C.E.,**
Hon. Mem. A.S. Ry. Servants.
Saxe-Coburg-street, Leicester, August 17.

### AN EASILY-MADE RAIN GAUGE.

[24646.]—The following account of an easily-constructed rain gauge may interest some of your readers, who, like myself, are situated far out of reach of mathematical instrument makers.

The following sketch is a vertical section; the tube and funnel (or receiver) are of tin, the receiver being 6·4in. diameter, and the tube 2in. The float consists of a bottle carrying a very thin wooden index rod, graduated to inches and hundredths. The zero point is obtained by pouring water into the tube until the bottle just floats, and marking it on the scale on a level with the guide A.



The receiver being 6 4in. diameter, has an area of 32 17 superficial inches. A cubic inch of water weighs 0·578 ounce; therefore, 32·17in. will weigh 18·59 ounces, and that weight of water poured into the tube represents 1in. of rain on the ground. But to eliminate any inequalities that may exist in the diameter of the tube, I take only half this weight at once. Then each time this quantity of water is poured in, the index will rise above the guide A, an amount equal to ½in. of rain on the ground; the scale can be marked off accordingly, and subdivided into hundredths afterwards. I have obtained very satisfactory results from an instrument of this kind; it may be attached to a fence-post, or placed in any convenient situation out of reach of cattle or other animals.

**George Williams.**
Urbanna, Virginia, August 1.

### AERONAUTICS.

[24647.]—It is fortunate for Mr. Lancaster that he lives so far away as Chicago, as he thereby escapes some of the kicks that he would be in danger of receiving if he were in the neighbourhood of London.

The various kinds of flight observable in nature may be summarised as follows:—1st, the slow flight, requiring great power; 2nd, the more speedy flight, requiring less power; 3rd, the still more speedy flight of the albatross, requiring no power except that of steering, but depending on upward currents above the waves to receive forward impulses; and 4th, the perfect soaring flight, requiring neither wind nor power, but merely steering.

You say in your leader that "Mr. Lancaster has satisfied himself that the mathematics of the matter go to destruction in the solvent of common sense." Now I beg to differ *in toto* with this, and I say that it is entirely in accordance with my views of the laws of nature that a bird, or a man, with aëroplanes and steering apparatus, properly formed and steered, should soar all day long without the exertion of any power whatever, except that of steering.

If the flight is required to be made slowly, then great power is required, and the slower the speed the greater must be the power.

I have been very much amused at the Inventions Exhibition. Juryman No. 1 and Juryman No. 2 looked at my model boiler. I explained it to Juryman No. 1 in a few words, with the aid of my blue book, and I ventured to show No. 1 the modified form for aërial machines; No. 1 immediately went away as if he had been shot at, and No. 2 made a sneering remark and followed No. 1.

There is a little corner in the East Avenue of the Exhibition devoted to Aëronautics, and your readers will find there a very neat model made and exhibited by Mr. S. F. Pichler, in which the planes form the figure of 8 in a very ingenious manner. I was not there when the Jury came round, but I should have been glad of the opportunity, had it been possible, to observe the comedy. I say that Mr. Pichler's device deserved some kind of medal, but the intelligent Jury have thought otherwise.

I must not trouble you with the remarks of the public; they are more fit for the pages of *Punch*.

**Thomas Moy.**

### WHAT IS "CREATION"?—MYSTIFICATION—ALUMINIUM.

[24648.]—In letter 24590, page 518) "F.R A S." declines to accept "creation" simply as a sufficient explanation of observed facts—otherwise inexplicable—in the organic world, and deems it necessary to inquire further, "What is the cause or operative agent in creation?" For the scope and purposes of the scientist, I consider this is quite as unnecessary as to inquire, What is the cause or operative agent in gravitation?

"F.R.A S.," however, seems conveniently to have overlooked the alternative which, in anticipation of his non-acceptance of "creation," I offered to him (letter 24552, page 477), "Why, as a true scientist, should he hesitate to declare the insufficiency of natural selection *per se* to account for organic nature as we find it?"

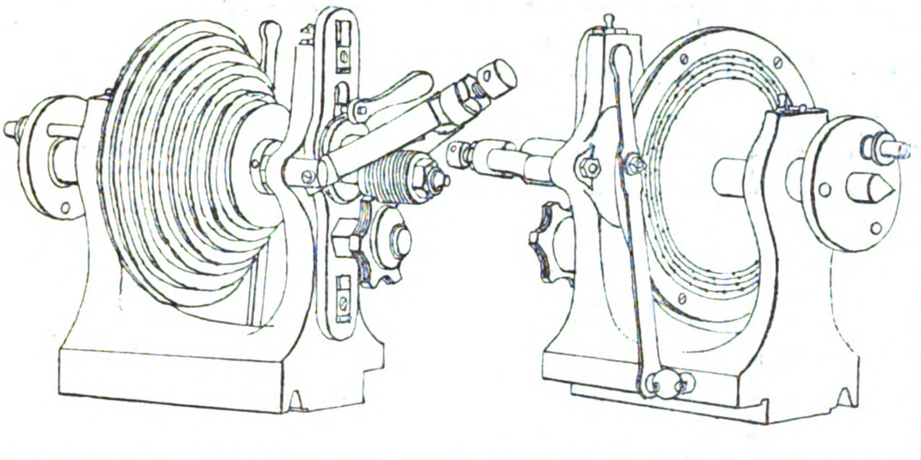
"Rho," in letter 24589, page 502, enters a protest against the "inordinate use of abstruse formulæ."

I sympathise with him so far, and am aware that many lecturers inflict on popular audiences terms and formulæ that are far beyond the comprehension of more than one or two of their hearers. While, however, deprecating such unnecessary pedantry, it will be evident to "Rho" that lecturers must be explicit, and, to avoid misapprehension, must have recourse to technical terms or formulæ. He himself affords an example of the necessity of this when he states that he would prefer the term "*cuprous* sulphate" to the symbol, "$CuSO_4$," which is not *cuprous*, but "*cupric* sulphate."

Before now the price of metals, notably that of copper, has been depreciated by reports of the discovery of new and economical methods of preparing aluminium, but in no instance have these reports been substantiated. The direction in which practical men look most hopefully for economy is in the production of cheaper sodium. Thus, in the process proposed by the late S. Gilchrist Thomas, the reduction of carbonate of soda is effected in cast-iron tubes or casings, with a thick internal lining of dolomite or magnesia. These are heated internally by reducing gases, which have been previously superheated by being made to pass through a small regenerator. **H. B. F.**

### GERMAN LATHE WITH TRAVERSING MANDREL.

[24649.]—Our lathemen seem to be taking their summer holiday; but I hope to revive the subject by sending you the inclosed photograph, for which I hope you will find space. The French form of traversing mandrel is well known to us in England, and has been several times illustrated and described



in these columns. The London pattern is also known. Here, however, we have something which will, I suspect, prove new to most of us. In this form the guide which steadies the mandrel and prevents it from traversing is semicircular; and it is fixed to a slotted plate attached to the back of the headstock in such a way that it can be moved up and down a short distance by means of the handle seen projecting to the right in Fig. 1. Attached to the same frame is seen the fixed guide, with its six threads. This is the same as in the London pattern, except that it requires no eccentric to raise and lower it. Having chosen the required thread, fixed the screw-guide on the end of the mandrel, and turned the corresponding thread to the top of segment nut, all that is required to set the mandrel traversing is to throw over the handle; this releases the mandrel by raising the semicircular stop-guide, and, at the same time, raises the guide-nut into contact with the guide-screw.

The mandrel is bored up; but is stopped at the end by the pin, which takes against the tail-pin. The fork which holds the tail-pin is hinged, to enable the ferrule guides to be changed.

These are the lathes introduced to us by Mr. Wenham, for which I think we owe him our best thanks. They are to be advertised in the "E.M." by the London agent of Mr. Walz. The workmanship and design pleased me very much, and a very curious and novel arrangement is used for trueing the screw-guides when in position, which I hope to introduce to your readers.

The only objection I can see to the arrangement is the difficulty of fixing or applying the spiral chuck to the tail end of the mandrel. I have been trying to contrive a plan of meeting this difficulty.

**F. A. M.**

## LATHEWORK AND OPTICAL INSTRUMENTS.

[24650.]—Myself, and many amateurs who possess lathes, are anxious to be able to fit up various optical apparatus and instruments, say, telescope, microscope, and the various accessories connected therewith, and we shall be extremely thankful if some one of your numerous contributors will give a short series of articles explaining the lathework and tools used in connection with the construction of these instruments, as the mechanical work connected with one equally applies to the rest. I hope some one versed in this line will intimate his readiness to help us.

August 17. **An Amateur.**

## GRINDING TOOLS FOR HAYDON'S CUTTER-BAR.

[24651.]—In answer to "J. D.'s" letter, No. 24574, if he will look at Fig. 3, page 433, he will find a thick-dotted line marked O°. This is the horizontal diameter of the grindstone, and the line he mentions, marked 2½°, joins it at that angle. All he has to do is to set this out with a protractor, or get the angle in any other way. This will give the height for grinding a tool that has a plan angle of 80°, if cutting edges of 60° are wanted—that is, if the tool is wanted for iron; but if you want a cutting edge of 80°, the same tool must be ground at the line marked "brass 80." But, bear in mind, the figures on the grinding gauge refer to the plan angle of the tool, and not to the cutting edge produced. All the heights marked "iron" for tools, with plan angles of 80, 90, 100, and 120, give the same cutting edges of 60°, although ground at different heights; but the tool must be held in one of Haydon's cutter-bars, properly made—that is, pitched at an angle of 55°. These remarks refer to all the other radiating lines. The horizontal lines are ruled parallel with the thick-dotted one, and are only for the purpose of conveniently marking the grinding gauge. The "×" "J. D." cannot find does not refer to a letter, but to a cross on the left side of A, Fig. 3. This explanation will perhaps make all clear. About advancing the tool as it has just been set for height, of course it must be horizontally, or the setting would be lost. By reversing the tool in the holder, it is meant that it should be turned half round for the purpose of grinding the top face.

The grinding angles are all from the tables left us by Prof. Willis. I have only adopted them to the pitch of Haydon's cutter-bar, and I do not know enough of trigonometry to explain the principle.

I trust "J. D." will not give up at the difficulties to be found just at the first. They soon vanish, and his reward will be a tool that always turns off long, bright shavings; one made in a short time for any kind of metal; and one you know must be right, needing no water, except for the last cut, when it leaves a surface like silver, one that should be touched by neither file or sandpaper. I should be glad to draw a grinding gauge on paper for "J. D.," if he likes to advertise his address; or examine his holder if he has any doubts as to its being correctly made, or I would let him know the maker of mine.

**A. Atkinson.**

## POWERS USED ON CERTAIN TELESCOPES.

[24652.]—I had intended referring to Mr. Sadler's interesting letter (24532, p. 456) before this, but want of leisure has hitherto prevented my doing so. It struck me at the time of reading, however, that the statements there made of the powers used by Struve and Burnham, the two observers who, of all others, have contributed the greatest quota of double star discoveries, were calculated to produce somewhat erroneous impressions. During an hour or two of leisure, I set myself the task of wading through the first half of Struve's "Mensuræ Micrometricæ" (as represented by Lord Lindsay's "Summary"), and the analysis made may perhaps interest Mr. Sadler and others. The first column gives the nominal powers; the second the corresponding actual powers, as measured by Σ.; and the third the number of double stars examined with each. The Dorpat achromatic had an aperture of $9\frac{6}{10}$in., and its focal length was about 14ft.

| Nominal powers. | Actual powers. | No. of stars. |
|---|---|---|
| 140 | 133 | 2 |
| 140-214 | 133-198 | 1 |
| 214 | 198 | 7 |
| 214-320 | 198-254 | 5 |
| 320 | 254 | 683 |
| 320-380 | 254-? | 33 |
| 320-480 | 254-420 | 416 |
| 320-600 | 254-532 | 38 |
| *380 | ? | 2 |
| 480 | 420 | 99 |
| 480-540 | 420-? | 3 |
| *540 | ? | 1 |
| 480-600 | 420-532 | 86 |
| 480-800 | 420-682 | 4 |
| 480-1000 | 420-848 | 1 |
| 600 | 532 | 13 |
| 600-800 | 532-682 | 5 |
| 600-1000 | 532-848 | 1 |
| | | 1400 |

The powers marked * are not mentioned in the introduction. Thinking it possible that 380 was a misprint for 480, I referred to the "Mens. Microm." itself, but found that it was copied quite correctly. And 540 might be intended for the 532; but this is merely a suggestion. It will be seen by inspection of the above table how much, or, rather, how little, was done with 100 to the inch of aperture. Nearly 50 per cent. (683) of the objects were measured with a power of 254—26·5 to the inch! And no less than 449 others, with powers of 254 to 420, the maximum being 44 to the inch. Power 682 was only used on nine objects, and 848 on two only, out of a total of 1,400. If even 90 to the inch is only used on *one* object in 700, we may well leave still higher powers to the time when, as quaint old Kitchener says, "the atmosphere be removed, and the earth stands still."

And now for the Chicago refractor. Mr. Sadler says:—"Most of the close pairs were measured by Mr. Burnham with the highest power, 925." In this month's *Observatory* there is an article on "Large *v.* Small Telescopes," by Prof. G. W. Hough, where I read as follows:—

"In the climate of the United States the nights on which the highest powers may be used are rare. I presume *three-fourths* of all the observations by Mr. Burnham and myself, with the Chicago refractor (18½in. aperture), were made with a magnifying power of 300, and the balance with higher powers up to 925." The italics are mine. In other words, 75 per cent. of the objects were examined with a power of 16·2 to the inch of aperture. Moreover, the highest power here indicated is just 50 to the inch. And I think no one can say that either of the two fine telescopes (at Dorpat and Chicago) are imperfect specimens of the optical art.

**W. S. Franks.**

## SAFETY BICYCLES.

[24653.]—As an old rider who has tried nearly every form of bicycle and tricycle, I may answer your correspondent (letter 24609, p. 520). The geared machines with small drivers are, in my own experience, most unsatisfactory, unless the machine *exactly* fits the rider. I have tried them, and found very slight differences in machines by the same maker produce a most extraordinary difference both in comfort and speed, and I have no doubt whatever that if your correspondent will try several machines until he finds one which exactly suits him, he will settle down to this with the most perfect satisfaction. I am 6ft. high, 46 years old, and weigh 200lb., and with a 40in. Safety geared to 56in. I can hold my own with most without effort, and can pass most riders on 50in. to 54in. ordinary bicycles. The presence or absence of jolting depends entirely on the length and proper strength of the seat spring. I can ride up any hill which I could surmount on any bicycle or tricycle I ever tried, and I leave the dust behind. The fault is not in the system, but in your correspondent's machine. My own has ball bearings throughout, a very long and elastic seat spring, and one of the best suspension saddles, and for the first time in fifteen years I may say I am perfectly satisfied, and can ride on ordinary roads as fast as I care and dare to do.

Your correspondent had better make a change, and not buy another before he has tried it thoroughly, and is perfectly satisfied both as to speed and comfort.

**T. F.**

[24654.]—In answer to letter (No. 24609) from "?" with reference to the Safety bicycles, I beg to send my experience; and as I have tried most machines, bone-shakers, bicycles, tricycles, &c., it may be of use to "?." By his letter, it is evident that he is not satisfied with a Safety; but I can't say that I agree with him. He says that there is a great strain on the wrists, and that the steering is hard. Here I in a measure agree with him. These machines are certainly more difficult to steer than an ordinary bicycle, though you after a time get used to them. He next states that he can't get up a speed above nine miles an hour. I cannot understand this, for whatever faults can be found with the unfortunate Safeties, loss of speed is not one of them. I have no difficulty in riding fourteen or fifteen miles an hour, and recently rode forty-five miles in three and a half hours. No rider on any kind of machine would, if he valued his tires, ride through newly-laid stones; but there is generally a path at the side which does for a bicycle, although useless for a tricycle. I have always found it *impossible* to go over the handles, except once, when a drunken drover caught my small wheel and lifted it up (the wheel caught him in the face and knocked him down). The vibration caused by the small wheel is considerable, especially in those machines in which the small wheel leads, but this is much reduced by a "cradle" spring and thick tires. I have never found the dust on the clothes worse than on a tricycle, although it is greater than on a bicycle, but it collects on the lower cog-wheel and chain. You say that you cannot ride hills which you could on a tricycle, and that your machine is hard to drive. The machine which I am now riding, and to which all the above refers, is a "Rudge" pattern, 40in. wheels geared to about 63in., with ⅞in. tires. With this, although geared much higher than yours, I can ride almost any hill much easier than on a tricycle (the one I have at present is a "Humber," geared to 54in., and this, in my opinion, is far the best type of tricycle, except for very rough roads, when two-track machines are most useful). I had a "Facile" for a short time, but did not care much for it. It is certainly very easy to drive, and the best hill-climber of any machine which I have tried, and also is quite safe; but to go at any speed you have to treadle very fast, and the motion is very jerky. I have not tried the "Xtra" (Singer's), but although its appearance is against it, several friends of mine speak very much in its favour. I have now and then borrowed a Safety with the small wheel in the front. On these it is quite impossible to take a header, as you are nearly half-way between the wheels. I can't say much either way about them from experience, as I have not ridden 50 miles altogether; but from what I hear, the "Rover" (Starley and Sutton) is one of the best.

To sum up, I think that a Safety is superior to a tricycle for speed, and hill climbing, and ease of driving, and that they are quite as fast as an ordinary bicycle, although not so easy to steer or drive; also that the vibration is greater than on either a bicycle or tricycle (except old rear-steerers). A well-made Safety is safer than either a bicycle or a tricycle, especially at night. I would not recommend one geared as high as mine, for, although I manage it all right, I have ridden for many years, and many who have tried my machine say it is geared too high for much hill work.

I must apologise for the length of this letter; but it has taken up much more space than I expected when I commenced. **C. A. W.**

## WATCHMAKERS' QUERIES.

[24655.]—I NOTICED in your paper about a fortnight ago a query with regard to the fitting of balance springs, signed "Caribbean." This week I find the query answered in two different ways. The first letter is by "Escapement" (57159), who answers the requirement satisfactory to me. His method of selecting a balance spring is that which I always have been accustomed to do—that is, if a watch requires a fresh balance spring I put one in that will stretch a trifle further out when the balance is suspended from the spring.

The next letter is by "Peganredstuff" (No. 57159), and he commences by saying the number of beats per hour must first be ascertained—say (says he), for instance, it is 16,200; that would be nine beats or vibrations of balance in two seconds. I should like to know how the number of beats can be ascertained in the first place. A watch may come to be repaired, and it, with the old spring in, may go at the rate of 20,200, and, if so, of what use is the old spring? It appears to me to be of no use in this case by "Peganredstuff's" way of reckoning. He further says, with regard to the testing of a balance spring: "Lay it on balance arms, verge upwards, and gently press collet down on it sufficient to hold spring." We are agreeable so far. Then he says: "Take hold of spring so many turns from outside coil as is right size." How can he tell that it is right size when the old spring is wrong altogether? What has he to go by? I should like "Peganredstuff" to say. Further, he says, hold it with the tweezers; "with a touch set it vibrating and count." Does he mean to say he is to count every action of that balance until it stops, then calculate the number he has counted and the time it has taken him? He then finishes by saying you can try any number of springs, and I believe him, for you may try many an hour before you are satisfied, and when you have got it in the watch you may be wrong after all.

"Escapement's" method is far the wiser, so far as I can see. I should like a reply.

**J. Brierley Delph.**

## COMPARISON OF TIDES.

[24656.]—THE tides during the month of July have been more in accordance with the predictions than they have been for several months past, and the fact that the law of the "diurnal inequality" has been correctly formulated has, in consequence, received ample verification. We simply challenge competition with any other tables extant, when placed side by side with the Admiralty Tables for Liverpool. The promoters of the method, of calculation, based on the Harmonic Analysis of the Tides, have been appealed to again and again to produce a sheet of predictions for any month, for the purpose of being compared with those given by Sir John Lubbock's method, revised and extended; but, with a haughtiness peculiar to themselves, which, however, indicates weakness, they simply decline, confining themselves to the Indian ports, for which the promoters are subsidised. A reference to the "Daily Meteorological Reports" points out when anticyclonic conditions have prevailed, and at those times the sea-level is depressed. This has been the case during the latter days of July, and hence the largest discordances have then become apparent. But it is noticeable how, even under these circumstances, the "diurnal inequality" asserts itself. For example: on the 29th, 30th, and 31st the tides are gradually diminishing in height, but the night-tides maintain their superiority, and each is higher by a foot than the preceding day tide, the summits of the tidal curves forming a zig-zag line which used to be excessively puzzling to early investigators, and even more so to early observers. The irregularity demanded explanation, and an explanation has been offered, which either is, or is not, the correct one. No one as yet has ventured to assail, or even to criticise, the explanation which I have offered in the method of computation offered by the Admiralty. What is to be inferred from this circumstance I must leave to others to judge.

**James Pearson, M.A., F.R.A.S.**

Fleetwood Vicarage, Aug. 6.

COMPARISON OF TIDES AT LIVERPOOL AND FLEETWOOD IN JULY, 1885.

| Date. | Calculation. | | Observation. | | Error. | Barometer | Wind. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| 1885. | ft. | in. | ft. | in. | in. | | | |
| July 1 | 25 | 4 | 25 | 2 | − 2 | 30·1 | W. | Fresh; anticyclonic. |
| | 24 | 1 | 24 | 0 | − 1 | 30·1 | W. | Fresh; anticyclonic. |
| 2 | 25 | 0 | 24 | 9 | − 3 | 30·2 | W.N.W. | Slight. |
| | 23 | 4 | 23 | 5 | + 1 | 30·2 | | Variable. |
| 3 | 24 | 5 | 24 | 4 | − 1 | 30·2 | N.N.E. | Slight. |
| | 22 | 9 | 22 | 9 | 0 | 30·2 | Calm. | — |
| 4 | 23 | 9 | 23 | 6 | − 3 | 30·2 | W. | Variable. |
| | 22 | 1 | 21 | 11 | − 2 | 30·2 | W. | Barometer rising. |
| 5 | 23 | 0 | 22 | 8 | − 4 | 30·3 | W.S.W. | Slight. |
| | 21 | 5 | 21 | 5 | 0 | 30·3 | Calm. | — |
| 6 | 22 | 3 | 22 | 2 | − 1 | 30·3 | S.W. | Fresh. |
| | 20 | 11 | 21 | 2 | + 3 | 30·2 | S.W. | Slight. |
| 7 | 22 | 1 | 21 | 8 | + 5 | 30·1 | S.S.E. | Slight. |
| | 21 | 4 | 21 | 11 | + 7 | 30·0 | S.S.W. | Fresh to strong. |
| 8 | 22 | 7 | 22 | 11 | + 4 | 29·9 | W.S.W. | Fresh. |
| | 22 | 5 | 22 | 9 | + 4 | 30·0 | W.S.W. | Fresh. |
| 9 | 23 | 6 | 23 | 7 | + 1 | 30·1 | S.W. to W.N.W. | Variable. |
| | 24 | 0 | 24 | 2 | + 2 | 30·1 | S.W. | Slight. |
| 10 | 24 | 10 | 24 | 10 | 0 | 30·1 | S.S.W. | Fresh. |
| | 25 | 9 | 25 | 7 | − 2 | 30·1 | N.N.W. | Slight. |
| 11 | 26 | 6 | 26 | 3 | − 3 | 30·0 | S.S.W. | Fresh; cyclonic. |
| | 27 | 3 | 27 | 2 | − 1 | 30·1 | Calm. | — |
| 12 | 27 | 8 | 27 | 3 | − 5 | 30·1 | N.E. | Moderate; variable. |
| | 28 | 3 | 28 | 2 | − 1 | 30·1 | Calm. | — |
| 13 | 28 | 2 | 28 | 2 | 0 | 30·1 | W. | Moderate. |
| | — | | — | | — | — | — | — |
| 14 | 28 | 9 | 28 | 6 | − 3 | 30·2 | N.N.W. | Fresh. |
| | 28 | 4 | 27 | 8 | − 8 | 30·2 | N.N.E. | Fresh to strong. |
| 15 | 28 | 8 | 28 | 3 | − 5 | 30·1 | S.W. | Slight to fresh. |
| | 27 | 6 | 27 | 9 | + 3 | 30·1 | S.W. | Slight; cyclonic. |
| 16 | 27 | 9 | 27 | 9 | 0 | 30·0 | W.S.W. to W. | Fresh. |
| | 26 | 5 | 26 | 5 | 0 | 30·0 | W. | Slight. |
| 17 | 26 | 6 | 26 | 8 | + 2 | 30·0 | W. | Fresh to strong. |
| | 25 | 3 | 25 | 2 | − 1 | 29·9 | W. | Slight. |
| 18 | 25 | 0 | 25 | 0 | 0 | 29·8 | S.S.W. | Slight. |
| | 23 | 8 | 24 | 0 | + 4 | 29·7 | S.S.W. | Slight. |
| 19 | 23 | 5 | 23 | 9 | + 4 | 29·7 | S.W. to W.N.W. | Slight; cyclonic. |
| | 22 | 0 | 22 | 2 | + 2 | 29·7 | S.S.W. | Slight. |
| 20 | 21 | 11 | 21 | 9 | − 2 | 29·8 | W. | Fresh. |
| | 20 | 11 | 21 | 2 | + 3 | 30·0 | | Large anticyclone. |
| 21 | 21 | 1 | 21 | 0 | − 1 | 30·2 | W.N.W. | Slight. |
| | 21 | 0 | 21 | 0 | 0 | 30·3 | Calm. | — |
| 22 | 21 | 2 | 20 | 10 | − 4 | 30·4 | N.N.W. to E.S.E. | Slight. |
| | 21 | 6 | 21 | 5 | − 2 | 30·3 | Variable. | — |
| 23 | 21 | 5 | 21 | 3 | − 2 | 30·3 | Calm. | — |
| | 22 | 6 | 22 | 3 | − 1 | 30·3 | Calm. | — |
| 24 | 22 | 2 | 21 | 10 | − 4 | 30·3 | Calm. | — |
| | 23 | 8 | 23 | 3 | − 5 | 30·3 | N. | Slight. |
| 25 | 23 | 1 | 22 | 9 | − 4 | 30·3 | W.N.W. | Slight; variable. |
| | 24 | 6 | 24 | 3 | − 2 | 30·3 | N.N.W. | Slight. |
| 26 | 23 | 8 | 23 | 4 | − 2 | 30·4 | W.N.W. | Almost calm. |
| | 25 | 2 | 25 | 0 | − 2 | 30·4 | N.N.W. | Slight. |
| 27 | 24 | 5 | 23 | 9 | − 8 | 30·3 | N.N.W. | Very slight. |
| | 25 | 9 | 25 | 2 | − 7 | 30·4 | E. | Strong. |
| 28 | — | | — | | — | — | — | — |
| | 24 | 10 | 24 | 2 | − 8 | 30·4 | E. | Fresh to strong. |
| 29 | 26 | 4 | 25 | 5 | −11 | 30·4 | E.S.E. | Strong. |
| | 25 | 2 | 24 | 5 | − 9 | 30·4 | E. | Strong. |
| 30 | 26 | 7 | 25 | 7 | −12 | 30·3 | N.W. to E.N.E. | Fresh to strong. |
| | 24 | 11 | 24 | 6 | − 5 | 30·3 | E.N.E. | Moderate. |
| 31 | 26 | 2 | 25 | 6 | − 8 | 30·3 | S.E. | — |
| | 24 | 7 | 24 | 5 | − 2 | 30·3 | S.E. | — |

## THE HISTORY OF THE TIDAL PROBLEM.—III.

[24657.]—THE harmonic analysis of the tides, which was introduced by Sir William Thomson, and was carried out into figures by Mr. E. Roberts, and which now is elaborated by means of a tide-predicting machine, produced by them jointly, demands only a few observations, and for this reason, that the reports of the British Association dwell upon this method exclusively, and appear to take it for granted that "any modification of what is called the *equilibrium theory*, which shall extend its details, and bring it into nearer agreement with the facts of observation, is simply impossible." In fact, Sir William Thomson has caused it to be set down in writing as his ultimate decision, "that he did not think it would be advisable to print any tables regarding this subject which are founded on any method less complete than that of the harmonic analysis employed by the British Association's Tidal Committee." We can, therefore hardly expect any fresh prizes to be offered for the best and most approved treatises on the subject under that sanction.

The principle of the method to which we are now alluding may be regarded as an extension of that introduced by Laplace. What is called a harmonic function is an expression of the form $R \cos. (nt-\epsilon)$, and the successive values it assumes throughout its cycle of changes may be shown by a very simple contrivance. Suppose two wheels of the same diameter (like the driving-wheels of a locomotive engine), with cranks attached to the centre of each, of equal length, and parallel to each other, the extremities of these cranks being held together by means of a connecting rod. Then, as is seen in the motion of a locomotive thus constructed, when the wheels turn round, the connecting rod will remain horizontal, but it will rise and fall *above* and *below* the line joining their centres once in each revolution; and its height *above* or depression *below* this line will be exactly $R \cos. nt$, where $R$ is the length of each crank and $n$ the angular velocity of rotation of the wheel—i.e., the angle through which each turns in a unit of time. The rise and fall of this connecting rod, then, will represent the rise and fall of the sea during a tide, so far as that rise and fall depend on *any one* of the causes, which are many in number, by the sum-total of which the whole tide is generated. I will add nothing more in reference to this theory, except to assert that although correct in principle, when certain modifications due to the actual operations of nature are kept out of sight, it fails under the actual conditions of the problem to serve as a basis for the accurate predictions required in tide-tables.

The next and last attempt at a solution of the tidal problem to which I have to refer, is based on Sir John Lubbock's method; but is a revision and extension of that method. The difficulty which has beset every attempt to form tide tables which should serve the purposes of prediction, and be a sure guide to harbour masters and others employed in the docking of ships, has arisen from what is called the "diurnal inequality" of the tides, by the operation of which it comes to pass, that when the tides are springing, for instance, their heights do not succeed each other by regular steps of elevation, but follow each other in a zig-zag fashion, the night tides being at one season higher than the day tides, and *vice versâ* at another. Now, what is claimed is, that a complete explanation has been discovered, both of the cause and effect of this "diurnal inequality" for the first time by this method, the proof being that tide tables, computed on the principles of this explanation, give results in exact accordance with observation. A refutation of this statement has been publicly challenged, but has never yet been successfully made, and the Admiralty tide tables for Liverpool having for ten years past been constructed by means of tables based on this method, are allowed to be put in competition with any others by whomsoever devised, and their correctness has never yet been called in question. It may be that the method is considered undeserving of criticism, because not brought out under the ægis of names renowned in the scientific world; but all this display of haughtiness does not affect the fact of the superiority and truthfulness of its principles. The law of this "diurnal inequality" has been so often enunciated that it is unnecessary to repeat it, and, although the regulations of the Royal Astronomical Society forbid any discussion of the method in the pages of its *Monthly Notices*, forsooth "because a similar communication has been made in the English Mechanic," yet "Magna est veritas, et prevalebit."

**James Pearson, M.A., F.R.A.S.**

Fleetwood Vicarage, July 30.

## GERMAN GUNNERY.

[24658.]—The high foot-second velocity reached by Herr Krupp's guns is a fact patent to all Europe. To ascertain the resistance of the air to the motion of shot at all practical velocities, is a problem that, up to a recent date, has baffled all experimenters, from Sir Isaac Newton downwards. Did the resistance of the air vary as the square or cube of the velocity, that is to say, was the resistance increased to four or eight times for doubling velocity?

To this task an Englishman, Professor Bashforth, devoted the cream of his life. Formerly a second wrangler in that splendid year when "Neptune" Adams was senior, Bashforth, seizing the extraordinary experimental difficulties of the problem, with his own hands constructed a delicate chronograph, which we have minutely examined, capable of recording the hundred-thousandth part of a time-second. Erecting 10 screens of thread-work, he superintended the discharge of 500 rounds of cannon shot, each of which, by electric action, recorded the precise instant of its passage through each screen, and at the same time a clock, beating half-seconds, dotted down the seconds of time. Microscopic examination of these electrical records published the exact epochs and diminishing velocities of the flying balls. As we have had the advantage of witnessing the calculations by which from these data the history of the flight of the ball is determined, we are prepared to appreciate the enormous labour undertaken, spontaneously by Prof. Bashforth when tutor to the advanced artillery class at Woolwich. It is, therefore, utterly improbable that Herr Krupp (whose mathematical acquirements are at least unknown) has calculated a set of tables of mètre-second velocities of cannon balls. But when we come to examine these German tables we find (with slight alterations) they are the identical tables evolved by such huge labour by Mr. Bashforth. We need not wonder, then, that he feels aggrieved, and justly distributes the following *protest*:—

"A Protest.

"'Reports on Experiments made with the Bashforth Chronograph to Determine the Resistance of the Air to the Motion of Projectiles 1865-1870,' (84/B/1941), were published in 1870, and the final report on experiments 1878–1880 (84/B/2909), in 1880, which contained coefficients of resistance for ogival-headed shot for velocities between 100 and 2,800ft. per second, or, between 30 and 853 mètres per second, and two general tables connecting velocity (1) with time, and (2) with space.

"In the following year M. Krupp published 'Table de Krupp pour le calcul des Vitesses restantes horizontales et des durées de Trajet des Projectiles oblongs. Essen, 1881.'

"These tables of M. Krupp are the same in substance as my general tables, substituting French for English measures. They differ only in supposing a slightly reduced resistance of the air due to a more acutely pointed shot, &c., to the extent shown in the accompanying diagram,[*] or, in a similar diagram given by Professor Greenhill in the *Proceedings* of the R.A. Institution, Aug., 1884, p. 60. M. Krupp makes no reference to the results obtained by any prior experimenter.

"I desire to direct particular attention to the fact that an intermediate report of mine, dated July 8, 1879, was printed and circulated in 1879 (84/B/2853), of which I received 100 copies. That report gave coefficients extending from velocity 430 to 2,250ft. per second, or from velocity 131 to 685 mètres per second, while M. Krupp's tables extend from velocity 140 to 700 mètres per second.

"Having devoted much time and labour (1864–1880) in carrying out ballistic experiments at Woolwich and Shoeburyness, I object to have results very similar to mine laid before the public as perfectly independent discoveries. I have no claim to make to anything beyond what was contained in my reports to Government, and published before the experiments of M. Krupp are said to have been made.

"F. Bashforth,
"Late Professor of Applied Mathematics to the Advanced Class of Royal Artillery Officers, Woolwich.

"Minting Vicarage, Horncastle, Dec., 1884."

And in another statement of the case we read:—

"Bashforth's general tables connecting space, time, and velocity of spherical and ogival-headed shot were derived from the results of more than 500 rounds of 3, 5, 7, and 9in. shot fired at Shoeburyness in 1867, 1868, 1878, 1879, and 1880. The satisfactory performance of these experiments involved the invention of a new chronograph specially adapted to the work to be done. . . Krupp's tables made their appearance at Essen in 1881. And it is stated that they have been "établi par l'usine Krupp au commencement de l'année 1880" (p. 18). But no details of the experiments have been furnished. No information has been given respecting the instruments used in making the experiments. No reference is made to any prior experimenter. The two tables of Krupp 1881 are precisely the same as those of Bashforth 1871, &c., except only that French replace English measures, and that a small reduction is made in the resistance of the air, which is such as might be expected from slightly improved steadiness, and a more acutely pointed form of shot. Krupp's attention has already been called to this matter in *Nature*, No. 753, April 3, 1884, p. 528. Krupp's publication is valuable as (1) confirming Bashforth's previously published results, and (2) showing the strictly practical nature of Bashforth's work originally undertaken in connection with the advanced class of Royal Artillery Officers, Woolwich."

Now that the results of Bashforth's experiments have come into general use in R.A. and Navy text-books, the late Government, through Lord Hartington, awarded him £2,000 in recognition of the value of his labours, which have been extended over 20 years.

The mathematical investigations are of the very highest order of research. The results are throughout tested by the principles of interpolation and second and third differences—principles capable of detecting the slightest errors of observation or calculation.

**G. W. Royston-Pigott.**

## LEGAL REPLIES.

[24659.] — Will — Dower — Freeholds (57051).—The clause quoted by the querist from the purchase deed has nothing to do with his will. It is a clause commonly inserted in conveyances to "bar dower," as the phrase is: that is, to prevent dower from attaching in the event of the purchaser dying intestate, when the widow would, in the absence of this clause, as dower, be entitled to one-third of the property; but when a will is made, as in this case, that overrides everything, and, as the querist here has made his will in his wife's favour, giving her all his property, both real and personal, this freehold would pass to her if it is in his possession at his death, while its having been bought since the date of the will is altogether immaterial.

Income Tax — Partnership — Returns — Exemption (57189). — The answer to this question by "Os" is so amazing, and may be so misleading, that I feel obliged to correct it fully. He writes: "The tax is levied upon individuals, not partnerships or firms. Let each partner send in a separate return, and no mistake can be made." This is entirely erroneous. By the Income Tax Act, 1842 (5 and 6 Vict., c. 35, s. 100), it is expressly provided that where a trade or profession is carried on by two or more persons jointly, *the return must be made and stated jointly*, and the duty is computed in one sum and separately from any other duty chargeable upon the same persons, or either or any of them. That clause is plain enough, and it is always acted upon. The only case in which a partner may make a separate return of his trading profits is where he seeks to claim exemption. If in this business each partner does really only earn an income below £150, he must make a separate return and declaration to that effect, and for this purpose he had better apply to his collector for the proper forms. But the law is as plain as possible, that except when claiming exemption no partner can make a separate return; but the return must be made and stated jointly. The Income Tax Acts are very hard reading, and very confusing. For this reason I have much pleasure in recommending a little book just published by Stevens and Sons, Chancery-lane, at 7s. 6d., and called "A Guide to the Income Tax Acts, for the Use of the English Income Tax Payer," by Mr. Ellis, solicitor, which I have found handy as a help through the bewildering mazes of the Statutes themselves.

Land—Contract — Completion (57206). — As money was paid on account, there seems to be a clear contract for the sale, if not, indeed, an actual sale, of this land. The querist can therefore compel the vendor to complete and give him a title by an action for specific performance in the Chancery Division, or he can let his bargain go and sue for his money back again, with damages for breach of contract, the amount of which will partly depend upon the rise or fall in the value of the land. As to the size of the house, this is often regulated by restrictive covenants, in order that neighbouring property may not be depreciated. If there was any agreement that such a covenant should be inserted in the purchase deed, then the querist would be bound thereby, but not otherwise.

**Fred. Wetherfield, Solicitor.**

2, Gresham-buildings, Guildhall, London.

## ORGAN DESIGNING.

[24660.]—If you will allow me, Mr. Editor, I should like to supplement my remarks on the above, which appeared on July 31, by an illustration, consisting of a specification of the chief, or great manual, of a first-class instrument. Compass, CC—$C^3$, 61 notes.

| | | |
|---|---|---|
| 1. | Double open metal, 16ft. and 8ft. | 122 pipes. |
| 2. | Double stopt wood, 16ft. and 8ft. | 122 ,, |
| 3. | Large open metal..........8ft. | 61 ,, |
| 4. | Small open metal..........8ft. | 61 ,, |
| 5. | Stopt wood, or gamba......8ft. | 61 ,, |
| 6. | Octave open metal ........4ft. | 61 ,, |
| 7. | Stopt wood................4ft. | 61 ,, |
| 8. | Mixture, 8th, 12th, 15th ...... | 183 ,, |
| 9. | Furniture, 15th, 17th, 19th, 22nd, 26th, 29th ................ | 366 ,, |
| 10. | Harmonic mixture, beginning at 8ft., containing 8ft., 5⅓ft., 4ft., and the whole harmonic series including the 7ths, XIV. ranks .............. | 854 ,, |
| 11, 12, and 13. | Double trumpet, trumpet and clarion of 16ft., 8ft., and 4ft. | |

The above contains three stops of 16ft., seven of 8ft., five of 4ft., three of 2ft., one of 5⅓ft., two of 2⅔ft., besides fourteen ranks of chorus, making up what in a modern organ would amount to twenty-four stops.

It will be seen that the stops are not given useless and ornamental names, such as "clarabella," "Höhl Flöte," and so on, but are described as what they actually are; the scale, material, and pitch alone being written on the stop handle. The specification contains, it will be seen, 13 stops instead of 24, the number of pipes being 2,135.

The performer finds the same variety as if every rank of pipes had its separate stop knob. No organist ever uses the doubles without the corresponding unisons. The fifteenth is never used by itself, nor the twelfth, and neither of them without the principal; so that in obeying the direction, "full to fifteenth," only one knob has to be drawn (No. 8) instead of three.

I might have put the three reeds under the control of one handle, for in such an instrument they would always be drawn together, as the solo reeds would be found elsewhere; but that would be too much of a shock to old-established prejudices.

I now append the corresponding pedal:—

| | | |
|---|---|---|
| 1. | Double open metal, | 32ft. and 16ft. |
| 2. | Bourdon ........ | 32ft. and 16ft., or 16ft., 10⅔ft., 8ft. |
| 3. | Open metal...... | 16ft. |
| 4. | Open wood ...... | 16ft. |
| 5. | Violone.......... | 16ft. |
| 6. | Octave metal .... | 8ft. |
| 7. | Octave wood .... | 8ft. |
| 8. | Mixture ......... | 8ft., 5⅓ft., 4ft. |
| 9. | Sesquialtra....... | 4ft., 2⅔ft., 2ft. |
| 10. | Contra Bombarde | 32ft. |
| 11. | Heavy Reed ..... | 16ft. |
| 12. | Light Reed ...... | 16ft. |
| 13. | Octave Reed..... | 8ft. |

Here in 13 stops we find the same contents as comprised in a pedal of 18—namely, two of 32ft., seven of 16ft., four of 8ft., two of 4ft., one each 10⅔ft., 5⅓ft., and 2⅔ft.

No. 8 might also contain 10th, 6⅖ft., as it would never be drawn except with nearly a full pedal.

**John T. Lawrence, B.A.**

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[*] The diagram is too large to reproduce satisfactorily.

## EXAMINATION OF MINERALS BEFORE THE BLOWPIPE.—IV.

[24661.]—Box No. 16.—White, opaque, amorphous, glittering, cryst. struct. (like loaf sugar); hardish (penknife makes little powder, but leaves no steel on surface); crushes easily.

| | |
|---|---|
| I. Powder in B acid. (1) Great effervescence for a short time only (*a*) yellowing the green p.c. (2) Transparent colourless balls, rapidly fusing into one large one, not quite round, (*b*) opaque hot; and evolving only a little opaline matter under treatment. | (1) Carbon dioxide.<br>(2) Probably a combination, or rather conjunction, of calcium and barium. |
| II. Fragment of mineral at point of pyrocone. (1) Yellow-green p.c. (2) Red orange p.c. in E P. (*c*) (3) Fragment turns green where heated. | (1) Barium. (2) Calcium. (3) Barium manganate (according to Plattner), but no proof of manganese here. |

There can be no doubt about this mineral.

Box No. 17.—White, semitransparent, amorphous, fibro-cryst. structure; soft, or very soft, crushes easily.

| | |
|---|---|
| I. Powder in B acid. (1) Red p.c. at bottom of bead. (2) Great effervescence, green p.c. unchanged. (3) Transp. fragments after long treatment, but one or two minute opaque balls. | (1) Lithium or strontium. (2) Sulphuric anhydride(*d*). (3) Cannot be aluminium silicate containing lithia or strontia, because the mineral is soft. |
| II. Fragment in E.P. (1) Orange red p.c. | (1) Strontium. |
| III. Added CoO. (1) No solution of cobalt borate. | (1) No alkali (no lithia). |
| IV. Powder fused with $K_2O$ (*e*) on Al plate, boiled, dried, and treated in B acid. (1) The whole transparent balls (2) A little grey opalescent matter. | (1) Strontium (the red p.c. showing it cannot be lime).<br>(2) A little combined water. |

What mineral is this? (*f*)

Box No. 18.—Nearly opaque, white, amorphous, hardish; little powder, but no steel left.

| | |
|---|---|
| I. Powder in B acid. (2) Momentary rose p.c. from bottom of bead. (2) Great but brief effervescence, with temporary yellowing of green p.c. (3) Transparent balls, larger ones not quite round. | (1) Strontium or lithium. (2) Carbon dioxide. (3) Strontium, the borate of which must have a higher sp. gr. than that of calcium. |
| II. Fragment in E.P. (1) Beautiful orange-red mantle completely enveloping the blue pyrocone. | (1) Strontium. |

What mineral is this?

Box No. 19.—Pale-green (some fragments violet) transparent, amorphous, but with apparently a cubic angle on one side—hardish.

| | |
|---|---|
| I. Powder in B acid. (1) Slight red-orange p.c. from bottom. (2) Great effervescence, with slight choking smell. (3) Transparent balls, larger ones quite round, giving off no opalescent matter under continued treatment. | (1) Probably lime. (2) Chlorine or fluorine. (3) Lime; not baryta or strontia. |
| II. On copper wire with B acid. (1) No blue p.c. | (1) No chlorine. |
| III. Bead with fresh powder boiled in glass bulb with drop of water. (1) Neck attacked. | (1) Fluorine. |

What mineral is this?

Box No. 20. Transparent, lamelar, amorphous, but cleaves in plates: soft.

| | |
|---|---|
| I. Powder in B acid. (1) Great and long-continued effervescence, green p.c.; unchanged; no smell. (2) Transparent balls, larger ones quite round. (3) Clear, hot. (4) Balls colourless when cold. | (1) Sulphuric acid (confirm according to note (*b*) "E. M.," p. 390. (2) Lime. (3) No magnesia. (4) No iron. |

What mineral is this?

Box No. 21.—Pale (apple) green, translucent, compact, amorphous; soft (penknife leaves considerable powder on surface).

| | |
|---|---|
| I. Powder in B acid. (1) Considerable, slow (not lively) effervescence, increasing with increased heat. (2) Only white opaque fragments after long treatment, but evolving streaks of opalescent matter, which render the whole bead opaline after a time. | (1) Sulphuric or phosphoric acid. (2) Probably a phosphate, as sulphates never afford these "streaks," but only generally diffused, grey, opalescent matter. |
| II. Powder fused with $K_2O$, boiled, dried, and treated in B acid. (1) Whole powder white opaque balls. | (1) Calcium (probably) phosphate (magnesium borate is similar, but balls clarified by long treatment). |
| III. Dissolved these by cautious addition of $K_2O$, and added potassium pyrotungstate (*g*) in excess, under H. P. (*h*). (1) A turquoise blue opaque bead. | (1) Phosphoric acid in large proportion; because part must have been previously removed by fusion with alkali. |
| IV. (*i*) Powder of mineral on the copper-wire B acid bead. (*j*) (1) A brilliant but momentary cerulean, or light blue colour. | (1) Chlorine as copper chloride, which has a blue p.c. |
| V. Powder of mineral with crystal of P acid, and drop of water heated in glass bulb. (1) No dulling of the polished neck of bulb. | (1) No fluorine. |

What mineral is this?

*Notes.*—*a.* This reaction constitutes another valuable distinction between carbonates and sulphates; bubbles disengaged from the latter lasting, in every case, at least double as long as those from the former: no carbonates of the alkaline-earth metals refuse, as far as I know, to speedily separate into balls and bubbles under this treatment, like the sulphates of barium and strontium.

*b.* This indicates that the *specific gravity* of the metal forming the carbonate is greater than that of those which form perfect larger sphericles; as, *e.g.*, calcium, magnesium, &c. These balls being produced through the law of the cohesion of fluids, larger ones of high sp. gr. are not round on account of the attraction of gravitation overcoming that of cohesion: just as the larger drops of mercury, scattered on a table, are not round, while the small ones are.

*c. Vide* ENGLISH MECHANIC, page 478, note (*b*).

*d.* It may be asked here, Is not this effervescence due to $SO_2$, not $SO_3$, as the latter is not known (practically, until here produced) in the form of gas? To this I reply it is certainly not $SO_2$, which has a pungent smell, whereas this is odourless.

*e.* This is the chemical formula for potash, used for brevity's sake, as before explained, for the ordinary potassium carbonate; as, of course, potash only is added to a bead B.B. the $CO_2$ being volatilised. I nearly filled my bottle with a pennyworth obtained from a druggist here. It is tested (1) by boiling in distilled water, when it ought to leave no residue, (2) by giving a violet p.c. *per se* B.B., (3) by not in the least altering the green p.c. of B acid B.B. (no soda.)

*f.* A "Mineralogist" (who, I must admit, has made pretty fair guesses at these minerals hitherto) states, "E. M.," page 498, that he found strontium sulphate to afford precisely the same reactions in E acid as barite; but if he will be so good as to analyse the former carefully over again, I think he will find the differences recorded here between Nos. 14 and 17.

*g.* See note *a*, "E. M.," page 431.

*h.* See note *e*, "E. M.," page 478.

*i.* This operation is induced by the *mineralogical* knowledge that this mineral, here proved to be a phosphate of calcium, generally contains chlorine or fluorine.

*j. One* bead ready for use may be kept months for this purpose on a roll of ordinary copper wire, provided the bead be previously tested B.B. to see that it contains no chlorine, which is rapidly thus driven off on account of its extreme volatility.

W. A. Ross.

## WHAT IS CREATION?

[24662.]—In letter 24590 a "Fellow of the R.A.S.," replying to "H. B. F.," *re* What is Creation, puts the whole matter in a nutshell most beautifully. Darwin's explanations and theories, founded upon the work of a lifetime, showing evolution, adaptation, natural and sexual selection, &c., all working together to bring about changes in existing matter, are met by his opponents simply with crude assertions—viz., such phenomenon cannot be explained, say, by natural selection—ergo, this, at all events, must be ascribed to "creation."

If a simple man demands to have an explanation of what "creation" signifies, why, either he is snubbed as an unbeliever, or ignored as a man not worthy a reply. Of course, the idea of creation *ab initio*—something out of nothing—is at present largely abandoned; but the logical consequence quietly ignored—viz., that if all phenomena are only the change of matter in one state into another, i.e., a simple transformation, "evolution" is at once seen to be the proper name for such a process. Of course, to postulate for "creation" and consequent "Creator" sounds grander; but, to my mind, it simply substitutes a greater mystery for a smaller one.

F. W. H.

## LANTERN SLIDES.

[24663.]—I WISH to ask the readers of the ENGLISH MECHANIC their opinion as to the desirability or otherwise of having slides for the lantern uniform in size.

In the first place, it is practically imperative that they should all be of one height—3¼in.—as otherwise they would not pass through the carrier.

Still, even then there is a difference of practice as to length or width, which is 3¼in. for the ordinary photographic slide, something under 4in. for the Benet photographic slide, and 4¼in., which is the usual quarter-plate in photography. These three sizes exist commercially, but they are all 3¼in. in height, and therefore will pass through the carriers with more or less difficulty with respect to registration on the screen.

It is no use discussing the question of uniformity of length or width, for these slides exist in such quantities that they must be dealt with as best the exhibitor can. Whatever the size of the glass, the pictures are all approximately the same size, somewhere about 3in. in diameter. It is more particularly to uniformity of this measurement that I would draw attention and invite discussion.

My plea is that, so long as the picture is fully lit all over by the condensers, and that the glasses do not exceed 3¼in. in height, the size and shape of the mask should be discretionary. I protest most strongly against the practice of masking all sorts of slides with uniform masks for the sake of uniformity of shape on the screen. This makes them lantern slides, but it prevents them from being lantern pictures.

I have long determined myself to compose my pictures for the lantern, but have found it quite impossible to adhere to either the 3in. circle or 3in. cushion shape without, in many cases, spoiling the picture.

I have also a unique collection of negatives of the Congo river and Central Africa sent me for publication as lantern slides. These are pictures carefully composed, and in many cases will not admit of the slightest curtailment of length so as to bring them in the uniform category of lantern slides. I could not attempt to do this even if I would, for though some might have a vast extent of sky printed in to fill up the frame, in others this treatment would be impracticable. They will have to be printed oblong, and must be shown so or not at all. I anticipate objections on the score of difficulty of register in dissolving with two lanterns. This I would venture to dispose of by saying that most people are heartily tired of dissolving views. I think, too, that this objection might be met in another way—by so arranging the dissolving apparatus that the picture fades away into darkness before the other one commences to appear. This, I should be glad to learn, may have already been done; certainly it is a most agreeable way of changing pictures on the screen. The same principle is found in Edwards' patent dissolver, which works with a single lantern, the first picture fading away into darkness, from which the new picture instantly appears. The form of dissolver most suitable is that known as the cat's eye; two angular apertures, hexagonal the best, the apices being an angle of 90° and the lateral angles 135° each. As the apertures pass over other each other the picture gradually fades, but more from the edges. This is a great advantage, for the spectator has completely forgotten, not only the shape of the picture just shown, but its position on the screen. Moreover, although with Edwards' dissolver there is a slight interval of darkness, during which the slide is changed, the rest to the spectator's eye is so complete that not only is the darkness not perceived, but he is also quite unable to detect an error of registration of even 6in. on the screen; while circular, square, oval, or oblong pictures can be shown indiscriminately without the slightest inconvenience or fatigue to the eyes of the spectators.

I assume that 4in. condensers are used; they are the standard size, and any lantern having smaller ones is but a toy. This being allowed, the screen being of such a size that it will take the whole of the disc lighted by the condenser, then I contend that the picture might with advantage be made of any size which would fall within such a circle.

One word more as to light: There is no greater mistake than to suppose that a denser slide is required for limelight than for oil light. A slide of proper density will be equally effective with either light, no matter what the size of the disc. Let me be clearly understood: a slide which is at its best when shown by an oil lantern on a 6ft. disc will be equally effective when shown by the most powerful limelight, whether on a 6ft. disc or 20. Any slide which will not bear that test is inferior and comparatively worthless. **George Smith.**

26, Colebrooke-row, N., 11th Aug.

### VENTILATION OF COAL-MINES.

[24664.]—Perhaps Col. Shakespeare will kindly give his views on the following points in connection with the opinions he has from time to time expressed on the above subject:—

(1) In what way does he suppose that the liberation of 50,000 cubic feet, say, per minute of compressed air expanding in volume to 200,000 cubic feet on liberation, would have the advantage of the same volume of air per minute being drawn through the workings of a colliery by means of a fan or furnace?

(2) The estimated horse-power that would be required to compress the above quantity of air, the approximate cost of the necessary plant, including the few miles of pipes to convey the air throughout the ramifications of the working, and the additional cost per ton of coal wrought which such a system of ventilation would entail.

The proper and adequate ventilation of our coal mines is a matter of paramount importance, and I, and doubtless many others of your readers, will look forward with much interest to Col. Shakespeare's reply to the above questions. **Lyons.**

August 11th.

## REPLIES TO QUERIES.

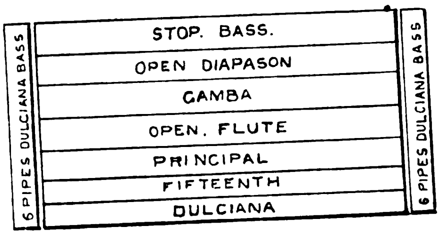
*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[56273.]—**Chemical Action in Leclanche.**—The zinc combines with the chlorine of the ammonium chloride, turning out the compound radical ammonium, and forming zinc chloride. The Am is transferred in the usual way till it gets to the $MnO_2$, here it decomposes into ammonia gas which dissolves in the water, and hydrogen which reduces the manganese dioxide. In one equation the action may be given $Zn + 2AmCl + 2MnO_2 = ZnCl_2 + 2NH_3 + H_2O + Mn_2O_3$.—Wm John Grey, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[56518.]—**Organ Building.**—To "Anxious."—Having recently built myself a small organ (five stops on manual, and full octave pedal bourdon), I have pleasure in offering reply to the questions as far as I can, though I should have preferred seeing a reply from some reader of wider experience. For a five-stop organ I would recommend three 8ft., one 4ft., and one 2ft. stop; and add another 8ft., to make six. (This means one more draw knob in either of the above, because of the stopt diap. bass on a separate slider, and an additional draw-knob, if the dulciana bass is placed separately.) If a *coupler* is intended, the soundboard must be 6in. longer if you carry out your intention regarding the 8ft. and 4ft. stops, so as to allow the extra 12 channels for the upper octave; but having a 2ft. stop specified on the manual, I should only make the coupler for the 42 notes—Tenor C upwards. The specification I suggest is thus:—

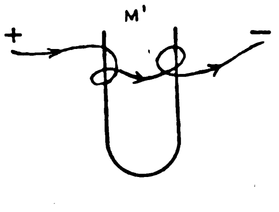
| | | | |
|---|---|---|---|
| Open Diapason | Metal 8ft. | C. 42 | pipes |
| Stop Diap. Bass | Wood 8ft. tone | CC. 12 | ,, |
| Stop Flute | Wood 8ft. tone | C. 42 | ,, |
| Dulciana | Wood and Metal 8ft. | CC. 54 | ,, |
| Gamba | Metal 8ft. | C. 42 | ,, |
| Principal | Metal 4ft. | CC. 54 | ,, |
| Fifteenth | Metal 2ft. | CC. 54 | ,, |

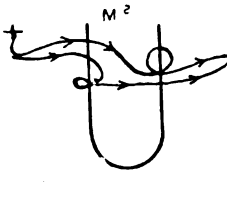
To reduce it, omit gamba. In your query, the dulciana is erroneously called a 4ft. stop. It is an 8ft. stop. If you wish to carry it through, make the bass of wood, stopped; scale, ¾in. by 2¾in. for CC. These you can place six at each end, using tubing to convey wind to them as well as to the treble pipes in the front. Plant the stop. diap. bass in a row on the soundboard at the back. Two at each end will stand on their own wind; the remainder to have grooves and tubing to supply them. I should say that with this arrangement it will be necessary to get a rollerboard action for six bass pipes, commencing with CC sharp, and then the remainder alternately; so that you will have six bass pipes each of the stop diapason, dulciana, principal, and fifteenth on the treble end of soundboard. The front dulciana pipes may be cut at the back for the purpose you name. If the organ is for a small building, I suggest the following scales:—Open diap. 2⅝in.; gamba, 2¼in.; and dulciana, 2in. at Tenor C. Principal, 2¼in.; and fifteenth, 1¼in. at CC. Pressure of wind better be 2½in. for the pipes to speak well. I should prefer feeders hinged on the front of bellows-board, so as to have pedal and hand-blower actions working at the back. You may get the feeders to work steadily by fixing a support at the back for a lever centred on a pin, with wood rods connecting to feeders. Make a socket at one end of the lever to take a movable handle for side-blower. Make the pedal-blowers like those of a harmonium, with wheels under feeders. To keep down the height of the organ, let the pipe feet of the six longest stopt diap. and dulciana bass project only an inch out of the block, and support the pipes by a wooden cleat screwed on the back to slip on a cleat-hook on a wood rail fixed as necessity may require. As an improvement, I would suggest, if you wish to have the dulciana as a "speaking front," that all the other stops be inclosed in a general swell, having Venetian shutters in front worked by a knee-swell lever. Let the bellows and feeders be, if anything, more than ample to supply full organ; possibly you may some time wish to add a pedal Bourdon. Do not count time devoted to securing correct measurement as time lost; it will prove ultimately time saved. Herewith I give rough sketch of the



arrangement of the sliders. I ought to say that I am supposing the key action to be by stickers, with back falls in a fan frame.—A. Evans, Bank, Llandudno.

[56649.]—**Extra Currents (U.Q.), and Testing by Received Currents.**—This query seemingly has escaped "Sigma's" notice, and having fallen into the U.Q. column, I beg to offer a few remarks to telegraphists. *Extra Currents.*—We will dispense with the automatic receiver, with its rather complicated double-wound multiple arc arrangement, and take an ordinary electro-magnet M, for what is true for one is true for the other. I inclose a rough sketch. We will suppose that





the battery current has just been broken, then the extra current travels in the direction of the arrows M¹. The arrows are not intended to show the battery current, but simply the extra current when the battery has been broken. Again, in the multiple arc arrangement the battery current is supposed to be just broken. The extra current travels in each wire in the direction shown M², when they meet at the point P, their forces being equal and opposite must of necessity destroy each other. I hope the rough sketch and poor description will be acceptable. *Testing by Received Currents.*—The current from the distant station is sent through 10000 + 10000, so that the variable resistances (battery and leakage) may be neglected. The higher the tangent the greater the insulation of the line. I suspect that the table contains a column of tangents opposite to which are the equivalent insulation R's, so that the c.c. can see at a glance what tangent 20, for instance, represents in insulation R. I don't know if I have gone sufficiently far into the subject to meet your requirements; but if not, write again and I will endeavour to give you satisfaction.—Experimenter.

[56768.]—**Ancient Lights (U.Q.)**—The following is from "A Guide to the Law, by a Barrister": —The owner of property is entitled to as much light and air only as fall perpendicularly on his land. A man is liable at any time within twenty years to have any new windows obstructed by his neighbour building against them. Neither a landlord nor a tenant can obstruct or darken windows existing at the time of the demise without each other's consent. If ancient lights are altered or enlarged or new ones are added, they may be wholly obstructed, and a man is justified when in obstructing new lights he unavoidably obstructs the ancient ones as well. From this it would seem that if the windows "X. Y. Z." wishes to build against have been in existence for twenty years he had better not obstruct them unless he can prove they have been enlarged within that period.—Zinci Sulphas.

[56790.]—**Limited Liability Company (U.Q.)**—There have been many vague questions asked in the query columns of the "E.M.," but "Klinkerfues" may fairly claim to have made the highest possible score with this query as to the "general duties of the managing director of a limited liability company."—Wm. John Grey, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[56888.]—**Bicycle Turning.**—I do not think that "Essar" quite understands me. In turning a corner the small wheel does not follow the large one—I mean on the same track. As soon as the handle is turned, the vertical planes of the large wheel, and of the backbone and small wheel, are at an angle, the small wheel describing a smaller arc. The touching the ground only in points is good in theory; in practice, owing to the weight, the elasticity of the tyres, and the uneven surfaces of the roads, the contact might be of ¼in. or ½in. I maintain, therefore, that the hind wheel must "drag" to a certain extent. Yet if "Essar" stands on a grass lawn, and locks the handle of his bicycle as far as it will go, and walks it round, he will find that the large wheel track forms a perfect circle, and the small wheel forms one also about 6in. within it, perfectly true to the same centre, without any signs of a drag.—J. R. T.

[56923.]—**Bleaching Shellac.**—While thanking "Nun. Dor." for his reply to my query as above, I should like to say I have tried several times to bleach shellac by a process given to me by a friend. Each time I have failed, and have not now that friend to set me right (he being dead), hence the query to the "E. M." The process is similar to that referred to in 991 of "E. M.," and is as follows: Dissolve 14lb. shellac in about 12 gallons boiling water containing 2lb. chloride of lime, stir well, and let stand two or three days; then add 1 pint hydrochloric acid, strain through flannel, keeping stream of hot water running on it all the time; when well washed, take shellac out and pull on a hook until white and silvery, occasionally placing it in hot water to assist the operation. As I have said, I have tried this process several times and failed. After reading the process referred to in 991, it occurred to me that perhaps the success of the whole thing lay in "cementing the air-tight cover while hot." I have not the least idea what "any ordinary luting" means. Should it be putty, or something of that kind, perhaps "Nun. Dor." will set me right on this and other points in my query, or kindly set me right altogether by giving a process with which I may be more successful. I require it for making sealing-wax (the brightest colours), and should require it solid.—J. L.

[56948.]—**Gas-Producing Apparatus.**—The statement as to risk of explosion refers to the benzoline generator made by me. The safety-box contains twelve layers of thick copper gauze, soldered tight at the margins. I have been unable to produce any explosion which will pass through four thicknesses of copper gauze, and I believe the apparatus to be absolutely safe, with a very large and unnecessary margin of safety under any possible conditions. I will sit on any of my generators whilst "Invicta" or anyone else does his best to explode it.—Thos Fletcher.

[56950.]—**Lead Burning.**—It is quite certain to us that Mr. Davies does not understand the merits of, as he sarcastically terms, our "wonderful machine." We have never pretended to say that the flame given is superior to that given by the machine made with spelter and acid. All we wish to claim its superiority over the old method for is that it is easy to carry about, and can be used anywhere "with safety," and that it is always ready for use. Mr. D. has certainly obtained an insight into the mode of working the apparatus, but it is certain he does not fully understand it. Surely, we would have adapted the water-bellows he speaks of if it had been any benefit to our apparatus, considering we used a similar one some 18 years since. This apparatus with the acid machine does very well for shop work, and is used in almost all chemical works. When we submitted our exhibit at the Inventions to the jury we were asked to show the flame to them. They were perfectly satisfied that the force of the flame was sufficient to melt the solder and to "burn lead," for which we are happy to say we have been awarded a "medal." We have written to Mr. Davies, if convenient to him, to meet us at his workshop on Saturday next, when we trust we shall be able to convince him that he has been mistaken as to the merits of our apparatus.—Briggs and Co., 58, Rokeby-street, Stratford, E.

[56956.]—**Ball Bearings.**—Mr. Hosken has probably failed to see the questions I put to him on p. 481. Will you allow me to add another? which is, whether he ever calculated what a bicycle, with bearings two and a half diameters of the axle would be like? Mr. Hosken betrays more than he thinks when he asks why "railway engineers don't apply ball bearings to railway carriages"? Let me have another question, and ask him Why they should? They know their business, and so do bicycle-makers. As an "engineer," Mr. Hosken advises plain bearings made "broad enough, with the patent needle lubricator." What is the "patent" needle lubricator? The patent ran out years ago, and nobody but Mr. Hosken would advise a needle lubricator for a bicycle or a cycle of any sort. However, I am still waiting for the name of one "first-rate rider" who is opposed to ball bearings. —Essar.

[56956.]—**Ball Bearings.**—As none of your correspondents seem to know why ball bearings are so satisfactory on cycles, and yet not applicable to other vehicles, I will endeavour to explain, the two wheels of a bicycle serving as an example. In the large wheel, the axle revolves and imparts a rotary motion to the balls, slower or about the same rate that it revolves itself; in the small wheel, on the contrary, the balls are carried round the axle by the hubs, and do not rotate on their own axis, the same taking place with ordinary vehicles that have a fixed axle, the consequence being that where there is much weight the axle gets cut to destruction, the balls acting as so many knives; and most bicycle riders must have noticed that the big wheel runs much smoother and quieter than the small one. I think Mr. Hosken said in a former letter that the balls grate and grind one another away. They would if packed in close together, as they used to be when first introduced; but now they leave a space of about half a ball in each row, and some makers keep the balls apart by means of a perforated brass cage.—G. Townshend.

[56957.]—**Ball Bearings.**—I have ridden bicycles with broad plain bearings made with the greatest care. They run nearly as easily as ball bearings when clean; but they require adjusting often, and they grind away. In my experience good ball bearings in a bicycle will wear as many years as good plain, broad bearings will wear months. If Chas. Hosken will consider the size of ball bearings used to carry a rider of 160lb. weight, and calculate the size required to carry a crank-shaft and fly-wheel of, say, 10 tons, he will know one reason why plain bearings are used for machinery. If he will consider the action of grit on the two classes of bearings he will understand the other reason—i.e., that ball bearings will run when full of grit, and plain bearings will not. Ball bearings grind the grit, whereas the grit grinds the plain bearings.—T. F.

[56997.]—**Hydropathy.**—As "Quixote" has not received any direct answer to his query, I will try to supply him. In the first place, the cold-water cure is a thing of the past, and should not be recommended as a first step in the cure of any complaint; such a course of mild treatment that will bring about the cure, and then your cold-water tonic, &c., if you like. The cold-water cure originated with Priessnitz, Germany, who performed some wonderful cures in some cases, but with some he made sad mistakes by not using a milder treatment. Dr. Wilson introduced it into England, but in a modified form, and it has now become a curative art. Should "Quixote" decide to go to an establishment, I would say by all means go; but I may tell him it is expensive—two to three guineas a week for able treatment, and a week or two's stay would really do but little for him. It just amounts to this, temporary relief; but, according to my experience, from four to six weeks to effect a cure. I was under treatment at Smedley's, Matlock Bank, several months, and was a careful observer during that time. I have practised it as home treatment over twenty years, and although I had taken gallons of medicine before then, I can promise you I have taken very little since. I beg to refer "Quixote" to some remarks in "E. M." of January and February last, and if, according to my experience, I can give him any useful information, he is welcome to it, or any other reader. Of course this would take more space than could be reasonably asked for here, as I should require more particulars from him; after that I would give him, out of a list of some two hundred, a course of baths suited to his complaint. This can only be done upon receiving careful particulars, and if he has a will he may practise hydropathy at home very successfully, and I would willingly supply him from time to time with any information he may require. He will now see that he has begun the wrong way about, and if he choose to advertise his address I will put him right. But let it be borne in mind that anything I say is intended only for such that are partially or wholly without any knowledge of hydropathy. I have at length completed my improved H.A. bath, which I have made mention of in these pages some months back. It is a complete success, and will willingly give description of it in "Ours" if requested to do so.—A Hinckley Man.

[56998.]—**Vibration from Steam Hammers.**—Stand the legs of the bedsteads on thick blocks of vulcanised rubber—bits of old valves will do. That is about the only thing: it will reduce the vibration, but not eliminate it, because the whole ground shakes in the neighbourhood of steam hammers.—Nun. Dor.

[57002.]—**Voltaic Cell.**—This querist will find what he wants by searching back numbers, and on page 482 "Sigma" explains the rationale. The querist, however, will act wisely by using the Léclanché cell for his electric bells.—Nun. Dor.

[57004.]—**Grinding Machine for Polishing Sheet Iron and Steel.**—"Tool Maker" ought to find no difficulty in buying emery wheels, and he can soon settle for himself what speed they ought to run at for polishing. I never knew there was any definite speed, but I suppose the quicker the thing goes the sooner the work is done.—Essar.

[57007.]—**Fishing-rod Joints.**—The best composition is no doubt marine glue, but probably Prout's will answer. The best varnish is stoved copal.—Essar.

[57016.]—**Am-meter and Volt-meter.**—This querist can find what he requires by looking up his back numbers.—Nun. Dor.

[57028.]—**Stamping in Relief.**—"Inquirer," for information on above, feels under deep obligations to "Os" for his very kind and lucid explanation, and, if not troubling him too much, "Os" would still further kindly reply to two or three queries. "Stamper" feels quite sure he could master the process, and gain considerable advantage over his future supplies, and feeling thereby deeply indebted to "Os" and the Editor for their great kindness. How is the lacquer for the tickets made? Does "just hot enough to hold" mean to be held by the hand, or to hold the lacquer? Would the same press be likely to do for the tickets and for stationery, with a different die?—No Sig.

[57049.]—**Gramme Dynamo.**—To Mr Bottone.—In consideration of the peculiar shape of the fields, which necessitates the ring being flatter than usual, the ring would be better if made of such a diameter as just to revolve between the pole pieces without touching them. The pole pieces may approach to within 2in. of each other, and take the form of a letter C, thinning off somewhat where they are nearest to one another. Greatly enhanced effects would be obtained if the pole pieces were deeply channelled, and the ring made in section like a letter ⋒, the rounded part running in the channel. At least 12 sections should be laid on the ring, the substance of which should be about ½in., except at the cogs, where it should be about ⅜in. thick.—S. Bottone.

[57055.]—**Electric Bells in Series.**—I am experimenting in this direction, and if I succeed in making my bells ring properly (I believe I shall do it) I will send in an account of my plan.—Zinci Sulphas.

[57072.]—**Siemens Alteneck Armature.**—Will Mr. S. Bottone kindly explain the principle how the winding of the wire on the above-named affects or magnetises the core, and also the reason that the ends of the wire are so curiously joined to the commutator? I have traced them out in your sketch—viz.: 1 + 1′ to E + F, 3 + 3′ to B + C, 5 + 5′ to C + D, 7 + 7′ to D + E, 8′ + 8 to H + A; then 2 + 2′ 4 + 4′ seem to be joined quite on a different principle, unless there is some error in the sketch. Would this gentleman please give the full particulars how to make an armature of this description?—A Very Old Subscriber.

[57122.]—**Problem.**—I am sorry to see that in my reply to this last week I have altered the lettering of the diagram, not observing that, to save space, it had been turned on its side. Instead, therefore, of $\angle CAB = \angle CEF = x$, I should have written $\angle ACB = \angle AED = x$, and for B C, the height on the wall, I should have written A B. The result remains unaffected.—W. A. S.

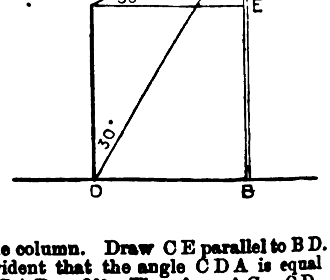
[57124.]—**Lifting Bar.**—Work in dynamics (or kinetics in the new nomenclature) being the effect of the action of a continued force with (or having) a continued motion and being measured by the product of the force and the space through which the force moves, it is true that when the bar is simply supported in a horizontal position by the hand at one end of it (or at any other point) without motion, no work is being done. It is also true that muscular force can be altogether exhausted without motion, and therefore without doing work. A man simply supporting a weight on his back without motion is not doing work according to the above-received definition of work. Without motion both the above cases belong to statics, for in both cases the muscular force employed only resists motion; but in the original case it produces motion in lifting the bar four feet and resists motion round the centre of the hand, and the case belongs partly to kinetics and partly to statics.—J. S. C.

[57128.]—**Storage Battery.**—I fancy from what "Werdna" says in the last issue, he is thinking of an accumulator of the Planté type when he mentions a lead plate coiled up into a spiral. If he wishes to make one of that kind, the best way is to take one sheet of lead and lay it out flat, and then place thin bars of wood across the 4in. way at short distances apart, and then place the other on the top and roll them up together, taking care that they do not touch anywhere. A strip of lead should be left projecting at the end of each plate for connection, and two sticks of wood should be laid across the bottom of the jar, or some similar device adopted, to prevent the lead plates touching the bottom, as, if they do touch, any deposit on the bottom may short-circuit the cell. The plates had, I think, better be made as long as possible, being one-third of an inch apart. Before formation is begun they should be placed in a solution of nitric acid; equal parts of acid and water. I do not know so much of the Planté as of the Faure type; but I think five or six cells of the above form would answer the purpose. These take longer to form and to get into working order than the Faure. The lead must be about one twenty-fifth of an inch thick. Read what Sprague says about these in his "Electricity."—Bunsen.

[57129.]—**Steam-Engine for Farm Work.**—I could not tell you how much power is absorbed by the gearing and shafting, but I think it must be small. The size of engine you mention is larger than I expected, and, I am afraid, beyond my powers to fit up with present tools. Supposing only one of the machines was driven at once, the engine could be smaller. The churn could be driven direct from the engine, causing less friction, and only one large pulley would be required to bring up the speed of the thresher. Scotch coals are 11s. per ton, *ex* ship. English slack 8s. per ton, both exclusive of carting. Would the new motor you speak of be powerful enough for my work? I suppose it is patented; then how could I make one for myself? Would it not cost more than an engine and boiler? I have no doubt it would be very handy, and from what you say it would do well for driving my workshop appliances. Do you refer to helping me with this motor, or a steam-engine. I am greatly obliged for the trouble you have taken, and shall be glad of any more help you can give me. —Young Farmer.

[57142.]—**Planing Machines.**—The only machines which will work by treadle are those sold by Selig, Sonnenthal and Co. These machines appear to be the same as those patented in this country by M. Haas. They have two pinions, one for the cutting, and the other for the return motion. The pinions are thrown in and out of gear by means of compound or double clutches, which are alternately in gear by means of a spring; the rack is made to slip about 1in. to avoid a jolt. The planer being patented, W. Bundy cannot make it; but if a screw-driven machine will do, I can give you designs of my own, which, as far as I know, are not patented. Advertise address if you want them.—F. Shakespear, Dresden.

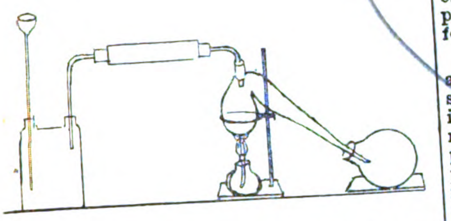
[57164.]—**Trigonometrical.**—In the accompanying diagram let A B represent the tower, and C D the column. Draw C E parallel to B D. Then it is evident that the angle C D A is equal to the angle C A D = 30°. Therefore, A C = C D. Now, in the right-angled triangle A C E, since C A E = 60° and ∴ A C E = 30°, therefore A C = 2 A E = C D = B E, and hence C D = $\frac{2}{3}$ A B = $\frac{2}{3}$ × 108 = 72ft., the height required.—J. E. Gore.



[57159.]—**Watch Query.**—The cause of your watch gaining may not be the spring, but the escapement, which is too shallow. If this is all right, the spring is three or four sizes too strong, and must be changed. To find the diameter of the spring, you must place it on the plate so that the centre of the spring is over the staff-hole, and notice where it would enter the hole in the stud. Now place the spring over the staff, and put a small piece of cork or wax on the pivot to keep the spring down. Take hold of the spring with the tweezers about where it has to be pinned in, and raise the balance. A slight movement of the hand will cause the balance to vibrate up and down. If the watch has an 18,000 train, the balance should make five vibrations in a second, or if a 16,200 train, four and a half. If this does not suit you, write again.—C. A. W.

[57166.]—**Model Well.**—Probably the bend of the siphon pipe goes through a water-tight hole in the side of the cistern, so that when the water rises above the hole the siphon bend is completely filled, and the water is siphoned off to the level of the bottom of the siphon pipe within the cistern, and this takes place again when the cistern is again filled by the smaller supply pipe.—W. Scudamore.

[57170.] — **Pure Phosphorus.**—To Mr. Bottone.—All that is required is a Wolf's bottle, in which are placed the necessaries for the



generation of carbon dioxide (chalk and hydrochloric acid). The escaping gas is led through a chloride of calcium tube to dry it. From thence it passes into the retort, wherein is placed the phosphorus which is to be redistilled. Heat is applied to the retort, when the phosphorus volatilises and is collected in the receiver under water.—S. Bottone.

[57173.]—**Easing Force Pump.**—I suppose your force pump is a lift and force of the usual make. Now, the question here is the tremendously hard work expended in forcing or lifting the water; if in forcing, an air-vessel will certainly improve it. *But I think* it is a case similar to what I experienced about 12 months ago. I made up and put down two pumps 2¼in. bore to lift water 25ft., and force it the same height, and I assure you it was very hard work indeed to lift the water, but not so to force it. So I made an alteration in the pumps, with the most astounding results—namely, that of the pumps lifting their own water and handle automatically, and only require forcing. The smallest child can work them with ease.—Pump Patent.

[57177.]—**Soldering.**—If you will kindly look over the first and second articles on "Electrical Instrument Making for Amateurs," now appearing in this paper, you will find full instructions under the heading "Soldering."—S. Bottone.

[57180.]—**Winding Laminated Armature.**—To Mr. Bottone.—The projecting shaft throws the wire on each side of itself (i.e. the shaft). But this is easily remedied by turning up the two first,

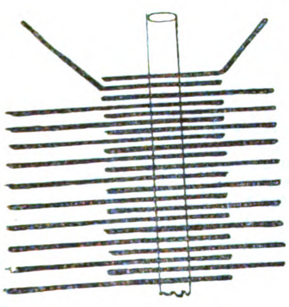


FIG. 1.

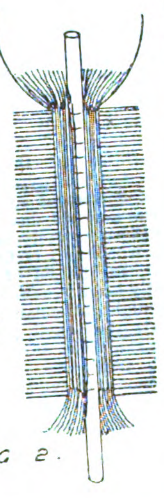


FIG 2.

and two last laminated, as shown at Fig. 1, so that they act as supports to the displaced wire, as seen at Fig. 2.—S. Bottone.

[57181.]—**Heating Greenhouse.**—"Thermo" would no doubt succeed with a slow combustion stove; but great attention would, I imagine, be necessary, as, without an evaporating pan for water, the air of the house would become far too dry for the plants. Dust and smoke are also inseparable nuisances. "Thermo" would find one of the cheap stoves with a "coil" boiler answer well if he has an outhouse or protection for the stove; or one of the "Loughborough" pattern (in which the boiler is built into the wall of the greenhouse, so that most of the heat is utilised, while it can be stoked from the outside) would be found very serviceable, and would, I think, satisfy 'Thermo" in every way.—J. T. Strange.

[57189.]—**Income Tax.**—"Os" is wrong; the tax is not levied on individuals, but on the firm or partnership. I, as a member of a firm, pay no Income-tax; this is paid on the whole profits of the business, and not by the individual partners. In the same way the Income-tax is paid on the whole dividend of a company, and deducted from each shareholder's dividend.—T. F.

[57193.]—**Balance Staff.**—A thorough reply to your queries would occupy more space than our Editor might care to allow; but I can refer you to a recent work invaluable to watchmakers wishing to learn—viz., "Britten's Watch and Clockmaker's Handbook, Dictionary, and Guide," 5s., to be had of all material dealers. The turns, turning, pivoting cylinder, and balance staff, &c., will be found admirably described in this book.—L. T. P.

[57193.]—**Balance Staff.**—You must first make a number of small holes in your runners to hold the staff, &c.; these can be made with a small chamfering tool. It is better to file part of the left-hand runner away, so that it comes to something like a point, and make the hole at the end of this. To put in a staff, first get some from the dealer in the rough; they are very cheap, and it saves a lot of trouble and time. Put a screw ferrule on one end and place it in the turns; fit the points of the staff into the holes in the runners. First turn down a shoulder on the brass to fit in the balance, and then reduce the remainder of the brass to fit in the collet. Turn the steel until the roller will go nearly up to the brass, and then polish it. Now shorten it until it is nearly the right length, which you can ascertain by placing the balance on the shoulder which you turned, and putting the centre of the staff on the potence slip without the jewel-hole in. When this is correct, turn the pivot down; when it is nearly small enough, place it on a brass runner and polish it with a soft steel polisher and red stuff; when it fits the hole well, round the end of the pivot, using a runner with a very thin edge in which a small hole is drilled for the pivot to come through; round it with a burnisher. Take the ferrule off and put it on the finished end, and make the top pivot the same as you did the bottom. When finished rivet the balance on: Pinions should *not* be oiled.—C. A. W.

[57197.]—**Watch Springing.**—Send the barrel to the material dealer, and order a best mainspring. State whether the spring is for a verge, duplex, lever, or horizontal watch. If you send your dimensions you will not get a suitable spring, and if you send your spring it may be the wrong strength or height for the barrel.—L. T. P.

[57197.]—**Watch Springing.**—I suppose your gauge has a number of different-sized cuts or openings in the edge. When the spring is out of the barrel, try which one of these openings it will go in. The number below this opening is the height of the spring. To find the strength, use a steel gauge, with two pieces of steel which are wider apart one end than the other. Put the spring between them at the wide end, and try how far it will go down. The numbers on the edge of the steel bars will tell you the strength.—C. A. W.

[57207.]—**Electric Lamp.**—You must test it. It may be 20 candle-power or 2. What size is it?—C. D. R.

[57207.]—**Electric Lamp.** — Get some kind friend who has a Wheatstone's bridge and coils to test the resistance for you. A five-candle lamp has a resistance of about 8 ohms, a ten-candle 20 ohms, a fifteen 37½ ohms, a twenty about 48 ohms.—S. Bottone.

[57207.]—**Electric Lamp.**—"Plumber" can only ascertain for certain the c.p. of his lamp by comparing its full light—by means of a photometer—with that of a standard sperm candle.—J. Kean, Northampton.

[57209.]—**Case-Hardened Iron.**—Place them in a crucible imbedded in powdered prussiate of potash. Wire the lid on the crucible, and give it a good cherry-red heat right through.—S. Bottone.

[57209.]—**Case-hardened Iron.**—Heat the iron studs to dull redness in the fire, roll them in a powdered mixture of equal parts of sal-ammoniac, saltpetre, and yellow prussiate of potash; wait a few minutes till the heat has had time to decompose the powder, and then plunge into a solution of 4oz. of sal-ammoniac and 2oz. of yellow prussiate of potash dissolved in a gallon of rain water.—W. Scudamore.

[57213.]—**Hydrostatics.**—As 92 parts by weight of the ice and 100 parts of water are equal in volume, and as floating bodies displace their own weight of water, it is clear that 8 per cent. of the volume of the ice will be above water. The thickness of a sheet of ice of sp. gr. 92, and which floats ½in. out of water, is found by the following proportion:—8 : 100 :: ·5 : $x$; $x$ = 6¼in.—J. T. M.

[57213.]—**Hydrostatics.**—Since sp. gr. of ice is to sp. gr. of water as 92 is to 100, therefore 92-100ths of the thickness of ice would be below, and 8-100ths above the surface of the water. Therefore, since 8-100ths of the thickness equal ½in., the thickness $= \dfrac{100 \times \frac{1}{2}\text{in.}}{8} = \frac{50}{8}\text{in.} = 6{\cdot}25\text{in.} = 6\tfrac{1}{4}\text{in.}$ Answer.—W. Scudamore.

[57213.]—**Hydrostatics.**—Let $b$ = breadth of sheet of ice, and $x$ = thickness. Then, since the weight of a floating body is equal to that of the fluid displaced, we have—

$$\begin{aligned} bx \times 0{\cdot}92 &= b(x - \tfrac{1}{2})\\ \text{or—}\qquad 0{\cdot}92x &= x - \tfrac{1}{2}\\ \therefore\text{—}\qquad 0{\cdot}08x &= \tfrac{1}{2} \text{ and } x = 6{\cdot}25\text{in., the} \end{aligned}$$

required thickness of the ice.—J. E. Gore.

[57213.]—**Hydrostatics.**—The weight of the ice and of the water displaced by it are equal. The volume (or bulk) of the ice and of the displaced water are inversely proportional to their sp. gr., and directly as their thickness and depth. Let $x$ be the thickness of the immersed part of the ice, or the depth of the displacement, then $(x + \frac{1}{2}\text{in.}) \times 92 = x \times 100$, or $92x + 46 = 100x$, or $100x - 92x = 8x = 46$, or $x = \frac{46}{8} = 5{\cdot}75$in.—J. S. C.

[57213.]—**Hydrostatics.**—Let $x$ = the thickness of ice below water, and $a$ = the sectional area of the sheet; then we have the following equation:—

$$\begin{aligned} (\tfrac{1}{2} + x)\, a \times {\cdot}92 &= x \times a\\ \therefore {\cdot}46 + x\, {\cdot}92 &= x\\ x &= 5{\cdot}7\text{in.} \end{aligned}$$

But there is ·5in. above water; therefore, the total thickness of ice is $(5{\cdot}7 + {\cdot}5) = 6{\cdot}2$in.—H. L. C.

[57214.]—**Electric Bell.**—2oz. No. 26 silk c., 1oz. on each leg, would be ample for $\frac{3}{16}$ by 1in. cores.—Zinci Sulphas.

[57214.]—**Electric Bell.**—Depends upon the distance of the push from the bell. If for ordinary use, as in a house, six turns on each bobbin will work with one No. 2 cell.—C. D. R.

[57214.]—**Electric Bell.**—Replying to "Constant Reader," I am afraid he will find his magnet too weak to do the required work, being only $\frac{3}{16}$in. diam. I use ⅜in. and $\frac{7}{16}$in. diam. cores for the same size gong. Three layers on each core of No. 26 c.c. copper wire will suffice.—J. Kean, Northampton.

[57215.]—**Experimental Pottery Furnace.**—A full description of such a one was given early last year in the *Photographic News*, under the head of "Ceramic Photographs."—S. Bottone.

[57220.]—**Batteries.**—You must be guided by the experiment you wish to perform. What are you going to use them for? Whose cells are they, and what form? Gravity cells should be used only for testing, &c. If you have procured them for any other purpose you have wasted your money.—C. D. R.

[57222.] — **Lecture Illustrations.** — 1. Yes. 2. A good three-wick paraffin lantern, on the Sciopticon principle, with 4in. condensers. 3. Yes; admirably.—S. Bottone.

[57223.]—**Chemical Action in Battery.**—In a battery of zinc and carbon with chloride of ammonia, the chemical action is as follows:—The zinc unites with the Cl of the ammonium chloride and sets free hydrogen and ammonia. This latter at first dissolves, but is afterwards given off as a gas, thus:

$$Zn + 2ClNH_4 = ZnCl_2 + {}_2NH_3 + H_2.$$

In a battery of zinc in a solution of ammonic-chloride ($NH_4Cl$), and a carbon rod in a porous cell, packed with oxide of manganese, the chemical action is somewhat different. Chloride of zinc is formed by the action of the Zn on the $NH_4Cl$, the separated ammonium immediately decomposes into hydrogen and ammonia, the latter of which at first dissolves in the solution, but escapes as a gas when this is saturated. The hydrogen, meanwhile, after causing successive decompositions of contiguous molecules of chloride of ammonium, appears through the porous cell and finds itself at last in contact with the manganese oxide; this oxidises the hydrogen to water, being in the first instance reduced to sesquioxide, according to the equation:

$$Zn + {}_2ClNH_4 + MnO_2 = ZnCl_2 + 2NH_3 + H_2O + Mn_2O_3.$$

The ultimate condition of the manganese oxide is not known.—J. Kean, Northampton.

[57224.]—**Prevention of Noise.**—I should make a wooden tray to hold 2in. or 3in. of sawdust, and place the lathe standard on pieces of board which rested on top of said sawdust; but these pieces must not touch any part of the tray itself.—A., Liverpool.

[57224.]—**Prevention of Noise.**—Put ½in. thickness of sheet rubber under each foot of the lathe, and put a thick rubber washer under the head of each bolt or screw used to fasten the lathe down to the floor, and the nuisance will cease. I have done this with a smith's anvil on a floor over a sitting room, and used the anvil constantly without any nuisance for years.—T. F.

[57224.]—**Prevention of Noise.**—If convenient take up the boards and put sawdust under the place where lathe stands. If this is not convenient, place the lathe upon two pieces of wood, with several thicknesses of stout felt under them; screw the wood to the floor. A thick piece of old carpet under all would also help. The wood floor must be covered to prevent vibration.—F. M. Bear.

[57229.]—**Gold and the Mint.**—There are dozens of respectable silversmiths and melters in London and Birmingham to whom you can send your gold and have the full value returned without any risk. Have you no local man?—C. D. R.

[57230.]—**Cardew's Voltmeter.**—This voltmeter should be connected as a shunt to the circuit, and it will then measure the difference of potentials at the point where it is connected; a table of the values of the readings in volts is supplied with the instrument. A push or switch is generally used, so that the voltmeter may only be connected when the reading is taken.—Eugene Brown.

[57231.]—**A Six-footed Pig.**—Not worth keeping, but if you intend doing so you can preserve them in spirits of wine in a glass bottle hermetically sealed.—C. D. R.

[57232.]—**Heating by Steam.**—"A. D." can heat his building from his boiler quite easy with steam, but he cannot put the condensed steam back into the boiler—that is impossible; but he can put back the steam again after condensation has ceased, and it will work away without attention with from 10lb. of steam upwards. I would not advise him to put the exhaust steam through, as it would choke his engine. I fitted up a worsted mill from the boiler and it works splendidly, and is not the least troublesome; so if "A. D." gives me his address in the Address column I shall treat with him.—Busby.

[57235.]—**Thermometer.**—Yes; a well-constructed thermopile in connection with a galvanometer.—S. Bottone.

[57236.]—**Paste.**—I find that a little borax, in powder, put into the paste during the process of making it has the property of preserving it as solid and good, although it be kept in an open jam jar for over a month, as it was on the day it was made. I also sometimes, for certain purposes, mix a little glue with it after having made it, which seems to increase its sticking powers.—A., Liverpool.

[57238.]—**Vacuum Tube Rotator.**—I know of an instrument which would suit "W. P. W.," but it would be very troublesome to describe, and would take much space; but if "W. P. W." will advertise his address in this paper I will communicate with him.—Accumulator.

[57239.]—**Coil Regulator.**—This has been described several times. See No. 1,042, page 40, Reply 56033.—C. D. R.

[57239.]—**Coil Regulator.**—If "W. P. W." wants to thoroughly upset his nervous system for a few days let him take the shock from a ¼in. spark coil. He had better make a new coil entirely for shocks and leave the ¼in. spark as it is. He will find plenty of instructions in back numbers.—Zinci Sulphas.

[57240.]—**Automatic Musical Instruments**—As a sequence to my articles in this journal for August 1st, 8th, and 22nd, 1884, "On the Production of Tune Bands for Automatic Musical Instruments," some explanation has been called for of the kind of instrument for which these music bands are adapted. As a description of mechanism, taken in a scientific sense, this is proper enough. The tone of the cross-examination that "B." subjects me to is more personal than practical; still, there is no reason why I should not reply. He first asks, "Is it practically successful?" Quite so; as may be judged from the simplicity of its construction; it is a machine that will not wear, or get out of order by long use, and as by the control of quality of touch given by the striker or finger piece, and the command of expression, the performance was found to be in advance of anything that had before been done in the way of a mechanical piano player. I secured it by patent, though my original object was to construct a machine for performing on the piano for my own use only, as a slight accident to my left hand had ever prevented me from doing this. I did not exhibit at the "Inventions" because I had no desire to engage in a business of this sort, or be involved in any way before I had fully satisfied myself as to the market prospects or demand that make it worth while as a manufacturing undertaking; therefore, it did not suit my purpose to part with the only instrument that I then possessed, and also provide a piano, and an attendant to perform upon it during the brief time allotted each day (no special demonstrations being allowed by the rules), so I did not feel inclined to be at any trouble for the sake of picking up orders that could not be executed. Having now a considerable stock of music in bands, I frequently use the machine and display its performance to my friends or experts. Nor (as may be judged by my communications) do I wish to throw any difficulty in the way of constructive amateurs desirous of trying their skill in this direction; but I cannot engage to play to persons not introduced, who may desire to listen to music only out of mere curiosity. If "B." has any particular object in mind in which I can aid him, will he kindly write to me or advertise his address in these columns?—F. H. Wenham.

[57242.]—**Portland Cement.**—There is an account of this substance in Wagner's "Chemical Technology," which will, I think, suit the querist.—Wm. John Grey, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[57244.]—**Dentistry.**—I will send "Mechanic" working drawing of vulcaniser, and, if he wishes to take a course of lessons, refer him to Address column.—Dentist.

[57244.]—**Dentistry.**—As a dentist has to deal with the living subject, there can be no toleration for such a thing as an amateur dentist, and if "Mechanic" wants to go in for dentistry he had better begin by serving a regular apprenticeship.—Dens.

[57244.]—**Dentistry.**—It is not possible for anyone to become proficient in the art of dentistry unless they serve time to a good master; then it takes several years before they are able to do anything more than a repair. Dentistry is so complicated that I should advise "Mechanic" not to attempt anything of the kind. I have been at dentistry about nine years, and if "Mechanic" likes to advertise his address in the English Mechanic, I should be happy to see him.—Vincent.

[57249.]—**Electromotor Reversing.**—Beyond the strain caused by the sudden stoppage, no harm would accrue.—S. Bottone.

[57251.]—**Agglomerate Blocks.**—I should say the blocks were not as they should be? Whose make are they? There are quantities of so-called agglomerates that have not a particle of manganese in them. Use the Indiarubber Co.'s, who are the patentees, and you will have no cause to complain. Why do you not charge with sal-ammoniac? It gives much better results.—C. D. R.

[57252.]—**Free Reeds.**—(1) Professional tuners nearly always omit the octaves until the bearings are laid, tuning by fifths upwards and fourths downwards, the fifths a shade flat, the fourths by a like amount. (2) The exact speed of beat is of course regulated by the absolute pitch at which the reeds are being tuned. For C' 264 vibrations per second the beats of the fifths are as follows:—

| | | | | | |
|---|---|---|---|---|---|
| C'' | to | g' | 53·4 | beats per minute | 1 |
| C sharp | ,, | g' sharp | 57· | ,, ,, ,, | 8 |
| d' | ,, | a'' | 60 3 | ,, ,, ,, | 3 |
| E' flat | ,, | B' flat | 64·2 | ,, ,, ,, | 13 |
| E' | ,, | b' | 67·5 | ,, ,, ,, | 5 |
| F' | ,, | A'' | 71·6 | ,, ,, ,, | 11 |
| F' sharp | ,, | C'' sharp | 75·6 | ,, ,, ,, | 7 |
| G' | ,, | D' | 80 4 | ,, ,, ,, | 2 |
| A' flat | ,, | E'' flat | 85·2 | ,, ,, ,, | 9 |
| A' | ,, | E'' | 90· | ,, ,, ,, | 4 |
| B' flat | ,, | F'' | 95·4 | ,, ,, ,, | 12 |
| B' | ,, | F'' sharp | 101·4 | ,, ,, ,, | 6 |
| C | | | | | 10 |

The figures in the last column give the order in which the notes in the first column are generally tuned. This plan keeps the bearings in the middle octave. For fuller particulars see Staines and Barrett's dictionary on "Temperament," or Broadhouse's "Student's Helmholtz," or Dr. Stone's "Scientific Basis of Music." For general purposes, from one beat per second to three beats in two seconds for flat fifths is quite near enough, such a thing as perfectly equal temperament being unknown except in theory. (3) Tune reeds in the instrument on a medium pressure, and go over the bearings again carefully the next day if possible before tuning the octaves.—A. B. C.

[57252.]—**Free Reeds.**—I am pleased to learn that "Amateur Tuner" has now definitely stated what he requires to know. I should be obliged to the querist if he would kindly state if he is not the author of the queries Nos. 56400 and 56676, although the signatures at the bottom differ? I ask on behalf of our professional friend, "G. L. B.," who seems reluctant to inform "Amateur Tuner" how to make a tuning apparatus, which has now been asked for. I will, however, reply to the questions asked in the above query. 1. It is not customary to tune by "fifths" only, and all octaves should be tuned perfect, which means without the least perceptible wave. 2. The "speed" of the waves, in the various intervals of the scale, varies. The most important, and at the same time most difficult, task in the art of tuning is in making a good "equally tempered" scale. To do this well requires considerable practice and experience, and also a good ear. The querist would do well to practice pianoforte tuning as well as reed tuning. I should advise him to procure "Hamilton's Art of Tuning," or any other textbook, which will give him all the theoretical knowledge he requires. Then, with plenty of practice, he may succeed. Little can be done to assist the querist by way of writing. 3. Tune the reeds under the same pressure as that to which they will be subjected when placed in the instrument in which the reeds are intended to remain. 4. I cannot answer the last question until I know under what conditions the reeds are sounded when out of the instrument. The question is, Does the pressure of air vary under the two different circumstances in which the reeds are set in vibration? A reed may be made to sound a trifle flat under various circumstances.—G. Fryer.

[57255.]—**Storage Battery.**—The size accumulator you purpose constructing is useless except for lighting small microscopic lamps. How do you propose to charge it? Read the article on page 28, No. 1,016, Sept. 12, 1884.—C. D. R.

[57257.]—**Equatoreal Mounting.**—Replying to your inquiry in this week's "E. M.," if you are in town, and care to call on me at 47, Botolph-lane, E.C., I can give you just the information you require, the result of some months' practical experience. I can also give you, with pleasure, the top of a stand I manufactured for equatoreally mounting a 3in. refractor (now discarded in place of a 6in. reflector). The appliances are in Dulwich. This would be very useful provided you only wanted to follow stars. If you want to find them, the matter is more difficult. For this purpose I have an instrument I bought of Negretti and Zambra for £3. I should be glad to sell, and some home-made ones to give; but this is not my object in writing. Having gone over the ground myself, with no one to teach me, I think I can help you considerably, and I should be delighted to part with the rough but useful appliances to anyone to whom they would be of service.—Fred. Wright.

[57258.]—**Chemical.**—"Organic Chemist" should get the very latest edition of G. Jarmain's "Systematic Course of Qualitative Chemical Analysis," price 1s. 6d. (Longmans and Co.), in which he will find tests and reliable tabular methods for the detection and separation of the organic acids he names.—W. Scudamore.

## UNANSWERED QUERIES.

*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

Since our last, "Experimenter" has replied to 56649; "Zinci Sulphas," 56768; W. J. Grey, 56790.

| | |
|---|---|
| 56802. | Shunts, p. 332. |
| 58803. | Electrical Calculations and Measurements, 332. |
| 56821. | Grass Seed, 333. |
| 56827. | Large and Small Chilled Rolls, 333. |
| 56829. | Paraffin Lamps. To Mr. Postlethwaite, 333. |
| 56996. | Melting-Points of Gums and Resins, p. 419. |
| 57006. | Unicomb Observatory Hive, 419. |
| 57009. | High Speed, 419. |
| 57011. | Continental Railways, 419. |
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| 57017. | Electric Brake, 420. |
| 57018. | Gas Works, 420. |
| 57019. | Chemical, 420. |
| 57021. | Brush Drilling Machine, 420. |

**The Asylum "Tell-Tale."**—This "Tell-tale," devised by Dr. J. Millar, L.R.C.P. Ed., Medical Superintendent, Bethnall House Asylum, and exhibited at the Inventions, Stand 2100, consists of a clock movement so arranged that the hour axle carries a paper disc instead of the usual hand. It is inclosed loosely in a strong mahogany locked box, which may be fixed anywhere and in any position. In the lid of the box a hole is bored sufficiently large to admit of the insertion of a pencil. The night attendant in passing a station merely inserts the pencil gently as far as it will go, and gives it a twist so as to insure a mark being made on the paper disc, which has been set so that it corresponds with the time a mark is made. On inspection in the morning, when the clock requires to be wound up, a record will be found on the paper of the time of each visit. To save changing the paper oftener than once a week, three differently-coloured pencils are used—a different one each night. By this means three nights will be recorded in the outer ring of the disc. As the colours are different there is no difficulty in recognising the marks. To bring other rings into use the clock is raised by one or two of the slips of wood provided, and upon these circles two nights each may be recorded, thus completing the week, when the disc should be removed and another substituted, recording upon it the station and date. The simplicity, economy, and efficiency of the arrangement have been proved by fifteen being in regular use at the Asylum, Bethnal-green, for more than six months, without a hitch. More than 100 are now in use in various asylums in England.

# QUERIES.

[57272.]—**Dynamos for Practical Purposes.**—I wish to make a dynamo for working a Griscom's motor, a small electric mallet, and a 2½ c.p. lamp for about five hours daily. Will some of your readers kindly tell me what form of small dynamo is the best for such work, and what power I should require for such a machine? Should I require secondary batteries or not?—F. H. Briggs.

[57273.]—**Radius of Curve.**—Would some reader kindly give the method of finding the length of radius in the annexed formula for calculating the ordinates of a circular arc:—

E F = ordinate
R = radius
V = versed sine
D E = distance from centre to any ordinate

$$EF = \sqrt{(R - DE)\,(R + DE)} - (R - V).$$

The case in point is to set out the camber on an iron girder, 70ft. span, with a rise of 7½in. in centre, the ordinates every 2ft. If there is any simpler mode of finding the ordinates, and setting out the curve, the formula will oblige.—Fred. Street.

[57274.]—**Organ Pedals.**—Will any reader of the Mechanic, or amateur organ builder, kindly inform me whether there is an exact gauge for organ pedals, lately decided upon by any musical authority? I am about to construct a radiated pedal board, and will thank anyone for exact dimensions required for a set of pedals, 30 notes CCC to F?—Pedlier.

[57275.]—**King's College Dynamo.**—I should be much obliged if any student in the engineering department at K. C., or anyone connected with the same, would tell me the sizes and quantities of wire required for winding the dynamos that are made by the students there; also how the commutator gear is arranged, and its candle power? I believe there is only one size.—G. Park.

[57276.]—**Experiments in Light.**—Would any of your correspondents kindly inform me what kind of lantern would be most suitable for illustrating the experiments in light, required by the Science and Art Department? Must be cheap, portable and effective.—R. R. R.

[57277.]—**Science and Art Department.**—To Wm. J. Grey.—The question having been asked in the House of Commons "whether the standard in these examinations had been raised," and a reply given in the negative, it would be interesting to me, and probably to others, to have different views on this subject. I therefore venture to ask W. J. Grey and others, to give me their opinion on the matter, and especially on the advanced theoretical chemistry, and the elucidation of questions 11 and 12 of elementary stage.—R. R. R.

[57278.]—**Recovering Silver.**—Would Mr. Lancaster, or any other correspondent on photographic subjects, kindly tell me how to recover the silver from an old nitrate of silver bath? About how much per cent. is wasted; also if it is worth the while? How to recover it from silver print clippings; and also the platinum from the clippings of platinotype paper? I may mention that I have the use of a wind furnace capable of melting steel.—G. Park.

[57279.]—**Planing.**—I am told a lathe bed can't be planed as well by hand as by steam—why?—F. Shakespear, Dresden.

[57280.]—**Spring Bell for Till.**—Would any fellow-reader kindly inform me how I can make a small bell to ring when a drawer is pulled out, about the sound of a tram conductor's punch? The bell to be hidden in the till somewhere, out of fear of molestation, the till to be screwed on top of a cupboard. Any hints will greatly oblige.—Fogeye.

[57281.]—**Queen's Taxes.**—Can Queen's Taxes be distrained for elsewhere than on the premises? Say I leave a house at October, with the taxes unpaid, can I be followed to another part of the parish, and distraint made there ten months after leaving, or is the landlord liable? And how about other taxes under the same conditions—poor rates, &c., I mean?—Victimised One.

[57282.]—**Watch Work.**—Will "Escapement," or some kind reader, inform me what tools are used to turn and cut the pivots on watch pinions? A list of the best kind, and about their cost, will oblige a five years' subscriber.—B. L.

[57283.]—**Cold Air Machinery.**—I want to produce cold air on a small scale for cooling purposes, in place of using ice. Will any of your readers who have any knowledge of the matter kindly inform me if it is practicable to produce on a small scale, a current of air cooled to about freezing point, and if there are any makers of machines for that purpose?—Transit.

[57284.]—**Copper Coating Boiler.**—Will some reader of "Ours" kindly give me some instructions? I want to coat with copper the inside of a washhouse boiler; it has slightly rusted, and clothes boiled in it are stained, causing a lot of extra labour. Could I clean it with dilute nitric, fill up with sulphate of copper solution, and then, using larger copper anode, deposit electrically? I find generally that coppering iron is not permanent, it appears to eat away the iron, and fill the space with copper; but it soon peels off. I cannot move the boiler, as it is built in brickwork.—One in a Fix.

[57285.]—**Focus of Lens.**—I am making a reflecting galvanometer, and wish to use a flat mirror and fix the lens (in a sliding tube) to the galvanometer bobbin, but do not know of any formula for determining the focus of such a lens. If any reader could give me an equation, he would greatly oblige.—Lens.

[57286.]—**Bed Sores.**—The patient, a middle-aged man has for some weeks been greatly troubled with bed sores. Suffering from hip-joint disease, he has been compelled to lie on his back for the last twenty weeks, the pain being so acute as to prevent his being moved, other than raising him a few inches while the bed sores are being dressed. The pain is frequently so great, that at times he cannot bear the weight of a sheet upon his legs and thighs, and dressing the sores is almost out of question. Would some hospital, workhouse, or any other experienced nurse kindly advise what is the best to do to give relief in such a case? The patient is laid upon a water-bed; the sores have been dressed with white of egg, starch, Fuller's earth, Fuller's earth and glycerine, and sanitary rose powder. In the case of the powders, they have been applied dry, without anything, but principally upon French oiled silk, covered with lint, strapped on with soap plaster, and finally covered with cotton-wool. Also please to say if anything better can be used than soap plaster for strapping on the lint, &c., the excessive stickiness of this plaster causing pain, and often a sore on removal? Advice is asked only from those who have experience in such cases, as this is a most unusual and serious case.—W. S. L.

[57287.]—**Angular Aperture of Micro. Objective.**—How can I tell the angular aperture of a micro objective, and what advantage results from the use of a large angle in objectives of equal focal length?—C.

[57288.]—**Machine for Tearing Rags.**—Would some kind correspondent help me out of my difficulty? I want to construct a strong but cheap machine for tearing up woollen rags, to be used afterwards for manure. I have a small water-wheel, about six horse-power, available to work the same. If someone would describe clearly a suitable machine, and give a rough sketch, and state the power required to work the same, he would greatly oblige.—A Farmer.

[57289.]—**Electric Lighting in Mines.**—We read that the great objection to the use of the electric light in dangerous mines is the liability to sparking and the consequent explosion of the firedamp. What is meant by the sparking in this case? Does it mean the sparks which are produced when the wires are being coupled up to the lamps, or uncoupled, or does it mean the sparks which are liable to be produced by the accidental breaking of the conducting wire?—Ex-Garrison Gunner.

[57290.]—**Woolwich Exam. Question.**—In the entrance exam. paper for June, 1884, there is an arithmetical question, which neither my son, who is a R.E., nor myself, a C.E., can solve satisfactorily, so that it is worthy of the "steel" of some of the readers of the "E. M.":—

Given log. 3 = ·4771213
log. 7 = ·845098
log. 3·6593 = ·563399
To find the log. of 11.

The last number 3·6593 is the cube root of 49, so that it could have been found from log. 7, which is given; hence the log. of this number must be given, I presume, as a clue to the solution. I can find the answer correct to about three places of decimals, but I suppose we are to find it correct to at least five places.—M.I.C.E., Bath.

[57291.]—**Weights of Copper Wire.**—Can any of our electrical friends inform me the weights per mile of the following wires (single and strands) by the new standard wire gauge, also the size in mm., and where I can obtain a good book on the subject, and whether there are any gauges made which contain the mm. decimals to an inch, and the number of the wire all combined in one, and also where obtained? I have got a standard wire gauge; it is from No. 1 to 26, but no mm. or decimals on it:—

| Single wires. | 7 Strands. | 14 strands. | 19 strands. |
|---|---|---|---|
| 1 | 7/1 | | |
| 2 | 7/2 | | |
| 3 | 7/3 | | |
| 4 | 7/4 | | |
| 5 | 7/5 | | |
| 6 | 7/6 | | |
| 7 | 7/7 | | |
| 8 | 7/8 | | |
| 9 | 7/9 | | |
| 10 | 7/10 | | |
| 11 | 7/11 | | |
| 12 | 7/12 | | |
| 13 | 7/13 | | |
| 14 | 7/14 | | |
| 15 | 7/15 | | |
| 16 | 7/16 | | |
| 17 | 7/17 | | |
| 18 | 7/18 | | |
| 19 | 7/19 | | |
| 20 | 7/20 | | |
| 21 | 7/21 | | |
| 22 | 7/22 | | |
| 23 | 7/23 | | |
| 24 | 7/24 | | |
| 25 | 7/26 | | |
| 26 | | | |
| 28 | | | |
| 30 | | | |
| 34 | | | |
| 39 | | | |

(14 and 19 strands the same as 7 strands.)

—Young Electrician.

[57292.]—**Ebony.**—I have made a book case, and want to finish it so as to look like ebony. I have given it several coats of paint, but find that it leaves it too rough, so now I have used pumice and made it smooth, but cannot get on further. Cannot I get a kind of enamel, like Judson's Artist's Black, only much cheaper, for it would take about 12 bottles like their 1s. size? I cannot stain it, for it has on the paint.—Vincent.

[57293.]—**Razor Grinding.**—Will some kind reader of the "E.M." inform me the practical way of grinding razors and scissors ready for use, as I am about to start in that line?—D. G.

[57294.]—**Haydon's Cutter Bar.**—I have made one of the above from instructions lately given in "Ours." Will the writer, or others, kindly explain the simplest way to grind the cutter, as I don't quite understand the shape of the point? Should cutter be made of piece of square steel, and is it ground while in the bar?—A sketch would oblige.—Surveyor.

[57295.]—**Bookbinding.**—What is the reason the backs of my books are not firm, and do not retain their round shape after blocking? The first time book is opened, the back goes quite flat, and edges on the twist, although I leave in press till glue is dry. Practical hints about blocking and cutting will oblige.—Surveyor.

[57296.]—**Surveying Chain.**—Should these chains be exactly 66ft. long, or is it usual to make them rather longer, so as to allow for them not always being pulled quite straight and tight? I have tried mine by a new tape, and find my old one a link too long. A nearly new chain which I have, I find is quite two links too long, and yet only has 98 links, the 10 marks being only 9 links from either end. The old chain has exactly 100 links. Hints as to testing chains from a practical man will be much appreciated.—Surveyor.

[57297.]—**Boiler.**—The boiler to the engine which I attend is fed by an injector, which acts in a very irregular way. I cannot use it at all under 40lb. pressure. Sometimes having to attend to other duties, the water during my absence will get low in the gauge; the steam likewise has gone down. Before I can put any water into the boiler, I have to fire up, and get up steam. Is the fault in the steam nozzle or water delivery? The highest pressure the Insurance Co. allows is 60lb. The boiler is externally fired, 2ft. 10in. diameter, and the water-feed is carried in from the top to 8in. from the bottom of the boiler.—W. S.

[57298.]—**Faulty Dynamo.**—To Mr. Bottone or Others.—I have been trying to make a small dynamo, from the instructions given in "The Dynamo," but find that it will not answer at all. On sending a current from a battery through the F.M.'s, I obtained shocks like those of an induction coil, and on revolving the A. got a very feeble current; without the battery it will give no current at all. The F.M.'s are only very slightly magnetised by a single bichromate; but their continuity and insulation seems to be perfect when tested with the galvanometer.—Disappointed.

[57299.]—**Steel Castings.**—I should esteem it a great favour if any of your steel and malleable iron-smelting correspondents could instruct me how to mix the metals for making steel castings, light and heavy work, and also the proportions of the metals used? Are there any chemicals used in the process, and the names and proportions, and how to use them?—H. K. B.

[57300.]—**To "Invicta."**—Many thanks for answering my query, No. 57109. I have got my 3in. achro. of 50in. focus, and should like to write you a few letters as to the mounting and making up of eyepieces. I know your time must be very limited, owing to the numerous correspondents you have through this journal; and I would not trouble you, but for this reason: That I am off to Australia in two months' time.—Focus.

[57301.]—**Shaft.**—On a shaft 12in. diameter there is keyed a wheel 12ft. diameter, which gears into a pinion 26in. diameter. What diameter must the shaft for the 26in. pinion be? Also what work on the strength of material would they recommend?—Lil.

[57302.]—**Scraping Metal.**—Will some reader kindly inform me why in scraping hollow in o.g. moulding (metal), I make it ridges, instead of straight, smooth surface. I think the scaper is a right one, being made by grinding half-round file.—H. H.

[57303.]—**Electric Motor.**—Will S. Bottone or "W. H. E." kindly help me in the following: I have a Crompton compound-wound dynamo giving 110 volts, and about 30 ampères. Now I wish to connect to above (which already works incandescent lamps in parallel) an electric motor of about one-man power. Will any of above give me directions as to winding?—Electra.

[57304.]—**Electric Bells.**—I want to connect an electric bell (single stroke) to an electric-light circuit, E.M.F. being 120 volts, and total C. about 40 amps. The dynamo working incandescent lamp. What res. must I give bobbins on bell? Distance over which they will have to work will be 20yds.?—Electra.

[57305.]—**Bronze.**—Will any of "ours" kindly give me a good recipe for above of a brownish colour? I wish to colour a few pieces of brass with it?—Electra.

[57306.]—**Dynamo.**—Would S. Bottone or others kindly give dimensions of armature for following machine: F.M. similar to Brush; eight coils (four each side), each coil about 250ft. No. 11 cotton covered. Faces of pole pieces about 10¾ dia. and space between for armature 2¼in. Present armature 8 coils No. 16 cot. cov., but perfectly useless, being wound anyhow. Wanted for incandescent lamps either series or multiple arc. Would plain iron wire core (Pacinotti form) do best, or what?—Incandescent.

[57307.]—**Microscopical Eyepieces.**—How can I find out the magnifying power of the eyepieces to my microscope? Would an optician be able to tell me?—Micro.

[57308.]—**Water Microscopes.**—"The Ghost of Stephen Gray" would confer a favour upon subscribers of "E.M." by giving a more detailed description of the above when next he pays a visit to the pale glimpses of the moon.—R. M.

[57309.]—**Algebraical.**—A vessel just contains a pint of wine; a pint of water is now poured gently into the vessel. Supposing the water to mix completely with the wine as the process goes on, how much wine will be left in the vessel after all the water is poured in?—B. H. B.

[57310.]—**Wheatstone Bridge.**—Will some reader of the "E.M." kindly inform me where I can find stated, or tell me, the best arrangement of "arms" to use when measuring resistances by this method—that is to say, which are the best arms—10 and 10, 100 and 10, 1,000 and 100, or what—to use when measuring high and low resistances respectively? Also, for what resistances (approximately) should a high resistance galv. be used, and for what resistance a low-resistance galvanometer?—M. C. G.

[57311.]—**Flour.**—The flour I buy is good in gluten, which is what I esteem; but in eating there is a grittiness. I have found sand in my pepper, which reminded me of the old saying forcibly—viz., "when you have sanded the sugar, and damped the tobacco, come up to prayers, Maria." But I hardly think this is the case with my flour. I wish to know what it is, and method of judging good flour for gluten, and to detect adulterations.—P. W. R.

[57312.]—**Truing Lathe.**—To "Invicta" or Others.—I have a 5in. screw-cutting lathe (Whitworth's pattern). Can you kindly explain how to set lathe-head true to saddle for cross-surfacing.—P. W.

[57313.]—**Steam Launch.**—To "INVICTA" OR OTHERS.—I have a 3in. bore by 3in. stroke direct-acting steam-engine. Can you kindly state what size boat, and at what rate, it will propel it with four or five persons in it? Also, what size boiler and propeller it will require? —P. W.

[57314.]—**Electrical.**—Will Mr. Sprague or some other electrician please explain the paragraph in Gray's "Absolute Measurements in Electricity and Magnetism," referring to Thomson's method of measuring low resistances? The paragraph runs thus:—"The sections A D are so far from the ends of the rods . . . by a small fraction of the actual resistance of the wire in each case." Chap. IX. pp. 98, 99 (referring to Fig. 12). Is not the current always parallel to the axis? And if not, how can fastening the wires at some distance from the end of the rod, and making A M D and B C L of certain resistances, have any effect? Also, what is meant by "The effect of any resistance of contact . . . the wire in each case"? —M. C. G.

[57315.] — **Botanical.** — What kind of paper do botanists usually use for mounting their dried botanical specimens, and what is the price of such paper? Is there any cheap glossary of botanical terms published, and, if so, what is its title, and author's name?—B.

[57316.]—**Turbine Wheel.**—Would any reader of this journal be good enough to say, through these pages, whose turbine water-wheel is the best at present in use; and what size of a wheel would best suit a 9ft. fall with 2,000ft. of water passing per minute, and how many horse-power the fall and quantity of water would give?—JAMES.

[57317.]—**Scarlet Fever.**—I should be glad to know if it is generally believed that the infection of scarlet fever can be conveyed in milk. What is the best mode of disinfecting a room, bedding, and clothes used by a scarlet-fever patient?—RUFFLER.

[57318.]—**Lippmann's Ampere-meter.**—I was much interested in your description of the above ingenious instrument, and should be glad of further particulars respecting it, as it accomplishes the object sought in a manner which has been long attempted—but hitherto in vain—by electricians, namely, that between the parts acted upon by the forces to be measured there should be no relative movement either of translation or rotation. This is accomplished most ingeniously in the instrument described, for the small element carrying the current to be measured always occupies the same position in the magnetic field. I should be glad if any fellow reader can give further information about it, as I am sure it would be interesting to others as well as—A. D. RAINE.

[57319.]—**Electro Magnet.**—Some time since I made an electro-magnet by winding two bobbins, 4in. long by 2½in. wide, full of No. 14 wire (4lb. wire exactly filled the two), core 1in. in diameter. What I wish to know is whether I can use the same for the fields of a dynamo to light when finished about 4 × 6 candle lamps. Could Mr. Bottone or W. H. Eaves give me the size and quantity of wire to wind on armature, proper size of pole pieces, &c. If I unwind wire I shall probably be unable to rewind it, as I have two coats of shellac varnish on each layer.—ZINCI SULPHAS.

## USEFUL AND SCIENTIFIC NOTES.

**Number of Nails in a Pound.**—The following table shows the number of nails of the various sizes contained in a pound: 2d fine, 1,000; 3d fine, 760; 3d common, 480; 4d com., 288; 5d com., 200; 6d com., 168; 7d com., 124; 8d com., 88; 9d com., 70; 10d com., 58; 12d com., 44; 16d com., 34; 20d com., 23; 30d com., 18; 40d com., 14; 50d com., 10; 60d com., 8. The length of each nail mentioned is as follows: 2d, 1in.; 3d, 1¼; 4d, 1½; 5d, 1¾; 6d, 2; 7d, 2¼; 8d, 2½; 9d, 2¾; 10d, 3; 12d, 3¼; 16d, 3½; 20d, 4; 30d, 4½; 50d, 5½; 60d, 6in.

**A New Test for Codeine**—M. Lafon has found a characteristic test for codeine. A minute quantity, even a fraction of a milligramme of codeine, imparts a splendid green colour to a solution of one gramme of selenite of ammonium in twenty cubic centimetres of strong sulphuric acid. It appears that morphia is the only known alkaloid that gives anything like the same reaction. When selenium is dissolved in strong sulphuric acid, the green colour is the result; and codeine is said to have the power of setting selenium free from the ammonic salt.

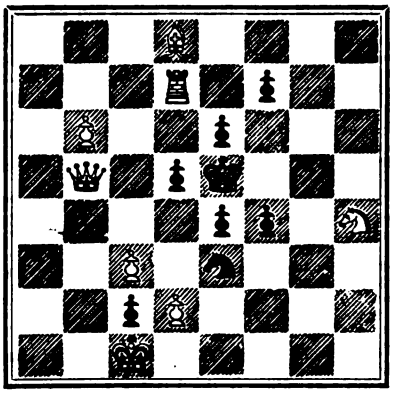
**Painter's Oils.**—The longer oil is kept the better, both as regards drying and transparent qualities. To make good nut oil, the skins of ripe walnuts should be peeled off, as it contains an acid which turns it brown. Poppy oil is made from the ripe seed of poppies. It is the best drying oil. The oil of spike, or lavender, is obtained by distilling spike with water; it is very volatile and fine for working with the pencil, or for enamelling. To make a good drying oil for extra-fine painting, take of poppy oil or nut oil one pint, of gum sandarac two ounces, of white vitriol and sugar of lead each one ounce. Boil the whole till the solid ingredients are dissolved, and the mixture is the colour of linseed oil. This oil will dry fast, and a portion of turpentine added makes a fine oil for use when the purest white tint is required. It may be mixed with other oils as a drying, where common drying oil would be injurious to the colour. Raw linseed oil for woodwork is best, as, being more volatile than boiled oil, it strikes into the wood and forms a hard, resinous filling.

## CHESS.

ALL Communications for this department must be addressed to J. PIERCE, Langley House, Dorking.

PROBLEM DCCCCLIII—RESPICE FINEM.

*Black.*



*White.* [8+8

White to play and mate in two moves.

SOLUTION TO 951.

| *White.* | *Black.* |
|---|---|
| 1. Kt-Q B 4 | 1. Anything |
| 2. Q or Kt mates. | |

(Five variations.)

### NOTICES TO CORRESPONDENTS.

CORRECT solutions to 950 by J. A. Miles (very good problem). That by E. Stanley Follwell is wrong, as Black's second move puts W K in check.

To 951 by E. Stanley Follwell, J. A. Miles (good), F. O'N. H., A. A. R., Lecluse (a splendid problem), Rev. W. Anderson (Old Romney), and W. D. Porter.

To 952 by Streetgate and E. S. (but second variation incomplete).

R. G. BROTHERO.—For a problem to be sound there should be only one solution possible from the first move. Black may have several defences; to each defence there should be but one way of mating, though the play on both sides in all the variations may be different. If in any variation there should be more than one way of mating this is considered a blemish, more or less serious according to the importance of the variation; as in several of your "sixteen variations" to 947, White's second move is exactly the same, the number is reduced to six.

J. RUSSELL.—Thanks for game.

As the Second Game Correspondence Tourney is very nearly concluded, we propose starting a third on different lines, as likely to be more acceptable than the preceding, although both the first and second Tourneys have been highly successful, and produced some excellent games. We think, instead of having three or four prizes obtained from the subscriptions, it would be much better to divide the amount according to the number of games won by each competitor. Thus: Supposing there are twelve players, and any given player (A) wins seven and loses four games, he would receive three times the stake on each game. If he lose seven and win four, he would have to pay that amount. We think also it would be fairer for each to play two games (simultaneously) with his opponent, so as to neutralise the advantage of first move. We shall be glad to receive the names of any who would like to join. We have already two; the number would be limited to sixteen. The stake on each game might be fixed at half a crown.

**Zinc Sheathing for Ships.**—The Chilian ironclad *Blanco Encalada* was docked the other day at Hebburn-on-Tyne. Much interest was attached to the circumstance on account of the ship not having been docked since she left England more than ten years ago. The iron bottom of the hull had then been covered with teak plank, fastened with iron fastenings, and sheathed with zinc sheets, in the hope that this arrangement would keep the underwater part of the ship fairly clean and free from decay. The *Blanco Encalada* was visited at Hebburn by Sir Edward Reed, M.P., under whose care she was originally built, and is now being refitted and re-armed, and with him was Admiral Latorre, Captain Montt, who now commands the ship; Mr. W. H. White, of the firm of Sir William Armstrong and Co.; Mr. Leslie, representative of Messrs. Penn, the engineers, and numerous other persons. It is worthy of record that the bottom was found remarkably clean notwithstanding its 10 years' immersion, and that the waste of the zinc sheathing was scarcely as much as had been anticipated. No evidence of any injury to the iron plating of the ship's bottom, which was examined in places, could be detected. The experiment of the zinc sheathing upon a single layer of wood was thus found to have been even more successful than could have been hoped.

## ANSWERS TO CORRESPONDENTS.

*** *All communications should be addressed to the* [illegible] *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

### HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

*** Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, Aug. 19th, and unacknowledged elsewhere :—

C. H. DAVIE.—Ezekiel Mundy.—Barnett and [illegible]—S. E. Cottam and Son.—W. Robertson and Co.—Ion.—W. Watson and Co.—T. Elderkin.—A Fellow of the Royal Astronomical Society.—J. Sutcliffe.—Eugene Brown.—E. R. P.—H. D.—Lt.-Col. Ross.—Sandrat.—G. Fryer.—S. Bottone.—W. A. Cooper.—Silly Billy.—Prof. R. B. Ball.—Draco.—Rob. Crus.—Aqua.—C. L[illegible]—Pinion D.—R. B.—M. H.—F. W. Gerhard.—Horological Tommy.—Tyro.—Fireclay.—R. B. F.—Ion.—Col. Shakespeare.

ELECTRICIAN. (There is the Society of Telegraph Engineers and Electricians; we do not know of any other.)—F. J. S. (If you consult the indices, you will find several. Perhaps that illustrated on p. 423 will suit.)—CANTON. (We know of nothing better than a good saw for cutting carbon into plates.)—J. H. G. (See previous answer, p. 141, Vol. XL., and the indices generally.)—A. M. (The Guide to the Whitworth Scholarships is published by Chapman and Hall, and can be had from the Secretary of the Science and Art Department, South Kensington. There is a little book published by Abel or John Heywood, Manchester, which gives a great deal of information about them, with useful hints to intending candidates.)—BEACONSFIELD. (We cannot tell whether you want it timed, tuned, or tinned. The word is written timed or tuned; but presuming you mean tinned, we remember there is a works at Bow. But perhaps Messrs. Hughes, of Drury-lane, would do it for you.)—COAL-GAS. (One is inflammable, the other is not; but there is no simple test for the other.)—C. O. N. (The Legislature of New York simply requires railway companies to fit their stock with automatic couplers. We cannot afford space to give plans and details of the various goods waggons running in the United States.)—J. K. S. (Goodeve's work published by Lockwood and Co., Northcott's by Cassell and Co., and some others; but see the indices, or the publishers' lists. 2. Look through your back numbers for the model boiler you think you can make. There is much on the subject in recent volumes.)—J. J. ALLINGHAM. (By all means, if you can "show a number of new experiments and habits of electricity as would electrify the scientific world," patent them at once, and then describe them. You are, of course, quite sure when you say you "can highly magnetise and demagnetise glass, brass, copper, tin, zinc, lead, and silver," that you do not mean something else.)—INSTRUCTOR. (Apparently you want a set of boring and well-sinking tools. 2. Pictet's ice-making machine is about the best on the small scale. It was illustrated in No. 921.)—ANOTHER AMATEUR. (Mr. T. W. Boord, M.P., 14, Berkeley-square, W., is, or was, the hon. secretary of the Amateur Mechanical Society.)—C. D. (See recent numbers—even last week's, pp. 511, 527. 2. See Mr. Wassell's letters, others now appearing on lens making, and the indices.)—AN OLD READER. (You mean an aged reader, for if you had perused the "E. M." you would know that it is either stain lacquered, or copper bronze mixed in suitable varnish, and painted on.)—ANTI-RUST. (The iron, thoroughly clean, is immersed in a bath of molten zinc, which is covered with sal-ammoniac to prevent oxidation.)—LEDGER. (Of any bookseller.)—WILLIAM TAYLOR. (Where do you find any mention of it? We do not remember the name.)—A LEARNER. (Frequently answered. Look up the indices. Such "works" as there are placed in the hands. 2. The effect is that the coil does not work so well as it otherwise would; but what do you mean by "large"—size of sheets or number? 3. No, we think not; but you can easily experiment. 4. E.M.F. stands for electro-motive force.)—NEWCHURCH. (For cleaning solder, see p. 247, No. 947.)—THOS. BLANDFORD. (No. 740 contains several; but as good a recipe as any possibly is Tartaric acid, 8 parts; carbonate of soda, 4; ground rice, 8. Mix well.)—BALLOON. (The information that you appear to require was given in pp. 20, 44, 71, 95, Vol. XL. Hydrogen will lift more weight than coal-gas.)—ANGUS MAC MUIR. (We cannot go to the expense of making illustrations of engines simply to illustrate queries as to whether they are now running or not, and we think the L.B. and S.C. engine mentioned has been fully described enough without a sketch.)

**Holloway's Ointment.**—Sore[illegible]tions, and other diseases affecting the skin, are capable of speedy amendment by this cooling and healing Ointment, which has called forth the loudest praise from persons who had suffered for years from bad legs, abscesses, and chronic ulcers, after every hope of cure had long passed away.

The English Mechanic
AND WORLD OF SCIENCE AND ART.
*FRIDAY, AUGUST* 28, 1885.

## ELECTRO-METALLURGY.*

TREATISES on electro-metallurgy written in French are not so numerous as those in English and German, although Roseleur's work and Becquerel's "Eléments d'Electro-chimie" take rank on the first line. As M. Fontaine points out, we have in English the works of Sprague, Napier, Watt, Urquhart, Gore, and Wilson, of which Watt's has run through so many editions that it is, we believe, to be superseded by a more elaborate treatise by the same author. As our readers are aware, Mr. Sprague does not deal much with the processes of the factory, but endeavours to give a clear comprehension of the principles underlying them, while the work of Dr. Gore is chiefly valuable as a record of investigations and experiments in electrolysis, some of which are little known and rarely repeated, not to say practised. The other works are more or less practical and trustworthy; but Roseleur's and Becquerel's are, as M. Fontaine says, the complements of one another and—out of date. He has had much experience, and for many years has been intimately connected with many specialists, especially those engaged in nickeling and refining copper, and is therefore justified in supplying what he terms a "lamentable deficiency" in French technological literature. We presume it occurred to Mr. Berly that what would be found useful to a French reader might not prove altogether valueless to English readers, and at all events many of them will thank him for introducing the work to their notice. Quite apart from its commercial applications, electro-metallurgy is a favourite "amusement" amongst amateurs, for schoolboys take copper "shells" off their plaster medallions, and modellers in wax and clay make permanent records of their artistic skill in the easily-worked copper process. Silver-plating and gilding, too, are practised by large numbers, and, though far more difficult to work with success, form interesting and sometimes profitable diversions. Though M. Fontaine, as a matter of course, describes the principal details of battery processes, the more valuable portions of his work deal with the application of the dynamo machine as the generator of current for the factory, and he divides the book into four principal sections, the first of which deals with theory, the second with the various batteries and dynamos used in electrolysis, the third with the deposition of the metal, and the fourth with the newer processes for refining metals and treating ores. With the first section we have little to do here, because although the theory differs in the phraseology and terms used by different writers, it comes to much the same thing, so far as the practical worker is concerned. M. Fontaine seems, however, to have consulted a large number of authorities, and has given in one chapter a variety of tabular data which will be valuable to those who have no other works of reference. It appears singular, though, to find in the English edition that "M. Sprague's" law on electrolysis—"the substances which, in becoming freed, absorb the smallest quantity of intrinsic energy are those which are liberated at the electrodes"—is the converse of that which M. Berthelot designated by the name of "principle of the maximum work." "M. Sprague's" law is, however, acknowledged as a "new conception"; but surely the printers and the publishers knew, if Mr. Berly did not, that "M. Sprague" should be Mr. Sprague. M. Berthelot is said to have "enumerated" instead of ennunciated a principle, which, like the first, may be a printer's error, but on p. 147 we find a more serious slip, which a translator from French to English should have especially guarded against. Thus we are told that "the deposition [silver] is begun with a current the electromotive force of which does not exceed 2 or 3 volts, and the intensity 50 ampères per square mètre." The unit names being given the student is not likely to be misled, but it would be better to avoid the term "intensity" applied in that connection. In the chapter on batteries we read "for thin depositions, and especially when the work is intermittent, Leclanché and Lalande and Chaperon's cells can be used, as also generally all cells having the property of giving a regular current for a long time, without wasting when not at work." Whatever may be the merits of the Lalande-Chaperon (oxide of copper) cell, the Leclanché can scarcely be adopted with advantage for electro-metallurgy, even when constructed, as M. Fontaine gives it, with agglomerate plates composed of 40 parts binoxide of manganese, 52 of carbon, 3 of bisulphate of potash, "5 of gum lac rosin acting as a cement to unite the two other substances." This mixture, he says, is heated to 100 degrees centigrade (212 Fahr.), and then submitted to a pressure of 4,500lb. to the square inch. The introduction of the word "rosin" tends to confuse, and the passage should probably read "gum lac resin," though "lac" simply, or "shellac," would be clear enough. M. Fontaine says that the Leclanché cell can be used with advantage in electrolytic operations when the baths have a great resistance, and he goes on to enumerate its advantages, but we should not advise its employment for any electrolytic purpose. Of the Smee cell, he says it is extensively used in England and America in small nickeling and electrotyping works, and is particularly applicable for operations in which the current must be energetic at the beginning and weaker afterwards. In France it has been almost forgotten, notwithstanding its economy. Of thermo-electric generators, he mentions and illustrates the Noé and the Clamond, the former being frequently used in Austria by goldsmiths, but M. Fontaine settles the latter by the statement that one cubic mètre of gas would develop through a Clamond a maximum power of 5 kilogrammètres, whereas the same quantity of gas consumed in an Otto gas-engine develops over 75 kilogrammètres. That statement shows very conclusively that thermo-electric batteries cannot compete with a gas-engine and dynamo, but amateurs and other dabblers in electro-metallurgy will probably find the Daniell or the Smee, all things considered, the best arrangement they can adopt, unless they do not mind the trouble involved in the use of the Bunsen, the objections to which are the poisonous fumes and the labour of cleaning up and recharging, although it is said that M. Dupré has succeeded in suppressing the nitrous vapours by using a depolarising liquid in which 77gr. of potassium dichromate have been dissolved per litre. In contact with the zinc he uses acidulated water or potassium disulphate. The dynamos described and illustrated are the Siemens, Gramme, Schuckert, Mather, Weston, and Elmore; but Wilde's machine comes in for some commendation as a device "the most perfect and the most generally used in industry before M. Gramme's conception made its triumphal appearance." Gramme unquestionably made a great step in advance, so far as electro-metallurgy is concerned, and the willing testimony of Messrs. Christofle is accorded to the fact that with the best batteries they had employed the cost of depositing was 3·87 franc per kilogramme for current alone, whereas with the Gramme machine it was reduced to 94 centimes, or less than one-fourth. These figures are the result of careful calculations based on five years' work at the factory of Messrs. Christofle, and are given on the authority of M. H. Bouilhet, chemist to the firm. It is evident, then, if evidence of the fact were needed, that the small man who employs a battery, and obtains his current from the combustion of zinc, cannot compete with the factories where a dynamo can be put down; but it is not unlikely that Mr. Kendall's gas battery, which we illustrate (in principle) elsewhere, will enable the amateur to compete on favourable terms with the large factories, as it is small and compact, and is readily worked by a gas blowpipe. In his table of the electromotive force of different cells, M. Fontaine gives the oxide of copper cell at ·8 to ·9 volt; but it is doubtful if it will maintain that for long. The third section opens with a chapter on "Nickel-Plating," in which it is stated that the purity of the salt of nickel is the primordial condition for the preparation of a bath giving good deposits. The selection of the water, too, is most important—waters from "rivers, sources, wells" (*sic*) being often defective from the salts contained in solution: hence, M. Fontaine says the best plan is to use distilled water, or in the case of large baths rain-water. For iron articles he advises the use of M. Pérille's system, which is 80 grammes of double sulphate of nickel and ammonium for each litre of water, mixing with the latter in an enamelled vessel when the temperature is at boiling. The solution should be filtered into the vat, letting it cool previously if the latter has a lining of guttapercha. The bath should be of. 6 – 8 degrees Baumé, and scarcely redden litmus paper. Before the iron is placed in the nickeling solution it is scoured and cleaned in an acid bath, which latter may be composed of water five, hydrochloric acid one. M. Fontaine rightly insists on the great importance of the preliminary operations, and gives the various processes adopted by Pérille, Pfanhauser, Elmore, and others. As to the E.M.F. required, he says experience shows that a good dynamo for nickel-plating must have an electromotive force capable of varying between 1 and 8 volts, and proceeds: "Mr. Sprague, who should always be consulted on matters of electric intensity or electromotive force, recommends beginning with five volts and finishing with about one." Silvering and gilding are treated at considerable length, and there is a useful chapter on electrotyping, and another on the deposition of various metals, including brassing and bronzing. Section IV. contains two chapters dealing respectively with the refining of copper and lead, and the treatment of ores by the electric method—a method which is being much more extensively utilised now that powerful and comparatively cheap dynamos are available. The object is to produce chemically pure copper, and not unfrequently considerable quantities of gold are obtained from the baths — for instance, the Norddeutsche Affinerie at Hamburg secured as much as 1,200 kilogrammes of fine gold in 1880; but then they produce about 2½ tons of chemically pure copper per day, and, consequently, deal with immense quantities of the crude material. The Elliott Metal Company, Selly Oak, near Birmingham, refine 10 tons of copper per week, and employ five improved Wilde dynamos, in which the armature carries a series of bobbins, which revolve between the free extremities of a number of cylindrical electro-magnets, arranged in a circle on each side of the armature, the bobbins of which have iron cores, thus differing from the Siemens alternating current machines. In this chapter M. Fontaine refers frequently to the experiments of Mr. Sprague, and also gives much information of a practical nature, and many useful data obtained from the practice at different factories. The Electro Metal Refining Company, of New York, work Keith's process; and referring to a statement that Mr. Weston had promised to supply a dynamo for £40 which will precipitate 40 tons of lead in twenty-four hours, M. Fontaine says that the power required will be 48 h.p., and that a dynamo capable of doing such work as that will cost the manufacturer at least £300. As to the treatment of ores, M. Fontaine refers to many of the best-known processes, patented and otherwise, but expresses the belief that there is not a single industrial application of electricity for the purpose. Hence he confines his remarks to descriptions of those processes which appear most ingenious and easy of realisation, and so concludes a work which is decidedly a useful addition to the literature of electro-metallurgy, and will be welcomed by those practically engaged in the industry.

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* Electrolysis. By HIPPOLYTE FONTAINE, translated by J. A. BERLY, C.E., A.S.T.E. London and New York: E. and F. N. Spon.

## ASTRONOMICAL NOTES FOR SEPTEMBER, 1885.

### The Sun.

| Day of Month. | Souths. | At Greenwich Mean Noon. Right Ascension. | Declination. | Sidereal Time. |
|---|---|---|---|---|
| | h. m. s. a.m. | h. m. s. | ° ′ ″ | h. m. s. |
| 1 | 11 59 45·80 ,, | 10 43 1 | 8 8 16N | 10 43 15·10 |
| 6 | 11 58 8·32 ,, | 11 1 6 | 6 17 31,, | 11 2 57·87 |
| 11 | 11 56 26·05 ,, | 11 19 7 | 4 24 9,, | 11 22 40·62 |
| 16 | 11 54 40·91 ,, | 11 37 4 | 2 28 53,, | 11 42 23·38 |
| 21 | 11 52 55·18 ,, | 11 55 1 | 0 32 24,, | 12 2 6·14 |
| 26 | 11 57 11·53 ,, | 12 13 0 | 1 24 34 S | 12 21 48·90 |

The method of finding the Sidereal Time at Local Mean Noon at any other Station will be found on p. 355 of Vol. XL.

Spots and other signs of solar activity are visible at intervals on the Sun's disc.

At 9 p.m. on September 22nd the Sun is said technically to enter Libra, and Autumn is supposed to commence. This, however, refers to the "Sign," and not to the Constellation, as at the instant specified the Sun is just below a line joining β and η Virginis, but nearer to the latter star.

The Zodiacal light may now be seen in the East before sunrise.

There will be an eclipse of the Sun on September 8, which will be total in New Zealand. As it will be wholly invisible here, this mention of it must suffice.

### The Moon

Enters her Last Quarter at 5h. 14·8m. a.m. on September 2nd, and is New on the 8th at 8h. 43·2m. at night. She will enter her First Quarter at 6h. 14·8m. in the early morning of the 16th, and be Full at 7h. 54·7m. a.m. on the 24th.

| Day of Month. | Moon's Age at Noon. | Souths. |
|---|---|---|
| | Days. | h. m. |
| 1 | 22·0 | 4 56·6 a.m. |
| 6 | 27·0 | 9 44·4 ,, |
| 11 | 2·6 | 2 11·3 p.m. |
| 16 | 7·6 | 6 14·6 ,, |
| 21 | 12·6 | 10 6·4 ,, |
| 26 | 17·6 | 1 11·7 a.m. |

The Moon will be in conjunction with Saturn at 3 a.m. on the 4th; with Mars at 7 a.m. on the 5th; with Mercury at 4 a.m. on the 8th; with Jupiter at 10 o'clock the same night; and with Venus at 10 a.m. on the 11th.

### A Partial Eclipse of the Moon

Will be partly visible at Greenwich on the morning of September 24th. It may suffice to say here, in connection with it, that the first contact with the Penumbra will occur at 5h. 2.1m. a.m.; but as the Moon sets at 5h. 45m. before contact with the shadow proper has happened at all, all that will be perceptible in this country will be a slight shading of her Eastern limb.

### Occultations of (and near approaches to) Fixed Stars by the Moon.

| Day of Month. | Name of Star. | Mag. | Disappearance. | Moon's Limb. | Angle from N. Point. | Angle from Vertex | Reappearance. | Moon's Limb. | Angle from N. Point. | Angle from Vertex. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | h. m. | | ° | ° | h. m. | | ° | ° |
| 1 | $\theta^2$ Tauri | 4½ | ‡10 1 p.m. | Bright | 97 | 62 | 10 52 p.m. | Dark | 285 | 247 |
| 1 | $\theta^1$ Tauri | 4½ | ‡10 2 ,, | Bright | 117 | 82 | 10 51 ,, | Dark | 265 | 227 |
| 1 | B.A.C. 1391 | 5 | 11 1 ,, | Bright | 155 | 117 | 11 32 ,, | Dark | 228 | 189 |
| 1 | 81 Tauri | 5½ | †11 9 ,, | S. by E. | 12 | 333 | | | | |
| 1 | 85 Tauri | 6 | 11 21 ,, | Bright | 59 | 20 | 12 1 ,, | Dark | 325 | 284 |
| 2 | α Tauri | 1 | †1 40 a.m. | N. by W. | 193 | 154 | | | | |
| 2 | 117 Tauri | 6 | ‡10 34 p.m. | Bright | 117 | 84 | 11 20 ,, | Dark | 257 | 221 |
| 2 | B.A.C. 1728 | 6 | 12 13 ,, | Bright | 48 | 9 | 12 48 ,, | Dark | 328 | 288 |
| 4 | 26 Geminorum | 5½ | †4 57 a.m. | N. | 181 | 146 | | | | |
| 4 | 68 Geminorum | 5½ | †12 58 p.m. | S. | 358 | 323 | | | | |
| 19 | 13 Capricorni | 6 | 8 4 ,, | Dark | 127 | 122 | 9 23 ,, | Bright | 264 | 272 |
| 19 | 14 Capricorni | 5 | 9 33 ,, | Dark | 141 | 161 | 10 41 ,, | Bright | 253 | 273 |
| 20 | 18 Aquarii | 6 | 6 47 ,, | Dark | 73 | 49 | 7 55 ,, | Bright | 319 | 305 |
| 21 | B.A.C. 7774 | 6 | 10 8 ,, | Dark | 136 | 136 | 11 22 ,, | Bright | 270 | 288 |
| 24 | B.A.C. 8365 | 6½ | 5 12 a.m. | Dark | 86 | 124 | ‡6 5 a.m. | Bright | 311 | 350 |
| 25 | μ Piscium | 5 | 8 12 p.m. | Bright | 132 | 94 | 9 9 p.m. | Dark | 269 | 233 |
| 26 | B.A.C. 741 | 6½ | 9 19 ,, | Bright | 65 | 26 | 10 3 ,, | Dark | 335 | 299 |
| 28 | 48 Tauri | 6 | 9 56 ,, | Bright | 73 | 33 | 10 45 ,, | Dark | 314 | 273 |
| 28 | γ Tauri | 4 | 11 46 ,, | Bright | 74 | 36 | 12 43 ,, | Dark | 314 | 279 |
| 29 | 75 Tauri | 6 | 4 41 a.m. | Bright | 136 | 149 | 5 41 a.m. | Dark | 242 | 268 |
| 29 | $\theta^1$ Tauri | 4½ | 4 48 ,, | Bright | 39 | 54 | 5 26 ,, | Dark | 338 | 1 |
| 29 | B.A.C. 1391 | 5 | 5 41 ,, | Bright | 84 | 109 | 6 51 ,, | Dark | 289 | 324 |
| 29 | α Tauri | 1 | 8 33 ,, | Bright | 132 | 173 | 9 19 ,, | Dark | 234 | 319 |
| 30 | 111 Tauri | 5½ | 3 2 ,, | Bright | 98 | 73 | 4 17 ,, | Dark | 275 | 268 |
| 30 | 117 Tauri | 6 | 5 15 ,, | Bright | 45 | 53 | 6 5 ,, | Dark | 321 | 341 |

† Near approaches. ‡ Stars below the horizon.

The observer possessing an equatorially-mounted telescope should look out for the Occultation of Aldebaran on the morning of September 29th, of which the details are given above. It is not predicted in the *Nautical Almanac*.

### Mercury

Comes into Inferior Conjunction with the Sun at 6 p.m. on the 2nd, and is a Morning Star during the entire month, attaining his greatest elongation West (17° 51′) at 7 p.m. on the 18th. About this time he may be well seen before sunrise. His diameter decreases from 10·4″ on September 1st to 5·4″ by the 30th.

| Day of Month. | Right Ascension. | Declination North. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 10 46.0 | 3 26·1 | 0 2·8 p.m. |
| 6 | 10 31·1 | 6 13·5 | 11 28·2 a.m. |
| 11 | 10 24·9 | 8 32·3 | 11 2·4 ,, |
| 16 | 10 32·3 | 9 24·5 | 10 50·1 ,, |
| 21 | 10 52·3 | 8 32·2 | 10 50·4 ,, |
| 26 | 11 20·4 | 6 11·7 | 10 58·8 ,, |

The somewhat complicated path thus described by Mercury lies in Leo (to a small extent in the N.E. corner of Sextans), and finishes in Virgo. On the morning of the 13th, Mercury will be some 48′ South of ρ Leonis, but will not approach so near to any other star of any size throughout his course.

### Venus

Is an Evening Star throughout September, and may possibly be caught just above the horizon after sunset; but as a telescopic object she is very destitute of interest, as her diameter, which is 12·4″ when the month begins, only increases to 14·2″ by the 30th. She is perceptibly gibbous now.

| Day of Month. | Right Ascension. | Declination South. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 12 41·1 | 3 49·0 | 1 57·5 p.m. |
| 6 | 13 3 0 | 6 22·5 | 1 59·7 ,, |
| 11 | 13 25·1 | 8 53·0 | 2 2·1 ,, |
| 16 | 13 47·5 | 11 18·9 | 2 4·8 ,, |
| 21 | 14 10·1 | 13 38·9 | 2 7·7 ,, |
| 26 | 14 33·1 | 15 51·3 | 2 10·9 ,, |

Whence it will be seen that Venus traverses a good deal of Virgo, and enters Libra towards the end of the month.

### Mars and Jupiter

(Who comes into Conjunction with the Sun at 10 p.m. on the 8th), are both invisible; but

### Saturn

Is coming into view again as a Morning Star. He rises, though, on the 1st at 11h. 32m., and by the end of the month at about a quarter to 10 o'clock at night. His equatorial diameter subtends an angle of 15·8″ on September 1st, increasing to 16·6″ by the 30th. His ring system is almost as open as it can be, and every week is now bringing this splendid object into a more favourable position for observation.

| Day of Month. | Right Ascension. | Declination North. | Souths. |
|---|---|---|---|
| | h. m. | ° ′ | h. m. |
| 1 | 6 27·1 | 22 21·5 | 7 44·6 a.m. |
| 6 | 6 28·8 | 23 23·8 | 7 26·6 ,, |
| 11 | 6 30·4 | 22 22·2 | 7 8·5 ,, |
| 16 | 6 31·7 | 22 21·2 | 6 50·2 ,, |
| 21 | 6 33·0 | 22 20·2 | 6 31·8 ,, |
| 26 | 6 34·0 | 22 19·3 | 6 13·1 ,, |

In pursuing this short path, Saturn forms a triangle of varying shape with μ and ν Geminorum.

### Uranus and Neptune

Are still both invisible.

### Shooting Stars

Are rare in September. The night of the 10th is that on which they will most probably be seen.

### Greenwich Mean Time of Southing of Twelve of the Principal Fixed Stars on the Night of September 1st, 1885.

| Star. | Souths. h. m. s. |
|---|---|
| Vega .. .. .. .. | 7 48 32·81 p.m. |
| ζ Aquilæ .. .. .. | 8 15 33·52 ,, |
| Altair .. .. .. .. | 9 0 29·36 ,, |
| $\alpha^2$ Capricorni .. .. .. | 9 26 55·34 ,, |
| α Cygni .. .. .. .. | 9 52 41·46 ,, |
| α Cephei .. .. .. | 10 30 55·58 ,, |
| α Aquarii .. .. .. | 11 14 49·89 ,, |
| ζ Pegasi .. .. .. | 11 50 35·07 ,, |
| Fomalhaut .. .. .. | 12 6 6·57 ,, |
| Markab .. .. .. .. | 12 13 49 71 ,, |
| γ Cephei .. .. .. | 12 49 26·02 ,, |
| δ Sculptoris .. .. .. | 12 57 36·37 ,, |

The method of finding the Greenwich Mean

Time of Southing of either of the Stars in the above list for any other night in September, as also that of determining the local instant of its Transit at any other Station, will be found on p. 356 of Vol. XL.

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## THE INTERNATIONAL INVENTIONS EXHIBITION.—XVII.

### Musical Instruments, &c.

THE division of the Exhibition devoted to musical instruments is chiefly remarkable for the splendid display of pianofortes, which are shown in all sorts of cases and in all sorts of styles, the larger makers apparently endeavouring to outstrip one another in the magnificence of their exhibits. Unfortunately for the public, and perhaps for the makers themselves, there is not much to be learned from the inspection of pianofortes as they are here exhibited, for in the majority of cases it is only the handsome exterior that can be seen, though a few exhibitors have done something to make their stalls instructive as well as attractive. The would-be purchasers of pianofortes, who go to the Exhibition with the idea of selecting an instrument, will find themselves sorely puzzled to make a choice, and many of them will probably withhold the order until they have taken expert advice. With a few exceptions, it may be said that all the great pianoforte-makers send specimens of their productions, but taking the division as a whole it is rather disappointing, for it is only a small percentage of the exhibitors who show the public anything more than the outside of their instruments; and not a few of the exhibits of musical instrument-makers are little more than "shop-front" advertisements. There is this advantage, however, so far as the visitors are concerned, that they can see in a comparatively small area a variety of instruments which they could not otherwise inspect, except at the cost of travelling from point to point—which means a good deal of hard work in London—and if they cannot handle the exhibits they can at least see what has been done. The preface to this division is from the pen of Mr. W. Barclay Squire; but it deals very briefly with the improvements in musical instruments, and contains some curious statements. Hawkins is rightly credited with the honour of being the inventor of the iron piano frame; but the following sentences scarcely give a correct idea of the history of the popular free reed instruments:—"The harmonium was completed as an invention by Debain, a Frenchman, in 1840; but the expression, which permits varying intensities of sound, was subsequently added by Alexandre. The now popular American organ, in which the wind is sucked instead of blown, was introduced by Mason and Hamlin, of Boston, U.S., about the year 1860." The harmonium is a natural development of the seraphine, and the now popular American organ is a development of the melodeon, and both had their origin in the patent granted by the United States to Aaron Merrill Peasley in 1818, though instruments of some kind having free reeds appear to have been known in Paris so early as 1810. It is generally conceded that M. Martin was the inventor of the harmonium, and it is indisputable that the late Emmons Hamlin made Carhart's melodeon into the American organ by his discovery of the art of voicing free reeds. To turn, however, to the exhibits, we must leave the large pipe organs for notice later on, and, for obvious reasons, cannot do more than notice the chief objects of interest in the other branches of the division. There are many pianos, harmoniums, reed organs, and other instruments collected here which have no special feature to recommend them, and which, as a matter of fact, are very ordinary productions. The chief novelty amongst the pianos is the organo-piano of Metzler and Co., Great Marlborough-street, W., in which a series of light hammers are kept in rapid motion by working a treadle placed near the right pedal. When a key is depressed the light hammer corresponding is brought into contact with the strings or "chord," and a sustained sound is produced. The hammer proper fulfils its own purpose; but, as it does not deliver its blow unless the key is "struck," it is possible to produce tones which resemble nothing so much as a stop on an American organ, while, at the same time, the pianoforte tone is available instantly. In the hands of a skilful player the effects produced are pleasing, and the device is, we presume, the best that has been done towards developing the sostenente piano. At the same stand is a Mustel harmonium, an instrument that many visitors will be glad to see. Brinsmead and Sons, Wigmore-street, W., besides several of their ordinary patterns, show a drawing-room grand, with the patent tone-sustaining mechanism and pedal, and a skeleton piano—that is, a complete action which, to preserve it from dust, is kept in a case with glass doors. Various portions are also exhibited at this stand, including the patent screw-tuning apparatus. Several makers seem to have abandoned the peg driven into the wrest-plank, and the Mason and Hamlin Co. exhibit a piano with a new system of stringing, in which the tuning pegs are square-headed screwed pins, which take a bearing on a ridge of the iron frame, the strain being thus direct with the length of the pin, instead of at one side and transverse. M. Alibert, of Paris, exhibits improved pegs for pianos and violins, which are intended to avoid all risk of slipping. Messrs. Broadwood and Sons, Great Pulteney-street, W., besides specimens of modern instruments, exhibit the original cottage pianoforte invented by Hawkins in 1800, Wölfel's iron back, with compensation rods, cast in 1867, and some instruments which have a special history attaching to them, such as that played upon by Chopin in 1848. The Rev. G. T. Driffield, rector of Stratford-le-Bow, exhibits, under the care of Messrs. Broadwood, Handel's tuning-fork and an old tenor fork; while at the stand can also be seen a number of Mr. Ellis's forks which have been measured by Appunn's tonometer. In the Albert Hall, in the loan collection of musical instruments, manuscripts, books, paintings, and engravings, Messrs. Broadwood exhibit a piano made by Johannes Zumpe in 1766. It is believed to be the oldest "square" in existence, and has 18 keys to the octave. They also show the grand piano and seat which they made for Mr. Alma Tadema, enriched with paintings by that distinguished artist, and inlaid with ivory, tortoiseshell, and mother-o'-pearl. It was illustrated in the *Building News* of Sept. 1, 1882. Most of the other large pianoforte makers have exhibits; but as a rule it is only the casework that attracts the attention of the public. Steinway and Sons, of New York, however, show their frames, and illustrate the numerous patents they have obtained. The steel frame and the laminated woodwork of these famous pianos attract much attention. Mr. Stiles, of Southampton-row, W.C., exhibits specimens of the pianos of Bord, of Paris, which have deservedly obtained a high reputation; and Carl Hofmann, of Vienna, shows what is probably the "smallest grand" in the world, as it is only 4ft. 10in. long. Mr. Rudd, of Dean-street, W., sends a grand piano by Muzio Clementi, which has been restored. Clementi is called the father of piano music, and this instrument is of peculiar construction, having an extra harmonic pedal, and a double length of vibrating string to each note, in order to obtain continuity of sound by the sympathetic vibration of a string carried over an additional bridge called the "bridge of reverberation." Actions are shown by a number of makers, and all claim improvements; but it is curious to note with what simplicity some of the foreign exhibitors send modifications of the famous Erard action, presumably expecting them to be considered as "inventions." The Comte de Nydpruch, of Brussels, exhibits a piano with the action made of metal-band, worked up into the required shape. The stickers, hammer-shanks, &c., are all made of metal, and it is possibe that in certain conditions the advantages may be considerable. Amongst other novelties connected with pianoforte-making we may note the tuning machine of Messrs. Schucht and Schönewald, of Store-street, W.C., in which the "hammer" is connected to the "key" by toothed pinions, and one turn of the former gives half a revolution on the tuning peg. Their hammer covering machine is an ingenious device, as by its aid the hammers can be refelted in situ. Mr. Outram, of Greetland, Halifax, exhibits his patent system of stringing, in which the strings are taken on both sides of the frame, passing over pulleys at the bottom and top, one pulley being carried in a shoe, which can be drawn up by means of a headed screw, so as to put the required tension on the string for tuning. Mr. Nosworthy, of Coldharbour-lane, S.E., exhibits a dissecting model, showing his method of relieving the soundboard of a portion of the down-pressure by dividing the string scale between two soundboards. Mr. A. Squire, of Wrotham-road, N.W., shows models of his pianoforte action, which is appreciated by many good makers; and amongst the folding or cabin pianos, those of Venables and Co., of Essex-road, N., are worth notice, especially as the hammers are waterproofed, and the parts are prepared to resist the injurious effects of damp atmospheres. Mr. T. Machell, of Glasgow, exhibits what is known as a tuning-fork piano; but although his arrangements are ingenious, we are afraid they are not improvements on the older-fashioned plan of wires. Messrs. Whitfield and Co., of Birmingham, have a good exhibit of cast-iron frames for pianos, which are tolerably well known to the trade, and altogether the show of "fittings" will be useful to the makers and to amateurs. Two or three exhibitors show the application of pedals to pianofortes; but the recently patented devices of Mr. Rushton, Child's Hill, N.W., are probably the best, as his simplex and independent attachments are applicable to pianos with under or over dampers. The piano can be lifted off the pedal portion and replaced again, as often as desired, without removing a screw or altering any of the arrangements. There is no attachment to the keys, the whole of the work belonging to the pedal action, except that connected to the pedal frame, being in the case of the piano itself. Amongst free reed instruments of the keyboard type we may note a voice harmonium by Mr. Colin Brown, of Anderson's College, Glasgow, with eight digitals in each octave, and the fingering the same in all keys of the scale. We described and illustrated this invention in Vol. XXIII., pp. 298, 320, 630. Mr. Brown also exhibits one of his monopolytones. Forsyth, Bros., of Regent-circus, W., have a selection of Dominion organs (American), and show in model and diagram the method they adopt of connecting the sub-bass to the manual and the pedals. Most of the best known makers of American organs and harmoniums have samples of their productions; but the only novelty seems to be the combination instrument of Jones and Co., Bristol, which has the exhaust system applied to the upper manual, and the pressure, or harmonium system, on the lower manual. Another instrument has this arrangement reversed. Mr. G. Cousins, of Birchington-on-Sea, exhibits a harmonium showing what is termed a method of tuning reeds so that they can be quickly raised or lowered in pitch to suit any other instrument. So far as can be seen, it consists of a clip to grasp the heel of the reed, which is worked by a thumb-screw from the rim of the "pan." The reed organs and harmoniums are mostly in a sort of annexe to the Central Gallery, and in the east end of this annexe will be found an ingenious hydraulic engine by Mr. Blennerhasset, of Vernon-street, W.C., blowing a double manual pedal harmonium by G. L. Bauer. The inlet valve of this engine is a simple three-way cock, the position of which is altered by a tappet arrangement. The supply valve is a cylindrical plug, which fills more or less of the pipe, and shuts off the water without any shock. The most ingenious part of the engine, however, is the arrangement for controlling the speed by the exhaust; a rod attached to the rising bellows of an organ connecting to a lever which closes the exhaust valve as the bellows becomes full, thus slowing the engine by back pressure. Mr. Blennerhasset shows his motor at work on a bellows supplying an organ a little distance away, and also employs it for driving a printing machine. The great four-manual concert organ by Messrs. Michell and Thynne, erected in the music room, is blown by two of these hydraulic engines, which are also applied to the model great organ by Brindley and Foster, and a three-manual pedal Mason and Hamlin American organ, exhibited by Messrs. Metzler. The vocalion of Mr. Baillie Hamilton, embodying that inventor's latest designs in connection with harmoniums and free reeds, can be seen in the department marked Siam on the plan, and on Friday afternoons there is usually a performance, in which its capabilities, which are great, are well shown. Fittings for free reed instruments are shown by a few makers, and concertinas are exhibited by two of the best known makers. There is a good display of other instruments, brass and "wood," the latter being a technical term which, we suppose, would include the cut-glass concert flute exhibited by Mr. W. H. Beeby, of Ridinghouse-street, W. Violins are exhibited by several of the best makers, and Mr. Twining, of Twickenham, exhibits a cellino or lady's violoncello, which is strung an octave below the violin. Messrs. Taylor, of Lower Edmonton, exhibit their patent double-strung violins, which simply duplicate the strings of the ordinary pattern, with what advantage remains to be proved. Mr. A. Cary, of Newbury, has a stand near Willis's great organ, at which he exhibits violins and their accessories, including the Spohr adjustable chin-holder, which we described on p. 318, No. 1,029; the patent bow guide of S. Williams, which prevents the bow swerving from its proper course, and sundry folding and portable music stands. Violinists will look admiringly at the fine case of bows by Mr. Tubbs, of Wardour-street, and not a few visitors will smile at the "amateur made" banjoes of Mr. Tallack, Selhurst-road, Norwood —not at the instruments, but at the phrase, for there are amateurs and amateurs, and the exhibitor in this case, we presume, merely wishes the public to understand that he is not a professional maker. G. Tiefenbrunner, of Munich, exhibits some beautifully-finished zithers; Thibouville-Lamy and Co., of Charterhouse-street, E.C., show, amongst their other exhibits, the pianista, which was described in recent volumes; and there are a variety of the now familiar automatic instruments of the organette type, in which the sounds are obtained by drawing sheets of perforated paper over the orifices of the tubes or cavities containing the reeds. The loan collection in the lower rooms and the gallery of the Albert Hall will interest many, for probably no exhibit of the like kind has ever been made before, and it will not be easy again to get together such a collection of ancient and historical instruments, and of manuscripts, prints, and paintings relating to music. A guide and catalogue has been recently published by Messrs. Clowes, to which Mr. A. J. Hipkins has written a preface.

## THE FIELDING HIGH-SPEED ENGINE.

We mentioned on p. 338 that Messrs. Fielding and Platt, of Gloucester, have at their stand (1193, West Annexe) in the Inventions Exhibition a very remarkable rotary engine, which almost baffles description. This "engine" may also be used as a liquid meter or a pump, and the following may be found probably as clear an account of its action as can be written. The motor is shown driving a dynamo; and a full-size model is available for inspection at the stand. The invention has been patented by Mr. John Fielding:—When two revolving shafts whose axes are inclined to one another at a considerable angle, such as 150°, are connected together by a universal joint, consisting of a gimbal ring, jointed at two opposite points to two arms projecting from the one shaft, and at two points 90° from the former to two arms projecting from the other shaft, each of those points of the gimbal ring, besides revolving around the point of intersection of the two axes, has a librating movement relatively to an imaginary central plane bisecting the angle at the intersection of the axes, and therefore moves from the one side of such a plane, across it, and to the other side during the one half of each revolution, and back during the other half revolution. If then a boss, in the form of a piston, projected from the ring at one of the joints in the direction opposite to the arm, which there connects the ring to the one shaft, and if this piston entered a cylindrical cavity carried on the other shaft, the librating movement above referred to would cause a to and fro reciprocation of the piston in the cylinder. As this movement is not in a straight line, but in the arc of a circle struck from the point where the axes of the shafts intersect, the cylinder has to be made as if its axis were bent to this curvature, so that it is really a portion of a bent tube, the piston having a corresponding form. Now, if by means of a suitable slide or valve fluid under pressure were admitted to the cylinder during the one half of each revolution of the shafts and were emitted during the other half revolution, the pressure of this fluid would cause the shafts to revolve; and, conversely, if the shafts were caused to revolve by extraneous power, fluid would be drawn into the cylinder during half of each revolution, and would be expelled during the other half revolution. The invention relates to the construction of apparatus, which, acting in the manner set forth above, may be employed as a motor when it is supplied with fluid under pressure, or as a meter of liquid passed through it, or as a pump when it is driven by extraneous power. In order to make the apparatus effective during both halves of each revolution, two cylinders and pistons, as referred to, are arranged diametrically opposite to one another on each side of the ring, so that while the one cylinder is discharging the other is receiving fluid; and, in order to provide against the dead centre at each change of direction of movement, the patentee preferably duplicates the arrangement by providing another pair of cylinders and pistons at the extremities of a diameter at right angles to that which joins the former pair, and on the other side of the ring. For governing the admission and emission of fluid, passages are made in revolving bosses, carried on the shafts, presenting facings against which bear stationary slides, so that as ports in these facings pass, in their revolution, corresponding ports in the slides, the fluid flows to and from each of the several cylinders alternately in the succession of their rotation. The accompanying drawings represent the construction and arrangement of a rotary motor of the kind described, which may be worked by steam or other fluid under pressure. Fig. 1 is a longitudinal section, and Fig. 2 is a plan; Figs. 3 and 4 are respectively side and front views of the gimbal ring; Fig. 5 is a front view of the stationary slide and the passages to and from it. A and B are the two shafts mounted in long bearings at an angle to one another, and having bosses *a b* fixed on them. The shaft B serves as a pivot, and does not communicate motion to other machinery. C is the gimbal ring, which is jointed by pins *e* to two arms projecting from the boss *a* and to two arms projecting from the boss *b*. The centres of the joints *c* are in one plane, but the ring C, as shown in Fig. 3, has recesses on each side to allow play for the moving parts, and, for convenience of construction, is made in four pieces, bolted to-

FIG. 1.

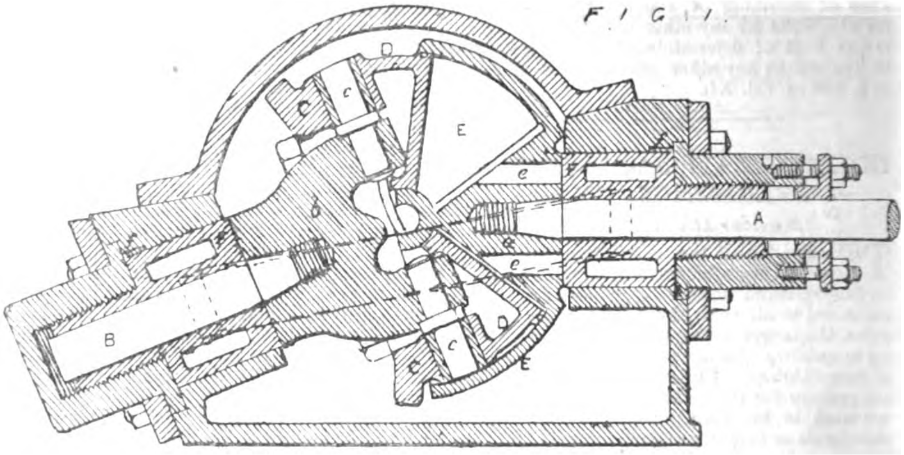


FIG. 2.

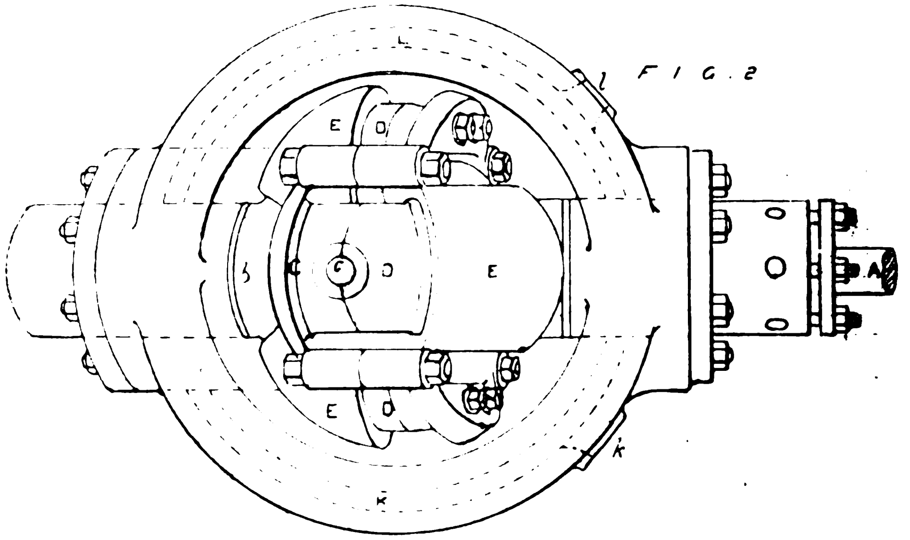


FIG. 3.

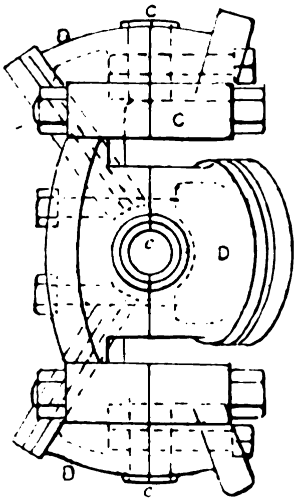
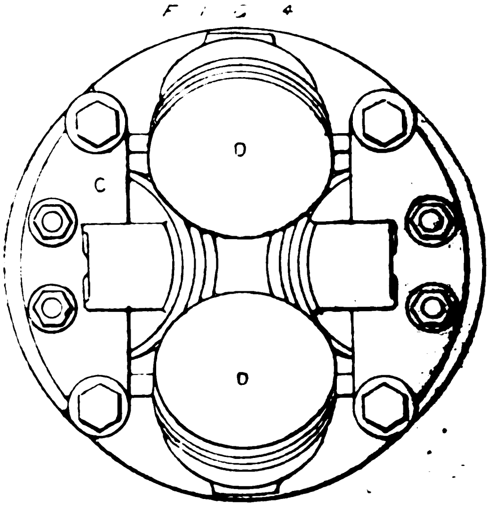


FIG. 4.



gether. From the ring C, on each side of it, project the two pistons D, each of which enters a cavity E, which, as explained above, has the form of a portion of a bent tube, but which, for the sake of brevity and perspicuity, is termed a cylinder, as it plays the part of the cylinder of an ordinary engine. These cylinders are formed, two of them in the body of the boss *a* and two in the body of *b*. Each cylinder has a passage, *e*, opening as a port in the facing against which bears the slide F, which is prevented from revolving by a key *f*. Within the body of the slide there is an annular chamber divided into two compartments, the one opening by a port G and the other by the longer port H to the facing. The slides F form bearings in which the shafts A and B revolve, and these slides are held within bosses of the fixed framing which are connected together by two semi-annular passages, K and L, the passage K opening into the G compartment of each slide, and the passage L into the H compartment. The passage K receives at *k* a supply of steam or other working fluid, and the passage L has an outlet, *l*, for discharge. As the two shafts revolve along with their cylinders E and with the gimbal ring C and its pistons D, the port *e* of each cylinder as it passes the port G of the stationary slide admits fluid to the cylinder, and as it passes the port H of the slide it allows fluid to issue from the cylinder. The slide F being in each case fixed in such a position that its ports G and H communicate with *e* during those parts of a revolution which correspond respectively with the outward and inward movements of the pistons D relatively to their cylinders E, the supply of steam or fluid under pressure causes the shafts to revolve, or, if the shafts be caused to revolve by extraneous power, fluid is drawn in at *k* and expelled at *l*. When steam or other elastic fluid is employed to work the motor, the inlet ports G are made, as shown in Figs. 5 and 6, considerably shorter than the outlet ports H, so that a comparatively small charge of elastic fluid may be admitted to each cylinder, in which it can act by expansion. When water or other liquid under pressure is employed, or when the apparatus is used as a meter or pump for liquid, the inlet ports G are necessarily extended so as to be open to *e* during the whole outstroke in each case.

FIG. 5.

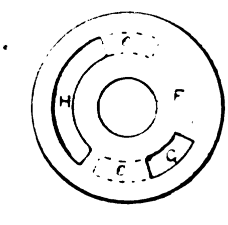
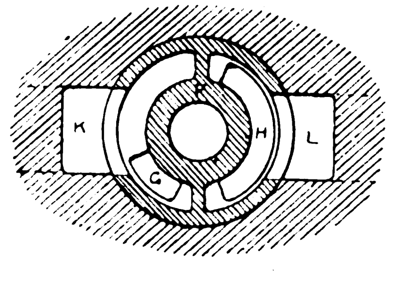
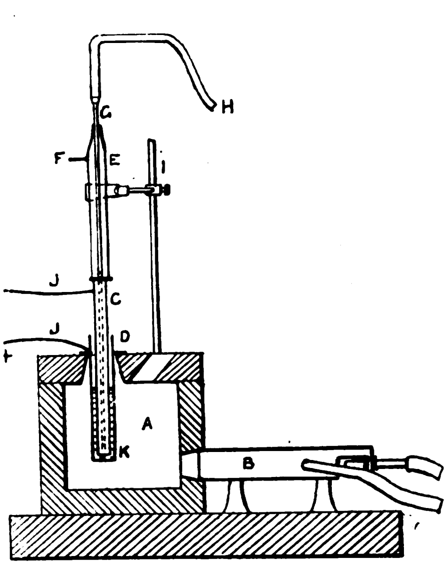


FIG. 6.



## KENDALL'S GAS BATTERY.

THE gas battery or electric generator exhibited by Mr. J. A. Kendall, of Middlesbrough, at stand 1,334, Inventions Exhibition, is specially worthy of notice, because it is an attempt to obtain electricity direct, without incurring the losses which must attend the use of the steam boiler, engine, and dynamo. Several inventors have endeavoured to obtain electricity from the oxidation of coal, carbon, or hydrocarbons without the intervention of the steam-engine, which wastes nine-tenths of the potential energy of the fuel, and Mr. Kendall's device, as probably the forerunner of other notable inventions, deserved even more than the silver medal it obtained. The battery is based upon the well-known phenomenon of hydrogen passing through platinum at a red heat, two platinum plates being used as the poles, one exposed to hydrogen and the other to oxygen. These plates are arranged in the form of concentric tubes closed at one end, and are separated by a fluid medium of fused glass. Hydrogen gas is continuously supplied to the inner platinum tube, while the entire apparatus is maintained at a high temperature by means of a furnace fed with coke or liquid or gaseous fuel. In the exhibit a Fletcher's gas blowpipe is used. The absorption of hydrogen by the platinum is accompanied by electric generation, and the current is led away by wires connected to the platinum tubes It is curious, however, that so long as the two platinum tubes are not connected by a metallic circuit, the passage of the hydrogen is slow; but that as soon as the electric circuit is completed the rate of flow is suddenly increased, and is steadily maintained at the higher amount. The speed at which the hydrogen will pass in a single cell may be gathered from the following experiment:—A platinum tube, K, 2¾in. long and ⅜in. in diameter, closed at one end, was soldered to a strong iron tube, E, and fixed vertically. The platinum tube was immersed for 2¼in. in fused glass contained in a platinum cell, D. This latter was 2¾in. deep and 1in. in diameter. The two platinum tubes were connected by platinum wires, J, with the galvanometer, and the iron tube was connected with a Sprengel pump by the tube H. The cell being heated to bright redness in an oxidising flame, a good vacuum was produced by the Sprengel pump. Then, while no bubbles of gas came down the fall tube of the pump, the galvanometer showed no deflection. The cell was then heated by a reducing flame. The galvanometer soon gave a steady deflection of 15deg., and bubbles of hydrogen came down the fall tube of the pump. The experiment was continued for half an hour, and during fifteen minutes the hydrogen coming down the fall tube was collected. It measured 1·33 cubic centimètres. The figure illustrates a single cell of the battery, and serves to explain the principle; but, at the Exhibition, a cluster or group of cells is shown, in order that the compactness of a gas battery on this principle may be understood, for one gas-blowpipe heats the group. According to Mr. Kendall, the E.M.F. of a cell is about ·7 volt, which is less than the theoretical efficiency; but the remaining energy appears to be developed in the shape of heat at the oxygen plate, and thus serves a useful purpose by keeping up the temperature of the apparatus. It is not necessary to use hydrogen, for in passing through the inner tube K, the gases are separated, the hydrogen being filtered off while the residuals are drawn off at the escape F, and can be taken to the furnace or blowpipe. Thus producer gas, a compound of hydrogen and carbonic oxide, will serve admirably for working this battery, which certainly promises to occupy a wide field of usefulness.



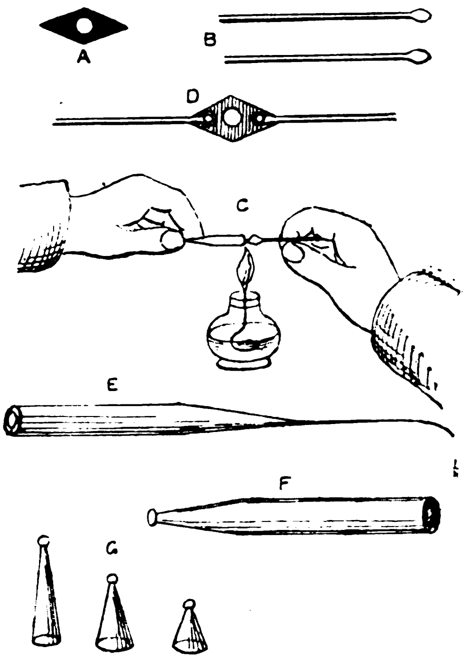
## ELECTRICAL INSTRUMENT-MAKING FOR AMATEURS.—II.*

By S. R. Bottone.

§ 5. SOLDERING WITH A FLAME.—In many instances a better joint and neater looking work can be made over the flame of a spirit or other lamp than with the soldering-iron. This is more especially the case in small work, such as joining wires, soldering pivots, &c. As an example, let us suppose we desire to make a poised magnetic needle out of two similar pieces of needle, joining them together by means of a short tinned-iron junction, in which the pivot is inserted. (It is evident that a pivot could not well be attached to an ordinary sewing needle were the needle in one piece.)

The needles (of which two are required) are broken off of the desired length by means of a pair of nippers. The heads may be the portions rejected, if a very light needle is required: the points, if a heavier needle be not objectionable. Care should be taken that the pieces be of the same weight, to insure a well-balanced needle. A small piece of sheet tinned iron ("tin-plate") about 1in. square should now be procured and flattened out. With a screw-drill, or small punch, a clean central hole is made a trifle smaller than the largest external diameter of the pivot. (See § 6 for pivots). The piece is now cut into the shape of a small lozenge, as shown at Fig. 2, A, and again flattened out by a light blow with a flat-faced hammer. The needles are now to be lightly sandpapered at the ends which are to be soldered to the lozenge, then these extremities immersed in the chloride of zinc soldering fluid. The soldering-iron is then to be heated, and a little globule of solder caused to adhere to the prepared extremity of each needle by its aid. The needles should now present the appearance shown in Fig. 2 B. The spirit lamp is now to be brought into requisition. The flame should not be too high for such work, so that the wick need not be raised much. Taking up the lozenge-shaped piece in the left hand, with a pair of tweezers (or longish piece of wire bent to a tweezer shape), and allowing one half to project, we apply with a feather a little soldering fluid to the projecting point. The needle with its adhering solder is now taken up in the right hand (a small piece of paper being wrapped round it, to prevent the fingers being burnt), and both the needle and the lozenge are held for a few seconds over the flame of the spirit lamp, in the position they are desired to remain (see Fig. 2 C). The solder will soon be seen to flow. As soon as this is the case the pieces must be pressed firmly together, and both hands removed from over the flame of the lamp, care being taken to keep the parts constantly pressed together until a sudden *dulling*

FIG. 2.



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* All rights reserved.

shows that the solder is set. In like manner the other needle is soldered to the other point of the lozenge. The needle may then be magnetised, and after magnetisation balanced on its pivot, as will be described further on. Fig. 2 D shows the needle ready for pivoting.

§ 6. *Pivots.*—These are in constant requisition; consequently, it is well to be able to make them of all sizes. The amateur will need only two kinds—viz., in brass and in glass. *Brass* pivots are very easily made from stout, hard brass wire. The most useful size is about $\frac{3}{16}$in. in diameter. A short length of this is placed in the jaws of a vice, with its circular section uppermost. A bit, capable of cutting a 3-16th hole, is placed in the screw-drill, and after being oiled, the drill is worked over the brass rod, the bit resting quite centrally, until the shoulders of the bit just touch the outside of the wire. This produces a good deep and evenly conical hole. The wire can now be removed from the vice, and the outside of the pivot also made conical by filing, while still on the brass rod; when the desired shape has been secured, it can be cut off with a fret-saw or file.

*Glass* pivots are extremely useful in all electrical experiments. The best way to make these is to soften a glass tube over a spirit lamp, and gradually but steadily pull it asunder. By so doing, two conical pieces are the result. If the extreme hair-like points of these are held over the lamp, they fuse up into a round globule, thus closing up the hole. The pivots thus produced can easily be cut off (when the glass is cold) by making a mark round the tube with a sharp triangular file, at the point where it is desired to break it off. On applying a little pressure between the finger and thumbs of both hands, the pivot easily breaks away from the remainder of the tube. The pivots may be made very long and thin, by allowing the glass to soften well, before beginning to pull asunder, and such long thin pivots are very useful for astatic galvanometers, or other cases in which two objects have to be poised on one pivot. Short pivots can be made by pulling asunder as soon as the glass softens in the flame. Fig 2 C shows how the glass tube should be held in the hands to soften over the flame. Fig. 2 E gives the appearance of the tube after pulling asunder. Fig. 2 F indicates how the hair-like extremity should be melted into a bead over the lamp, so as to close the capillary aperture, and Fig. 2 G shows finished pivots.

## THE MAGNETIC TELEPHONE.

WE have recently had an opportunity of testing a new magnetic telephone, the invention of Mr. E. J. Gillett, of the Signal Engineering Company, which has the promise of coming into extensive use, especially as the Company purpose to erect the lines and supply instruments outright for a moderate sum. The instrument is a modification—an important one—of what is known as the ENGLISH MECHANIC telephone, which was first described in an article on experiments in telephony, p. 551, Vol. XXIII. It is put up in vulcanite cases like the Bell receiver, and has a magnet and the usual bobbin of wire round the pole, but there the resemblance to the Bell instrument ceases, for the diaphragm is a membrane prepared in a special manner to protect it from the effects of the atmosphere. To this membrane is attached a piece of hardened steel, and that being attracted by the magnet, puts the diaphragm into vibration, and so transmits or receives the sounds produced by the voice of the speaker, as conveyed by the variations produced in the current. The instruments are thoroughly efficient, and are turned out in first-class style. As the ENGLISH MECHANIC telephone has been specially disclaimed from Bell's patent, it was only necessary to construct a perfect instrument according to the description given in the volume above mentioned, and that appears to have been accomplished by Mr. Gillett, for certainly speech can be clearly transmitted and received by means of the magnetic telephone of the Signal Engineering Company, which can be seen and tested on presentation of card at the offices of the Company, 181, High Holborn, W.C. A small illustration in our advertisement columns will give an idea of the shape and appearance of the instrument.

THE new volume in the "Nature Series" will be "Flowers, Insects, and Leaves," by Sir John Lubbock.

## EVOLUTION IN THE VEGETABLE KINGDOM.—II.

(*Continued from p.* 538.)

THE most powerful antagonism to this effort of Brongniart to confirm Lamarckian principles from the phytologic side thirty-one years before the appearance of Darwin's "Origin of Species" was offered by the eminent English botanist, Dr. John Lindley, who found a fitting occasion to meet the great French palæontologist on his own ground while engaged with William Hutton in the preparation of their "Fossil Flora of Great Britain," 1831—37. Of this truly great work we are here concerned only with certain discussions which were directed against the then infant doctrine of biologic evolution in the vegetable kingdom, and which were not only marked with great acrimony, but were allowed to influence and to warp the classification adopted by the authors into forms which even to botanists now appear ridiculous. The introductory remarks in the first volume, as well as much of the general discussion throughout the work, are characterised by a most astonishing and apparently wilful ignorance of the true principles of palæo-phytology as they were set forth by Brongniart, Sternberg, and even Schlotheim, and which are now universally accepted.

One of Dr. Lindley's remarkable aberrations was the pertinacity with which he contended for the existence of cactaceous and euphorbiaceous plants in the coal measures. It is true that Parkinson had seen a fancied resemblance between certain stems and those of large cacti, and similar guesses had been made by Volkmann, Walch, and other authors of the eighteenth century, when it was supposed that the counterpart of every fossil plant must be found in the living flora, but all these imaginings had been long since laid aside only to be revived by the leading botanist of Europe.

The theory of a former tropical climate in England and on the Continent of Europe was assailed, the existence of tree-ferns in the Carboniferous was denied, the relation of the Calamitæ to the Equisetaceæ questioned, and many other tolerably well established generalisations were remanded to the domain of doubt and discussion.

The true secret of this sweeping scepticism is, however, not far to seek. It is found in the more general denial, which was finally made, of the conclusion to which the acceptance of these rejected theories would naturally lead and had actually led M. Brongniart and others. The authors say: "Of a still more questionable character is the theory of progressive development, as applied to the state of vegetation in successive ages. In the vegetable kingdom it cannot be conceded that any satisfactory evidence has yet been produced upon the subject; on the contrary, the few data that exist appear to to prove exactly the contrary." All the denials and assertions made in the work opposed to Brongniart's teachings are made to support this view. The existence of Cactaceæ, Euphorbiaceæ, and other dicotyledons in the Carboniferous would negative development; the admission of a former tropical climate was a strong argument for the nebular hypothesis as well as for geologic progress; tree-ferns would argue such a former tropical climate; if Calamites could be shown to be a Juncus, a higher type would be found in Palæozoic strata than Brongniart believed to occur. Still another good point was thought to be gained by proving what is now admitted—viz., that coniferous plants occur in the coal. All botanists then held, as many still hold, that the gymnosperms were a subclass of the dicotyledons, co-ordinate with the dicotyledonous angiosperms. But, curiously enough, Brongniart had forestalled this argument by making the gymnosperms of lower type, intermediate between the cryptogams and the angiospermous phanerogams. By a special insight, characteristic of true scientific genius, he had used their lower geological position as a proof of their lower organisation—i.e., had postulated evolution as an aid to organic research—a method which is now becoming quite common, although unsafe except in the hands of a master.

Dr. Lindley laid much stress upon the fact "that no trace of any glumaceous plant has been met with even in the latest Tertiary rocks," thus freely employing the fallacy which he elsewhere warns others to avoid, that because a class of plants has not been found, therefore it did not exist at a given geological epoch. But to cut off the possibility of a reply to the position he takes he finally declares that "supposing that sigillarias and stigmarias could really be shown to be cryptogamic plants, and that it could be absolutely demonstrated that neither Coniferæ nor any other dicotyledonous plants existed in the first geological age of land plants, still the theory of progressive development would be untenable, because it would be necessary to show that monocotyledons are inferior in dignity, or, to use a more intelligible expression, are less perfectly formed than dicotyledons. So far is this from being the case that, if exact equality of the two classes were not admitted, it would be a question whether monocotyledons are not the more highly organised of the two; whether palms are not of greater dignity than oaks, and Cerealia than nettles." Teleologic and anthropocentric reasoning like this pervades all the discussions in this work and vitiates the scientific deductions. The elaborate experiment that Dr. Lindley made and described in the first dozen pages of the third volume was obviously animated by the same spirit of uncompromising hostility to the development hypothesis. By showing that the higher types of plants when long immersed in water are earlier decomposed than ferns, conifers, and palms, he thought he had demonstrated that the reason why we find no dicotyledons in the Carboniferous is simply because they had not resisted, and from their nature could not resist, the destructive agencies to be overcome in the process of petrifaction. One could wish that he might behold the four thousand species of fossil dicotyledons now known, and realise how vain had been his experiment as well as all his theorising!

It is such resistance as this, coupled with the power of the Jussiæan method, that has retarded the progress of correct ideas respecting the development of plant life. Systems of classification have been chiefly modelled after those of the early founders. The text books of botany still generally invert the order and begin with the phænogams, although this is doubtless merely intended to facilitate study, and does not at all imply that our leading botanists believe this to have been the order in which plants have developed. This inversion of the order, however, shows how completely the notion of development is ignored in modern botany, and the system throughout rests upon the evidence furnished by the organs of the plants as they are understood. Nevertheless, it is proper to say that at the present time quite a large body of the most thorough students of vegetal embryology and histology, chiefly in Germany, have rejected much of the modern system of botanical classification, and especially that which concerns the position of the gymnosperms. They prove in the most satisfactory manner that these plants constitute a lower type than any of the remaining phanerogams, and they also find that in their reproductive organs they form a more or less natural transition from the cryptogams to the phænogams, between which they place them. This result is most gratifying to the palæo-botanist, for nearly all works on fossil plants give the gymnosperms this position at the base of the phænogamic series, so sagaciously assigned to them by Brongniart. They have been compelled to do this in the face of the prevailing botanical systems, because this is the position which they are found to occupy in the ascending strata of the earth's crust. It is astonishing that botanists could have remained so indifferent to such a weighty fact, and it is certainly most instructive to find the geological record, so long unheeded, confirmed at last by the facts revealed in living plants. There is no evidence that those who have thus confirmed it were in the least influenced by it, since Sachs and Caruel are as silent respecting palæontology as De Candolle or Bentham.

The founders and perfecters of the prevailing system of botanical classification have not been influenced to any marked degree by the idea of development in vegetable life. Few of the earlier ones had ever heard of development, except at least as a visionary theory. This system had become established long before the doctrine of the fixity of species had received a shock, for although Lamarck, himself a botanist, had sown the seed of its ultimate overthrow, still it required half a century for this seed to germinate, and it was during this half century that the Jussiæan system was supplanting the Linnæan and gaining a firm foothold.

Shaking off, for the time being, all fixed allegiance to any system, let us glance for a moment at the lesson which vegetable palæontology now teaches upon the subject of development.

## BACTERIA AND THE CELL THEORY.[*]

PATHOLOGICAL science has always been more or less governed by some dominant idea. At one time it was the blood and fluids of the body; at another the action of the blood vessels; at another that of the nerves, in which men saw the initial stages of morbid change. The autonomy of the cell and the share taken by cell life in pathological processes replaced the older theories, and now the idea of parasitism seems to overshadow all. The cell theory is becoming subordinated to the operation of microbes, and diseased action is coming to be regarded as the expression of the vital resistance of the tissues to the invasion of external organisms. Professor Virchow, in an article entitled "The Strife between Cells and Bacteria" (*Archiv. der Path. Anat.*, Bd. 101, Heft 1), points out that in spite of the modern advances in bacteriology the cell doctrine is by no means extinguished. Indeed every new discovery tends, he thinks, to confirm the truth that the whole work of the body, and all the changes it undergoes in disease, are the result of the special activities of the cells that compose the organism. Each cell may be regarded as an individual, and every discovery that demonstrates the independent activity of the cell strengthens this doctrine. Thus the discovery of the mobility of cells and of the facts of cell migration did not displace the cell theory, as some think, but merely widened its conception. The matter is somewhat different with the new ideas concerning the influence of micro-organisms; and it becomes a question how far the older view of cellular activities will have to be modified by the introduction of the notions of parasitism. Virchow accordingly traces the development of this, the etiological, side of pathology, which he admits had been much neglected. The notion that fungi could produce disease arose out of the discovery by Bassi of the muscardine disease of silkworms in 1835, of the fungus of favus by Schonlein in 1839, and that of thrush by Jul. Vogel in 1841. Some pathologists — notably Henle — generalised upon such scanty facts, and propounded a theory of disease based on parasitism, which went beyond even our present knowledge. Facts, however, accumulated but slowly; for although the life-history of the ordinary fungi was known, that of the large group of schizomycetes was ignored or misinterpreted. Ehrenberg classed bacteria among the infusoria, and their vegetable nature was for long in doubt. Again, in those days there were none of the powerful microscopic appliances now in vogue, no idea of "cultivations," none of the methods of staining which are now employed—for, indeed, the staining reagents were not then discovered. Moreover, the ubiquity of these micro-organisms, their presence in every drop of water or bubble of air, may have been one reason why they were overlooked as causes of disease.

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[*] From the *Lancet*.

Professor Virchow relates an example of this oversight from his own experience in cholera investigation. In the first fatal cases of the epidemic of 1848 he detected "numerous vibriones" in the intestines, and noted the absence of any such foreign matter in the blood. He found in choleraic evacuations "vibriones and ciliated monads," but could determine no special forms, and concluded that their presence was due to decomposition. It is possible, he remarks, that these "infusoria" were identical with common bacilli, but twenty years later he found, in a case of arsenical poisoning with choleraic symptoms, that the large intestine contained "masses of bacteridia and vibrios corresponding with those described by Klob and others as cholera fungi." In 1868 he wrote to the effect that, although the minuteness of such organisms rendered their differentiation difficult, he did not despair that some day a specific form of vibrio in cholera would be found by experimental research. Therefore he would not abandon the notion of there being a cholera fungus, and of the cholera miasm being a ferment; and, looking to the present stage of inquiry respecting the comma bacillus, he holds that the question is still unsolved, even in spite of improved instruments and methods.

The idea that infective diseases are due to the presence of micro-organisms remained hypothetical until the discovery of the anthrax bacillus by Pollender, Davaine, and Brauell, that of the micrococci of variola and vaccinia by Keber, and of the spirillum of relapsing fever by Obermeir came to supply definite facts as to the presence of microbes in the blood. Yet how much remains to be done, even in the first stage of this etiological research—viz., the proof of the presence of micro-organisms! Such proof is wanting in the case of a large number—and these the commonest forms—of infectious and contagious diseases. For the mere discovery of the presence of a microbe is of slight gain either to pathology or treatment. Is relapsing fever, asks Virchow, better understood or treated since the discovery of the spirillum? Of what influence has the discovery of micrococci been upon the doctrines of small-pox and vaccination? Had it not been for Pasteur's application of the principle of attenuation of virus to the practice of protective inoculation, the sole practical outcome would have been, that of Lister, which, it must be remembered, was the result of a stroke of genius, and not of the demonstration of actual fact. Nevertheless, micro-organisms occupy the field. They occupy the thoughts and fill the dreams of many old and all young physicians. The part played by cells is forgotten, or deliberately ignored, and in evidence thereof Virchow quotes a passage from a Paris journal in which it is declared that the republic of cells has been vanquished by the forces of parasitism. No wonder that the great founder of cellular pathology should cry "Poor little cells! Many a man with his 'Abbe-Zeiss' seeks to render them invisible, and to bring into view only the stained microbe. Yet they are there, and can wait; their time will come again when physicians have finished the task of filling up the lacunæ of botanical knowledge. Then the cell will once more take up its position in the front rank of scientific and practical interest."

If, however, cell life should become again the foundation of morbid processes, it will be more or less under the influence of the new doctrines. For after a parasite has been discovered, and its mode of life ascertained, there remains the problem how it excites disease. When Koch discovered the tubercle bacillus, many said that all the careful labour of former days upon phthisis had been thrown away. Phthisis was a unity, for the bacillus was at its root. Pulmonary tuberculosis was identical with caseous hepatisation, glandular tuberculosis with scrofula, and so on. But in a short time it was found that this unity could not be maintained, and pulmonary phthisis remains what it was—a process of varied origin, sometimes the outcome of mere inflammation, sometimes of specific tubercle. He who would understand it aright must learn something more than how to stain bacilli. So little light has the discovery thrown on phthisis that even the upholders of bacillary phthisis have to fall back upon the notions of predisposition and immunity. The knowledge of a bacillus may be necessary for a full comprehension of the origin of a morbid change, but it does not explain the lesion nor render its examination superfluous. So is it with leprosy. The discovery of the bacillus lepræ excluded a large number of other possible explanations, but made no positive advance in the diagnosis, prognosis, or cure of the disease, and will make no advance until by the application of the older knowledge of the local affections of leprosy to the bacillus we gain some insight into the relations between the two. That relation may be expressed in the terms of the title given by Virchow to his paper. We may conceive a state of war between the microscopic cell elements of the body and the microphytes. Both cell and microphyte are endowed each with its own life and powers. Which is the aggressor? What excites its attack? Does the other combatant resist, and, if so, by what means? Which of the two is vanquished in the struggle? These are questions to be answered. In olden time disease was regarded as a struggle. The definition of Schultz-Schultzenstein made it a struggle of life with death; but it is the living thing that struggles, and not life, while death is no active opponent—it is merely a negation. Schonlein was nearer the truth in his statement that the living body contends against cosmic and telluric assaults. At present we know more of the properties and activities of cells than we do of these vegetable parasites, but knowledge of the latter, and of their product — ptomaines — grows day by day, with clearer evidence that the nature of their action upon the cells of the body is a chemical one. The near future will have to determine what is the nature of the resistance offered to this agency by the living cell; and already the researches of Metschnikoff have thrown some light upon this, showing how bacterial organisms can be taken up and destroyed by the cells of the animal body. Thus Virchow predicts we shall see inquiry enter once more within the domain of cellular pathology. The search for the cause of diseased action will lead to the further question as to how that cause operates, and to answer this our knowledge of cell life will need to be expanded. If, then, the modern pathologist is engaged in detecting and describing bacterial organisms, he will so much advance our knowledge of disease; but he cannot, in this limited view, give that fulness to knowledge which will embrace not only the causative agent, but the organism acted upon; not merely the parasite, but the host; not the bacterium only, but the cell that it attacks. We need to be reminded of such things, if only to teach us a little humility, and to prevent us falling into errors which would do much to bar real progress in knowledge.

## ON THE COLOUR CORRECTION OF DOUBLE OBJECTIVES.*

By CHARLES S. HASTINGS.

### I.—Review of Attempted Methods.

IF we call the focal length of two thin lenses in contact P, one of the lenses being made of a material with indices of refraction $n$, and the other with indices indicated by $n'$, we may write—

$$\frac{1}{P} = \phi = (n-1)A + (n'-1)B \quad \dots\dots\dots\dots(1)$$

where A equals the sum of the curvatures of the two surfaces bounding one lens, and B the corresponding sum for the other.

In order that this system may be achromatic, it is necessary that P or $\phi$ should be invariable with $n$ or $n'$, or, in other words, that the equations—

$$\frac{d\phi}{dn} = O = A + \frac{dn'}{dn}B \quad \dots\dots\dots\dots\dots\dots(2)$$

$$A = -\frac{dn'}{dn}B \quad \dots\dots\dots\dots\dots\dots\dots\dots(3$$

should be satisfied. Unfortunately, this is in practice impossible, because at present no two varieties of glass are known in which $\frac{dn'}{dn}$ is constant. On the contrary, this coefficient is itself a function of $n$, and has an infinite number of values, all included in practical cases, however, within limits nearly approached. Thus, since the last equations cannot be satisfied for all values of $n$, the problem is reduced to finding that value of $\frac{dn'}{dn}$, which substituted in (3) will make the combination the most advantageous one.

The first efforts to find a solution of this problem were attended by one of the most brilliant discoveries in physical optics. Only in objectives of considerable size does the question become of great importance, and as Fraunhofer was the first to attempt such objectives, so he was first confronted with the problem. To solve it, he performed an elaborate series of experiments on the optical properties of various glasses, during which he discovered the lines in the solar and certain stellar spectra universally known by his name. Moreover, as it was evident that the accepted value of $\frac{dn^1}{dn}$ should depend upon the relative intensity of lights of different refrangibilities, he made a photometric determination of the brightness of the various parts of the solar spectrum. With data thus derived, his theoretical method of determining the best value of the coefficient $\frac{dn^1}{dn}$ was to deduce various values by observation, multiply each value so obtained by the relative brightness of the corresponding region of the spectrum, and divide the sum of these products by the sum of the numbers denoting the brightnesses. For example, if ${}^{n}a$, ${}^{n}\beta$, ${}^{n}\gamma$, &c., are the indices of refraction for the first medium corresponding to the Fraunhofer lines $a$, $\beta$, $\gamma$, &c., ${}^{n'}a$, ${}^{n'}\beta$, ${}^{n'}\gamma$, &c., the corresponding quantities for the second medium, and $q_1$, $q_2$, $q_3$, &c., are the relative quantities of light contained in the solar spectrum between the lines $a\beta$, $\beta\gamma$, &c., then the accepted value of the co-efficient is given by the equation—

$$\frac{dn'}{dn} = \frac{q_1 \frac{{}^{n'}\beta - {}^{n'}a}{{}^{n}\beta - {}^{n}a} + q_2 \frac{{}^{n'}\gamma - {}^{n'}\beta}{{}^{n}\gamma - {}^{n}\beta} + \&c.}{q_1 + q_2 + \&c.}$$

Fraunhofer found, however, that for a combination of crown and flint glass this method always gives too large a value for $\frac{dn'}{dn}$—that is to say, that an objective so constructed would be notably under-corrected. Nor is it difficult to recognise that the theory is imperfect, for it implies that light of all refrangibilities is of value in the formation of the image exactly in proportion to its intensity, whereas in reality light of the extremes of refrangibility, instead of assisting in defining an image, is absolutely harmful. Fraunhofer was driven, therefore, to a purely empirical determination of the quantity under discussion, and from his time to the present the only way for an optician to determine the relative foci of the two components of an achromatic objective, is by a laborious process of altering the curves, and testing the result, until the outstanding colour, about the image of a bright star, is such as *experience* has shown is attended with good definition. A few of the more scientific opticians determine the coefficient by means of prisms instead of lenses, and thus by a knowledge of the mathematical relations involved, save a great deal of manual labour. Still, even in the case where a pair of prisms combined to form a *diasporometer* is used, instead of a pair of lenses, the accepted value of the coefficient depends upon an exercise of the judgment alone, and hence this process yields no unambiguous solution.

### II. A Theoretical Solution.

In order to investigate the best theoretical value for the coefficient $\frac{dn'}{dn}$, we may begin by expressing $n'$ either directly or indirectly as a function of $n$. The most naturally suggested course is to express each as a function of the wave-length of light according to Cauchy's well-known formula; but not only is the labour of computing the constants for the necessary three terms of such a formula great, but the accuracy of the expressions thus obtained is very inconsiderable. In another article*, however, I have shown that $n^1$ may be expressed for all cases of practical importance, as a function of $n$ by a simple trinomial of the second degree, so that the residuals are smaller than the errors of observation, except in cases where very extraordinary accuracy is attained. We have thus—

$$n^1 = a + \beta n + \gamma n^2;$$

and the equations above become—

$$\frac{1}{P} = \phi = (n-1)A + (a - 1 + \beta n + \gamma n^2)B \,..(1')$$

$$\frac{dy}{dn} = O = A + (\beta + 2\gamma n)B \dots\dots\dots\dots\dots(2')$$

$$A = -B(\beta + 2\gamma n) \dots\dots\dots\dots\dots\dots(3')$$

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* From the *American Journal of Science*. Third series, Vol. XXIII. No. 135.—March, 1882.

* *American Journal of Science*, Vol. XVIII. p. 429 1879. See also ENGLISH MECHANIC, p. 447.

The problem is to determine the particular value of $n$, which can be most advantageously substituted in the last equation. This value will be designated as $n_o$, and the corresponding focal distance as $P_o$.

To accomplish this solution we must first find a criterion of excellence in an objective. This we may easily do, after defining the sense in which we here use certain certain terms, as follows:—

Light, for the purpose of this investigation, is defined as that form of radiant energy which affects the retina. Its quantity is measured, not by the value of the energy, but by the physiological effect which it is capable of producing. The *intensity of light of refrangibility*, $n$, is measured by the quantity of light contained between the refrangibilities, $n$ and $n + dn$, divided by $dn$. Thus, if $q_n$ equals the quantity of light so defined, and $\iota_n$ its intensity, then—

$$q_n = \iota_n \, dn.$$

In what follows we shall consider only such light as is given out by a very hot solid body. This light is composite, and contains light of all refrangibilities from a little less than that of the Fraunhofer line A, to practically a little more than that of the line H. We let $n_r$ and $n_v$ represent these limits of refrangibility. Then if Q is the total amount of light falling upon a given area—*e.g.*, upon an objective—we have evidently—

$$Q = \Sigma q = \int_{n_r}^{n_r} \iota \, dn$$

In this expression $\iota$ is an unknown function of $n$; but we know enough of the properties of this function for the present purpose.

A perfect objective would concentrate *all* the light incident upon it from a distant point in its axis to a very small circular area in the focal plane, which area would be constant for all telescopes of the same angular aperture. The most perfect attainable objective then would be that which concentrates the greatest attainable amount of light within this area. To investigate the conditions which must be satisfied to this end, we must determine the amount of light falling within a small circular area $\sigma$ at $P_o$, the radius of which we will set as $a$ tan. $\frac{1}{2}$ $\alpha$, where $\alpha$ is the angular aperture of the objective. It is evident that all the light of such refrangibilities as substituted in ($1^1$) would yield values of P contained between $P_o - a$ and $P_o + a$ would fall within the area $\sigma$. These limiting refrangibilities shall be denoted by $n_{-a}$ and $n_{+a}$. Only a portion of the light of refrangibilities less than $n_{-a}$ and greater than $n_{+a}$, however falls upon this area, the amount of light for the refrangibility $n$ being clearly—

$$q_n \frac{a^2}{(P_o - P_n)^2};$$

hence the total quantity of light falling upon $\sigma$ would be equal to the sum of the three integrals, the first taken from the extreme red up to $n_{-a}$; the second from $n_{-a}$ up to $n_{+a}$, and the third from this last up to the extreme violet—that is, if $q$ be this quantity—

$$q = a^2 \int_{n_r}^{n_{-a}} \iota_n \frac{dn}{(P_o - P_n)^2} + \int_{n_{-a}}^{n_{+a}} \iota_n \, dn$$
$$+ a^2 \int_{n_{+a}}^{n_a} \iota_n \frac{dn}{(P_o - P_n)^2}.$$

To find the value of $n_o$, which will render the last expression a maximum, it is necessary to find the first derivative of the function with respect to $n_o$ and set it equal to zero. Remembering that $\frac{dP_o}{dn_o} = 0$, we see that $P_n$, $n_{-a}$, and $n_{+a}$ are the only quantities dependent upon $n_o$; hence we obtain by differentiation under the signs of integration.

$$\frac{dq}{dn_o} = 0 = -2a^2 \int_{n_r}^{n_{-a}} \frac{\iota_n \, dn}{(P_o - P_n)^3} \frac{dP_n}{dn_o}$$
$$+ a^2 \frac{\iota_{n-a}}{(P_o - P_{n-a})^2}$$
$$+ \iota_{n+a} - \iota_{n-a} - 2a^2 \int_{n_{+a}}^{n_r} \frac{\iota n \, dn}{(P_o - P_n)^3} \frac{dP_n}{dn_o}$$
$$- a^2 \frac{\iota_{n+a}}{(P_o - P_{n+a})^2}$$

But from the definition of the quantities $n_{-a}$ and $n_{+a}$ we have—

$$(P_o - P_{n-a})^2 = (P_o - P_{n+a})^2 = a^2.$$

Hence, the value of $\frac{dq}{dn_o}$ reduces to minus the product of $2a^2$ into the sum of two definite integrals $dn_o$, and the problem becomes simply the determination of the value of $n_o$, which will cause this sum to vanish, as since $\frac{dP_n}{dn_o} \cdot \frac{1}{(P_o - P_n)^3}$ must have opposite signs in the two integrals because $\frac{dP_o}{dn_o} = 0$, that value which will make the two integrals equal. If both $\iota_n$ and $P_n$ were symmetrical with respect to some one value of $n$, that value would evidently answer the condition: otherwise it is necessary to know the function $\iota_n$.

It would be easy to find a transcendental function which would express empirically the photometric observations of Fraunhofer, or the more recent and elaborate ones of Vierordt; but a simple consideration of the physical limitations of the problem will enable us to dispense with this operation. Hitherto, we have made no restrictions as to the value of $\sigma$. Let us now suppose that $\sigma$ is so small that it may be regarded as the image of a star, then $a$ is small, and since $\frac{dP_o}{dn_o} = 0$, $P_n$ may be regarded as symmetrical with respect to $n_o$ for values not differing largely from $P_o$. Again, for white light $\iota_n$ is shown by the photometric observations above named to have a single maximum corresponding to a certain value of $n$, which we will designate as $n_1$, and consequently may be regarded as a symmetrical function of $n$ in the region of this maximum. Finally, $\frac{dP_n}{dn_o}$ is never large in practical cases between the limits $n_r$ and $n_o$, while $P_0 - P_n$ increases continuously in numerical value toward these limits. If, then, we set $n_o = n_1$ the two definite integrals become sensibly equal, and $q$ is a maximum.

The value $n_1$ corresponds to light of a refrangibility greater than that of the Fraunhofer line D, and less than that of E; nearer, however, to the former. The only prominent Fraunhofer line readily seen with a crown-glass prism of moderate dimensions in this region is that of wave-length 5614. This I will assume as defining $n_o$, and consequently the ratio of A to B in (3). In all substances practically useful in telescope making, $\gamma$ of (2′) is positive, therefore $P_o$ is a minimum.

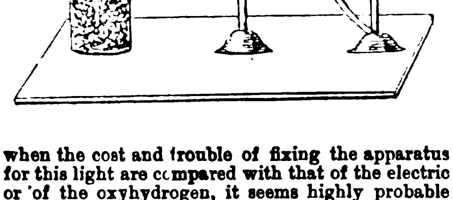
The reason given above is evidently applicable to all forms of radiation transmitted by the lens system, if appropriate definitions of $q$ and $\iota$ are given, and $\iota$ possesses a single maximal value. For instance, in the case of radiant energy, pure and simple, $n_o$ should nearly equal $n_r$ (lenses of glass); and for a photographic objective where silver salts are to be acted upon $n_o$ should be nearly equal to $n_g$.

(*To be continued.*)

## THE NITROUS OXIDE AND CARBON-DISULPHIDE LIGHT.*

By Wm. Thos. Jackman, M.R.C.S., &c.

THE light obtained by burning a mixture of nitrous oxide gas and the vapour of carbon disulphide is well known to be very powerful for photographic purposes. It is of an intensely blue colour, and very active in photographic-chemical properties, being, according to Stein, twice as powerful as that of the oxyhydrogen flame, and three times as powerful as that of the electric lamp. This able scientist points out that when in full power it illuminates a larger surface than the same sized flame of other artificial sources. Moreover, when the cost and trouble of fixing the apparatus for this light are compared with that of the electric or of the oxyhydrogen, it seems highly probable that this form of artificial light will be more extensively used than it is at present. The want of a reliable, cheap, and uncumbersome artificial light has long been felt by photographers; hence I am emboldened to draw attention to this source, and explain shortly the apparatus required for its use, and refer to a few of the experiments which have been made with it, hoping thereby to encourage its more general trial in the art of photography. An ingenious apparatus for the mixing and burning of the nitrous oxide and carbon disulphide vapour has been invented by Delachanal and Mermet, of Paris, by which a constant light can be obtained, and the danger of an explosion obviated, for it must be borne in mind that carbon disulphide vapour is very explosive under certain conditions. The apparatus consists of a double-necked flask of about 500 c.c. contents, which is filled with pieces of sponge or pumice, saturated with the vapour of carbon disulphide. Into one mouth, A, a bent tube is fixed, through which the nitrous oxide gas passes into the flask. A second bent tube is fixed into the other mouth of the flask; this passes into a wider tube of metal, B, 20 c.m. long, which is tightly filled with iron filings, the object of this being to prevent the flame passing back into the explosive vapour contained in the flask. After passing through this tube, B, the mixture of nitrous oxide and carbon disulphide is led by means of an indiarubber tube to a modified Bunsen's burner. This burner has neither the usual opening for the admission of air nor the arrangement for regulating the quantity of gas passing through it. The nitrous oxide enters the flask through A, and after mixing with the vapour of the carbon disulphide in the flask passes through B to the burner, where it can be ignited with safety, and with the production of a very blue flame. The size of this flame depends upon the dimensions of the apparatus. The amount of the mixed gasses to be burnt can be regulated by a stopcock placed between the tube B and the Bunsen burner. E. Sell, of Berlin, produced, a few years since, some excellent photographs with this light, which were exposed a shorter time than when using the electric or magnesium light, and were in every way more perfect. Riche and Bardy, of Paris, also made extensive experiments with this light, and proved it to be twice as powerful as the magnesium, and three times as powerful as the limelight. They further showed that the photo-chemical power of the light was due to the blue flame of the sulphur in the combination. Oxygen may be used instead of nitrous oxide gas, but the latter is recommended as being safer.



## RED PRINTS FOR DRAUGHTSMEN.*

AN innumerable quantity of red photographs are made daily in the city of New York. These red prints are termed silver prints, and although they, in reality, do not deserve to be called silver prints, *par excellence*, there is a certain reason or excuse for that generally adopted name. Hardwich's theory of substitution—that is, gold substituting the silver of the photograph in the toning process, does not find any application here, as the prints in question are simply silver proofs, fixed, without being toned, in a pure and plain solution of hyposulphite of soda, washed and dried. A majority of the illustrations of our daily newspapers, trade journals, price lists, and various other publications, when printed on the ordinary press from relief plates or zinc etchings, have for a base the photographic silver, or red prints. Such prints, taken from the ordinary negatives, are placed in the hands of a draughtsman, who reduces the photographic half tone, or stipple—in fact, breaks up the original photograph into a system of lines, destroying its original character altogether. The photograph having so far served the purpose of being a sketch to the finished picture is now removed from the paper. A strong solution of bichloride of mercury is poured over it, and in the manner of the so-called magic photographs, the silver deposit on the paper is bleached out, leaving visible only the India ink work upon a white ground.

Such pictures are, or ought to be, a correct representation in line manner of the photograph employed. In portraits the likeness can be kept well, and in landscapes, in machinery, and other inanimate objects, the most intricate details can be rendered sharp and distinct as in the original photograph.

The drawing in its present condition is handed now again to the photographer, who reproduces from it a negative of extremely strong intensity, fit to make from it a relief plate, or to print it on a bichromated albumen or asphaltum film upon a zinc plate, preparatory to the etching process.

Photographs for red prints are mostly always enlargements of the originals in the proportion of one to three. By reducing the drawing afterwards to the original size, the lines are rendered extremely sharp and delicate. Etchings and relief plates managed in this manner are frequently of a beauty equal to any well executed wood engraving.

The making of red prints for the engraver or draughtsman, simple as it may appear, has its difficulties, as well as any other photographic process. The tone of the print is of great importance; if inclined to be black, or when printed too deep, the draughtsman is unable to see the ink lines, especially when very fine. The negative must also be of a certain quality; all details must be visible, and great contrasts between light and shade must be avoided; still the plate must be able to give a well-defined and somewhat brilliant print. Negatives for red prints, which are mostly made on collodion, are somewhat over-exposed and slightly intensified. Ordinary Rives paper is used for printing, salted with chloride of ammonium or barium, from 10 to 30 grains to the ounce of water. Citric acid, the same quantity as the chloride, may be added to the salting bath, or the salted paper, when dried, may be floated for a minute, before silvering, upon an acid solution of the same strength. The strength of the silver should be regulated according to the strength of the salting bath; weak solutions are, however, preferable. After the proof has been printed to the desired depth, it is washed in water acidulated with citric acid, and after all acidity has been washed away, fixed in a fresh hyposulphite-of-soda solution, 1·8. Organic matter, like gelatine or boiled starch, in the salting bath, assists in keeping the red colour.

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* From the *Photographic News.*

* By C. E., in the *Photographic Times.*

A brick-red or a muddy yellowish tone is probably caused by too strong a silver solution or impure hypo. The quality of the negative has as much to do with a good tone of the print as in any other process. The washing of the print must be done quickly and thoroughly. Hypo in the print prevents the perfect bleaching of the print with mercury; too much washing softens the paper and makes its surface woolly, hence the addition of gelatine or starch is advisable, also to impart strength to the paper. The red tone of the print is of great importance; it assists greatly the engraver's work. The fine lines he draws upon the photograph are more distinct and more visible to him than when made upon a bluish-black ground. There is a great demand for silver prints in the engraving district of New York, and when they are made in the manner described, or by a similar process, they are always satisfactory to the engraver. These prints find a practical application.

How to obtain beautiful and decided red tones has been described repeatedly. The methods with bichromate, grape sugar, and silver development, and many others, give splendid results, and are highly interesting to the student as well as the practitioner, but neither of them has gained such a popularity as the simple so-called silver print.

## THE DYEING OF FEATHERS.

THE *Teinturier Pratique* remarks that the dyeing of feathers (like that of tissues) requires two operations, scouring and dyeing.

*Scouring.*—This operation is intended to remove from the feathers the fatty substances and impurities which they may contain. For that purpose the feathers are steeped for some hours in benzine or mineral essence, and are then exposed to the air. When dry they are carefully soaped in a hot bath of Marseilles soap, being afterwards rinsed and dyed.

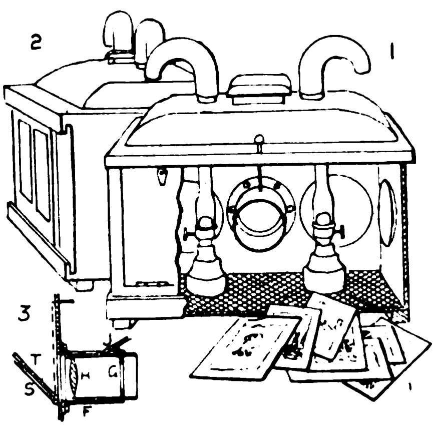
*Bleaching.*—For white feathers the soaping with a hot bath is renewed two or three times. Then rinsing follows, and afterwards azuring in a bath mordanted with a little sulphuric acid, and containing a small quantity of aniline voilet or aniline blue. The feathers are rinsed, passed through a solution of starch, vaporised, and curled.

*Dyeing in Black.*—The feathers are plunged after scouring into a bath of sulphate of iron (green copperas) at 10 or 15 deg. B. They are let soak for two or three days in this bath, then washed and passed in a hot bath of Marseilles soap. The feathers are rinsed and are steeped for forty-eight hours in a solution of tannin at 5 or 6 deg. B. After being again rinsed they are replunged for twelve or eighteen hours into the bath of sulphate of iron, and then washed. Finally they are dyed at 158 deg. to 167 deg. Fahrenheit in a bath containing the quantity of logwood necessary to obtain the shade required. They are then washed and passed through a cold soap bath, after which they are starched, dried, vaporised, and curled.

*Dyeing in Violet, Blue, Green, and Aniline Pink.*—Into a bath of water at 122deg. or 131deg. Fahrenheit, and mordanted with a little sulphuric acid or tartaric acid, there is placed the quantity of colouring substance necessary for the depth of shade required. When it is dissolved the feathers are plunged into it, and are constantly manipulated till dark enough in colour. They are carefully rinsed, and are passed into a light starch bath and dried. They are shaken to remove the excess of starch, then vaporised and curled.

## A REFLECTING MAGIC LANTERN.

A MAGIC-LANTERN which can be used for showing opaque objects has been recently patented by Messrs. H. and G. Davenport, of Somerville, Philadelphia, U.S.A., and is thus described by the *Scientific American*:—On the inside of each end of the front, and on the inside of each end of the box, is a concave reflector; these are so placed as to concentrate the light upon the picture at the centre of the back of the box. In a tube, F, projecting inward from the front, between the mirrors, is arranged a sliding tube, C, holding a convex lens, H. This tube is moved for focussing by means of a rod, J, extending up to the top of the back of the box. In the box two lamps or other lights—such as calcium or electric—are placed between the mirrors at each end, as shown in Fig. 1. Above each light is placed a detachable funnel. The top of the box is curved and the under side is polished to reflect the rays of light. In the top is a ventilating opening provided with a hood to permit the hot air to escape; the supply of air is admitted through the perforatted bottom. The pictures are held in a sliding apparatus moving between two longitudinal grooves (Fig. 2) secured on the outside of the back of the box, and having two apertures, which can be closed by hinged doors. The pictures are held in place by closing the doors, and can be shifted to appear in an opening in the back of the box. The light from the lamps is reflected by the mirrors upon the picture, and from the same through the lens upon a screen or wall. By means of a mirror, T, on a door, S, hinged to the front of the box below or at either side of the tube, the light can be reflected upon any desired surface. Any opaque object, such as a photograph, chromo, or drawing, can easily be reflected upon the screen in any desired size, all parts being clear and distinct. The pictures do not become heated sufficiently to injure them, and may remain in the apparatus for hours without being destroyed.



## USEFUL AND SCIENTIFIC NOTES.

**Effects of Lightning.**—At a recent meeting of the Berlin Verein für Innere Medicin, Dr. Liman described the changes present in the bodies of two men who had been killed by lightning when taking shelter under the trees of the Thiergarten. In the one subject, the hair over the left temple was singed, and the skin from the left ear to the shoulder-blade was discoloured a brownish-red, the chest and abdomen being covered with red and white streaks. Reference was made to the dendritic figures described in many cases, and attributed often to impressions of twigs, leaves, &c. (a specimen of which was figured in our columns not very long ago), and in this body there was a figure which could be compared to a palm-leaf, but which was undoubtedly due to the contact of the folds of the shirt. The parts thus pressed upon remained white, the surrounding skin being reddened. The apex of the heart was the seat of an irregular cavity, which communicated with both ventricles; evidently the lightning stroke had caused rupture of the organ. In the other case, the skin and hair were simply excoriated and singed, and numerous ecchymoses occurred beneath the serous layers of the pericardium and pleura; the lungs were much congested. Here death was evidently due to asphyxia. Dr. Liman mentioned, and Professor Leyden confirmed, the fact that death by lightning is occasionally accompanied by rupture of internal organs, as the brain and liver.

A PIECE of amber weighing 8lb. is at present being exhibited in the Mark Museum at Dantzig, for which the owner has refused £1,500. It is probably the largest piece in the world without blemish. Frederick the Great, more than a century ago, paid the same sum for a piece weighing 13lb., which is preserved in the mineralogical museum at Berlin, but it has gaps and cavities. Two beautiful pieces of work in amber are also to be seen in Berlin. One is a flute, which also was an acquisition of Frederick the Great. The other is a complete tobacco-pipe, belonging to Frederic William III., the father of the present Emperor; it bears an admirably carved likeness of that monarch.

A FORTNIGHTLY journal called the *Linguist* is to be published, written in five languages—viz., English, French, Spanish, Italian, and German.

## SCIENTIFIC NEWS.

THE death is announced of Prof. Worsaae, the distinguished Danish archæologist.

Mr. William Gough Birchby, the hon. sec. of the Vegetarian Society, died recently at the early age of 35. He was head-master of the New Jerusalem Schools, Salford, a Swedenborgian, and a Fellow of the Royal Meteorological Society.

An international cookery and food exhibition is to be held at the Westminster Aquarium in December. The exhibition will comprise 150 classes, and besides gold, silver, and bronze medals, there will be "valuable money prizes."

Prof. Simon Newcomb is visiting Stockholm as the guest of Prof. Gylden, the astronomer-royal of Sweden. He will proceed to Pulkowa in order to view the great Russian observatory.

The fifty-eighth meeting of the German Association of Naturalists and Physicians will meet at Strasburg on Sept. 17.

The American Association for the Advancement of Science is in session at date of publication, and it is expected that some useful papers will be read, especially in Section D, in which a discussion will take place on the best method of teaching mechanical engineering.

In the aquarium a the Inventions there are now some specimens of the black bass, which is indigenous to the rivers and lakes of Canada and the United States. We believe it has been proposed to introduce the black bass into our waters, but anglers object on account of the voracity of the fish, although they provide excellent sport. The introduction of the American catfish is also objected to on the same grounds; but according to Professor S. F. Baird, the United States commissioner of Fish and Fisheries, the catfish does not molest other fish, and does not exclusively prefer live food. The National Fish Culture Association has made some investigations, and at present cannot disprove Prof. Baird's assertions; but judging by the appearance of the specimens in the tank at the Inventions, the catfish should prove to be a useful addition to our rivers, both as a food fish and as sport for the angler.

In connection with "fish," a curious story comes from Vadö, in East Finmarken. Dr. G. A. Guldberg, of the University of Christiania, says that the fishery of rorquals or fin-whales continues to be turned to good account for scientific purposes, and that considerable quantities of the flesh of the whales killed at Vadö have been "tinned" for consumption in Catholic countries—a statement which has caused some remarks to be made about the zoology of the Church. In spite of Prof. Flower's monograph of the whale, not much is known as to the suitability of its flesh for the food of man; but the blue whale is known to feed on a small crustacean, and the absence of the *Balænoptera Sibbaldii* from the coast of Norway is attributed to a scarce food supply. Rudolphi's whale, *B. borealis*, is the "fish" that is tinned, and that has been caught in large numbers.

In connection with the British Association, which meets at Aberdeen on Sept. 9th, it is interesting to learn from the *Scotsman*, which gives an account of the "arrangements," that "Her Majesty the Queen had agreed to drive a party of excursionists round by Balmoral." The guarantee fund now amounts to over £2,505, and the number of "excursions" should satisfy the most ardent follower of the Association for the Advancement of Science.

The Essex Field Club has recently published a paper by Mr. T. V. Holmes, F.G.S., in which he reviews the evidence as to the antiquity of the human skeleton found a short time ago at the Tilbury Dock excavations, which was described by Sir R. Owen in his recent work on the "Antiquity of Man." The skeleton appears to have been found at a depth of 34½ft., nearly 2ft. below the upper surface of the sand, and is described by Sir Richard as that of a robust man who had attained old age, and the thickness and strength of whose thighbone indicated power and frequency of locomotion. The forehead is low and narrow, matched by low Australian and Andamanese skulls; and if the skeleton is, as Sir R. Owen considers, the first unquestionably palæolithic bones of man yet discovered, the conclusions which he draws, with the eloquence and clearness that still, as always, characterise whatever he writes, are fully justified. Mr. Holmes, however, points out that, as the illustrious and venerable naturalist has never visited the docks himself, he does not appreciate the difference of age between those older alluvial deposits of the Thames Valley in which Mr. Worthington Smith has found palæolithic implements and the newer alluvium of Tilbury.

The original MS. of the lectures delivered by William Harvey before the Royal College of Physicians in 1616 and the following years, which were discovered a few years ago in the British Museum, are to be published in a facsimile reproduction, together with an interleaved transcript made by Mr. J. S. Scott, of the MSS. department of the Museum. The work will be issued by Messrs. Churchill, probably in the spring of next year.

With reference to the article on "Electricity and Dust," which appeared on p. 377, it has been pointed out by a German paper that a similar experiment to that of Prof. Lodge was described by C. F. Guitard, of London, in the *Mechanics' Magazine* for Nov. 2, 1850. The following is an extract:—"Some time since, in experimentalising on the electric state of the atmosphere, I employed for that purpose a large glass cylinder, about 18in. high and 9in. diameter, open at bottom and having a neck at top. In placing the lower end of this cylinder in water the more perfectly to exclude the air, and allowing small quantities of tobacco smoke to enter the neck at top, the smoke, after assuming various actions, according to, probably, the hygrometric state of the atmosphere, would gradually spread itself into a cloud filling the cylinder, and at length, as successive portions came in contact with the sides of the cylinder, condense. Sometimes half an hour would elapse before this effect took place. It now struck me that if I brought a wire from an electrifying machine into the neck of the cylinder, the air would immediately become charged with electricity, which would cause each portion of the smoke to fly to the sides of the cylinder, and that thus more rapid condensation would take place. The effect produced was perfectly magical. The slightest turn of a small electrifying machine produced immediate condensation. It was astonishing to see how small a quantity of electricity produced a most powerful effect. I am not aware that attention has ever been drawn to this subject; and the question will probably arise, Has electricity anything to do with the condensation of steam in the condenser?"

Prof. S. P. Thompson calls attention to the neglect of the means which mechanical science has provided for the automatic extinction of fires. He alludes to the "sprinklers or distributors of water which are now to be found fitted up in many mills and warehouses in Lancashire and the North, and which are almost universal in New England and other parts of the United States. This may seem remarkable, yet it is not to me so remarkable as the fact that nine out of every ten intelligent persons to whom I have spoken on the subject do not even know what an automatic sprinkler is, and have not the faintest conception in what way a system of sprinklers can be arranged in a factory so that in whatever part a fire may break out, there the water will be automatically discharged without waiting for any human being to notice the outbreak."

At the meeting of the Leicester branch of the Amalgamated Society of Railway Servants, held last week, attention was drawn to the fact that at some recent inquests unexpected questions were asked and evidence given which seriously implicated certain railway servants, and the opinion was expressed that an officer of the society should attend and watch the case in the interests of the society. The Binegar accident was referred to, and after Mr. Stretton had explained the circumstances he was requested to communicate with the signalman's solicitors, and render assistance in defending him.

The report of the Trinity House Committee on lighthouse illuminants contains the following conclusions:—(1.) The electric light is the most penetrative of the three luminaries in all conditions of the atmosphere, fog included. It, however, is more costly than either gas or oil, and its dazzling effect in clear weather renders it unsuitable for general adoption around the coast. (2.) The gas and the oil lights are practically equal; but the latter system is considerably cheaper, and is simpler and more convenient than the former. The committee, therefore, recommend that "for the ordinary necessities of lighthouse illumination mineral oil is the most suitable and economical illuminant, and that for salient headlands, important landfalls, and places where a very powerful light is required, electricity offers the greatest advantages."

With reference to the application of electricity to the working of railways, the second section of the Railway Conference at Brussels reported that, in view of the great progress which had already been made in this respect, they look forward to further improvements; but they made no recommendation. Eventually, however, the second and third sections consulted together, and reported that considerable progress has been realised in the employment of electricity on railways, and that it is probable that further progress will be made, which will largely augment their security, and that it will be desirable, having regard to this question, to ascertain whether preference should be given to electricity or to mechanical appliances, and that this is a question for the future, having regard to the necessities of distance, climate, and the nature of the apparatus, which can only be decided by experience.

The Cunard steamer *Etruria* has made the trip to New York in 6 days 5 hours 31 minutes corrected time from Queenstown—the quickest on record. The average hourly speed was 19 miles, which means that on occasions over 20 was the rate. It is probable that with favourable weather the *Etruria* will also make a quick passage home, and thus put the quickest voyage on her record.

# LETTERS TO THE EDITOR.

*[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]*

*All communications should be addressed to the* EDITOR *of the* ENGLISH MECHANIC, 332, *Strand, W.C.*

*All Cheques and Post-office Orders to be made payable to* J. PASSMORE EDWARDS.

*** *In order to facilitate reference, Correspondents, when speaking of any letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.*

"I would have everyone write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet, to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks a vice from whence great inconveniences derive their original."
—*Montaigne's Essays.*

## TELESCOPIC POWERS—EQUATORIAL MOUNTING—PHOSPHORESCENCE OF THE SEA.—THE MOTION OF THE SUN IN SPACE—HOME-MADE MICROSCOPES—RAIN-GAUGE—MEASURING THE POWERS OF A MICROSCOPE.

[24665.]—AT the place whence I write I have no means of access to No. 191 of the *Astronomische Nachrichten*, which is quoted in letter 24596 (p. 519) by Mr. Rogers. Hence I am curious to know whether, in addition to the astounding statement that a 3in. object-glass ever bore a power of 550 on Mars! anything is said about the manner in which such (alleged) power was measured?

"Landbird" (query 57257, p. 529) should send to the office for numbers 52, 296, 300, 421, 612, 613, 661, 673, 774, 778, 791, 796, 808, 898, 902, 973, 976, and 979 of the ENGLISH MECHANIC, in which he will find descriptions of very diverse forms of equatorial mounting—all of them, however, of a fairly simple kind, and within the power of construction of any fairly skilful amateur. Descriptions of more elaborate forms of the equatoreal appear in other volumes; but these are of a more costly and complicated character than your correspondent evidently requires.

The familiar phosphorescence in the English Channel, to which the same correspondent refers in query 57269 (p. 530), is produced by the Noctiluca miliaris, one of the protozoa. Why should this not be visible in smooth water? I have seen the sea luminous alike from the pier of an English watering place and the deck of a "Trooper," in the Mediterranean. In every case it is traceable to some lowly form of animal life.

One of those philanthropists who arise at intervals to set the whole world to rights, a gentleman named Tischner, of Leipzig, is circulating in this country a brochure entitled "The Fixed Idea of Astronomical Theory," with a view to show that all the (alleged) blunders of astronomers have their origin in the assumption of the fixity of the sun. Speaking merely for myself, I have always been under the impression that so fair a case had been made out for a motion of translation of the entire Solar system in space in the direction of the constellation Hercules, that such motion was ordinarily referred to in textbooks as an established fact. It is not, however, so much the mere translation of our system bodily in space, as the alleged results of such translation which form the subject matter of the funny little pamphlet before me. Between absolute and relative motion, Herr Tischner seems wholly unable to discriminate. The planets, he asserts, do not describe closed curves, on account of the proper motion of the system of which they form part; but, surely, we, here on earth, at a practically infinite distance from the Universe of Stars, must refer our movements to the centre which dominates them. Let me take a simple illustration. Suppose that Herr Tischner were to travel by railway from Leipzig for an hour, and on starting were to lay his watch, face upwards, on one of the cushions of the carriage, then, in the course of that hour, the end of the minute hand would complete one revolution about the centre of the dial. But, meanwhile, the carriage will have travelled, say, 35 miles on the rails. The whole part of the earth on which those rails are laid will have been carried rather more than 648 miles round the earth's axis by her rotation, and some 66,199 miles in her orbit in common with the whole world, to say nothing of the little journey—or part of it—towards Hercules; so that to be consistent (on Tischnerian principles) we ought strenuously to deny that the curve described by the extremity of the minute hand of our hypothetical watch is a closed curve at all! I have selected this one contention from the pamphlet as a fair illustration of its style of argument. It is wholly needless to discuss what its author says with reference to the non-existence of "centrifugal force," a term never now to be found in the most rudimentary books on mechanics, celestial or terrestrial; or his astonishing notion that the motion of the sun in space causes the precession of the equinoxes! Enough has been said to show in what a muddle an earnest and well-meaning man may involve himself who meddles with what he does not understand. Did Herr Tischner ever hear how the existence of the planet Neptune was not only independently predicated by Adams and Le Verrier; but its very position in the sky pointed out, by the application of that law of gravitation which he asserts to be non-existent?

In thanking Mr. Hippisley (letter 24637, p. 540) for his most courteous offer to send me specimens of microscopic lenses of his own manufacture, I must express my regret that I am precluded from accepting it by the inexorable rule as to my incognito. I gravely question whether it would be possible to define the curve assumed by the surface of a piece of glass melted into a lens in the manner he describes. In point of fact, I should say that it was made up of three or four curves, differing considerably in character.

May I be allowed to refer Mr. Williams (letter 24646, p. 542), to page 339 of Vol. XXXVIII. of this journal?

"Micro." (query 57307, p. 551) presumably wishes to know the magnifying power of his eyepieces with different object-glasses. He may do so with probably sufficient accuracy for his purpose by getting a stage micrometer divided to hundredths, and for high powers, thousandths, of an inch, and a rule divided into 10ths of an inch. The latter is to be placed at a distance of 10in. from, say, the left eye, and the micrometer scale viewed through the microscope with the other eye; by shifting the rule about a little, some of its divisions may be made to correspond with one of those of the stage micrometer, then a simple-division sum will give the power. Thus, suppose that 1·7in. on the rule, as seen with the naked eye, exactly coincides with one of the (magnified) divisions of a hundredth of an inch, then must the microscope magnify 170—and so on.

**A Fellow of the Royal Astronomical Society.**

## THE DAYLIGHT OCCULTATION OF ALDEBARAN.

[24666.]—WHILE sharing Mr. Pearson's desire to bring this correspondence to a close, I feel I cannot do so without pointing out that, notwithstanding the honourable position attained by him in the mathematical tripos of 1848, he fails to grasp the fact that my expression, "different geographical positions," includes differences both of *latitude* and longitude, and thus indicates a knowledge he is so good as to say I ought to possess.

In the concluding paragraph of Mr. Pearson's letter the following passage occurs: "If Mr. Peek is still unconvinced, I have done with him." Convinced of what? I am certainly not convinced that the prediction of the circumstances of an occultation ever can, or ever were intended to, take the place of the observation itself, especially when I remember that the lat. and long. of any station must be accurately known before such prediction can be accurate, whereas the very object in observing the occultation is to deduce the long. from it. Such extreme accuracy is, however, by no means necessary for practical purposes. It is quite sufficient if the time of its occurrence is known within such limits as will allow the observer to be ready at his telescope before the phenomenon takes place.

That there is a necessity for computing the circumstances of occultations at places distant from Greenwich no one for a moment doubts, as it would be sheer waste of time for a traveller to remain at a place where the occultation of a fifth or sixth mag. star takes place in the full blaze of sunlight, and anyone who contributes to the simplification of the computation necessary to ascertain this fact is doing very good work. What I maintain, however, is this: that the results obtained by a partially graphic method cannot be compared, for accuracy, with the results of actual observation when the instrument used is a good telescope, and the time taken by a chronometer, the error of which on local sidereal time is accurately known; the former is theory, the latter is fact.

**C. E. Peek, M.A., F.R.A.S.**

## TELESCOPE POWERS.

[24667.]—With reference to H. Sadler's "contradiction" (letter 24628, p. 539), I beg to say that my authority in stating that Mädler used a 3in. refractor in his observations of Mars in 1830 is to be found in the *Observatory* for September, 1877, p. 180. In a letter on "Drawings of Mars," Mr. W. G. Lettsom there states that Mädler's observations "were taken with a Fraunhofer refractor of only 3in. aperture and 45in. focal length, English measure." I presume the correction now afforded by H. S. is just; if so, I am obliged to him.

My own experience with regard to telescopic powers is that about thirty-five to the inch is as much as can be employed with perfect satisfaction for ordinary purposes. **W. C. Rogers.**

August 24.

## MOTION OF STARS IN THE LINE OF SIGHT.

[24668.]—My attention has just been called to a report which appears in your issue of the 5th of June of a lecture on "The Motion of Stars in the Line of Sight," which was delivered by me to my students in Trinity College. The report omits, however, to mention that many of the facts discussed in this lecture had been taken from a very interesting article which had been published in the *Observatory* for April and May by Mr. E. W. Maunder. I also take this opportunity to say that the change in the direction of the movement of Sirius had been demonstrated by Mr. Huggins's observations alone, and that it was afterwards confirmed and extended by the observations at Greenwich, to which Mr. Maunder has so largely contributed. **Robert S. Ball.**

## LUNAR GLACIATION—TO "F.R.A.S."

[24669.]—I fear the letter I wrote in reply to the inquiry by "F.R.A.S.," on p. 167, April 24, has shared the fate of two other home letters, and been suppressed in the local post-office for the sake of the sixpenny stamp. Government know this partiality of our Babus for any undefaced stamps, and wisely issue envelopes with stamps embossed on them.

If, when run out of such "overland envelopes," we use a common one, and forget to deface the stamp by some means, the result is too often what we see in this case.

We are all hot to educate the native, but omit all training in morality, honesty, and such; the outcome is a race that can quote Shakespeare, drink unlimited "grogs," and curse parents in a way that takes an old Indian's breath away. I hope "F.R.A.S." will write me an ass if I trust to Babu honesty again.

Now, regarding the slow decline of atmosphere on the moon, and its taking place unequally, I should say the decline took place equally, and not in patches or zones, with semi-vacuum between.

Restating the entire case, I should say that the moon has long ago passed through what I call an "erosive era"—such as our earth is in now—where temperature was higher where there was air, and rivers, and seas of water. That gradually the globe cooled, and as it did so, atmosphere became more rare (a phenomena seen to go hand in hand elsewhere, as in Venus and Mars), the result being that this "era of erosion" gave place to one of surfacing by deposit of frozen moisture.

Towards the close of this erosive period, the air would fail as means of transport for aqueous vapour, which latter would only move by diffusion; there would, in fact, be no winds or moving air, or mist, and the permanent deposition of ice on the poles would begin. These ice caps, slowly extending on all sides century after century, would here and there leave deep bays or indentations in the margin (like in the line of the Altai), and due to deeper water, or warm springs, or submarine volcanic vents, such as are common on earth. The moisture raised off the liquid areas would become slowly diffused in the rarefied air, and be unable to travel far or fast, for all over the ice-sheet the temperature would be much lower, and cause its fall as spicula, on and about the margins, thus slowly raising ramparts. As time went on, and glaciation advanced, the horns of the bays would extend, and appear as in Fracastorius or S. Iridium, and at last meet, as in Pitatus, or in Beaumont, &c., where this rampart would be necessarily small, or even incomplete, on the seaside of the lagoon at first. But as glaciation still further advanced, it would increase in height by the deposit of the aqueous vapour off the lagoon, the floor of which (as in Posidonius, &c.) would thus become lowered as the wall rose.

In this way such forms as "Clavius" originated, and after its floor became at last frozen, or the liquid areas restricted to the larger vents that caused it, other vents opening out under the ramparts, would liquefy large areas as lakes that would again raise their own ramparts.

If a first-class heat vent persisted for immense periods, we should not only see complex rings as terraces, but floors deeply depressed, as in Tycho; and at last, ever after the floor or lake surface had frozen over, the moisture still given off by such orifice would slowly pile, and form the vast central cones that are such conspicuous features in these deep and terraced craters.

They would also mark not only the period about which water, as liquid, ceased to exist on the lunar surface, but also of air, as diffusion of aqueous vapour ended.

Thus, during the formation of a huge polar ice cap, covered by these circular forms, and bounded by irregular promontories and bays, the moisture raised in the attenuated air would slowly become diffused and fall on or near the margins of the seas, bays, or inland lagoons, and would not travel far afield to deface older formations in higher latitudes.

Moisture, as aqueous vapour, would only be found near areas of liquid—in any quantity, at least; but the great ice caps continually extending as the globe steadily cooled, would at last come more within the zone of solar influence, which would long retard glaciation on the equatorial seas (as internal heat had also retarded it in bays).

But, as secular cooling would still go on, the moisture raised off these seas, and diffused in the air, would pile for ages around and form the vast maritime ranges, the higher ridges of which, being cooler, would resist solar energy. Gravitation would transport an enormous amount of material literally *à la* glacier, and form vast raised regions, sloping gently from the main crest along the sea edge. The incline towards the warmer sea side would naturally be steepest, and at the actual sea level many thousands of feet below, in warmer strata, so to speak, by melting (at times of greatest solar influence), cause the precipitous profile there seen.

But at last even the seas would glaciate one after the other, by zones around the edges, leaving lagoons, large and small, here and there, as Archimedes, &c., and "clefts," due to subsidence, would appear as internal shrinkage went on. Where such "clefts," as huge crevasses, passed right down through the ice crust to the warmer and moister interior, they might give a series of orifices through which aqueous vapour would pass, and, congealing at the openings, form the strings of craterlets seen in many places, or may give but few openings, one here and there.

The existence of water (as liquid) at the surface, and the existence of air, seem to have ended simultaneously, and at last, after the period of piled cones and craterlets, any aqueous vapour given off flashed steam-like into the vacuum, and formed the well-known cloud, which, being of ice particles, would fall and form the equally well-known rayed white patch or nimbus around orifices.

I hope "F.R.A.S." will still look into the matter, and send any objections that he may see. I have no desire to bolster up a false theory, however ingenious it may appear. Also I hope Mr. T. Gwynn Elger may look into the above.

I would urge here that the question of complete absence of colour in lunar detail, even under the higher powers, be admitted as another argument, and added to those on page 127, April 10th. Surely if there has been water, we should see polar caps? Where temp. is admitted as low as 60° or 70°, and if polar caps are admitted, how comes it that there is no edge or line of demarcation from the tropics that are confessedly of same tint and structure? But, as far as possible, the various parts of this theory should be viewed together.

First, the probability that the temperature of the smaller globe is less than ours.

That there have been seas of water, and also polar ice caps, and that these *mares* are more like frozen sea surfaces, covered with bergs, than dried up sea *bottoms*.

That the entire series of circular forms from seas, like M. Crisium, to craters are due to formation of lagoons in a glaciating crust (the *floors* are all ominously level).

That this entire series beautifully illustrates decline of heat and atmosphere.

That the prevalent monotint is suggestive of an ice surface stained by meteoric dust that remains on the *levels*, and is removed by gravitation on the steepest inclines, as lips of craters and rugged mountains.

That the dark masses seen between Gambart and Copernicus are really *mountain peaks* that protrude through the ice sheet; also that volcanic surfacing, as a rule, is conspicuous for brilliant colouration on large areas.

That bays are *unfinished* craters, and not *deformed* circles, and afford proof of the truth of the lagoon origin.

That maritime zones are due to the seas solidifying first around the margins.

That "clefts" are huge crevasses, and due to subsidence of an adjoining area.

These are some of the main features to hold in view, as well as that Professor Langley's lecture at the Royal Institution bore out so completely the general *possibility* of this theory being sound.

**S. E. Peal.**

Sibsagar, Asam, July 26, 1885.

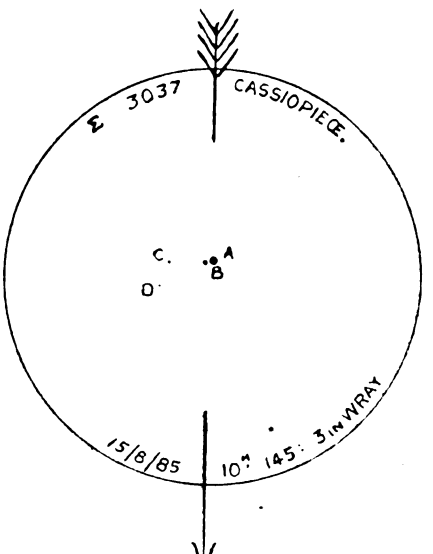
## Σ 3037 CASSIOPEIÆ.

[24670.]—Whilst observing this pretty triple on the night of Aug. 15th, I saw another *comes* in the neighbourhood of that given in "Celestial Objects" as of mag. 9.

The air was unsteady and the star very faint, so that I could but glimpse it now and then; but of its existence I have no doubt.

I should suppose it to be of about the 11th magnitude, the P.A. somewhere about 230°, and the distance from its primary from 40" to 60" ±.

The accompanying diagram may help to its identification; it is there marked D.



Would Mr. Sadler or Mr. Gore, to whom I return thanks for favours, kindly communicate the details of this fourth star?

Perhaps Σ 3037 Cass. may be classed among the quadruples.

Aug. 17. **H. D.**

## THE MICRO-OBJECTIVE.

[24671.]—The general method of mounting lenses is well known—I mean the burnishing them into a cell. It is also the best for a permanency.

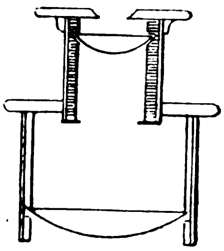
I will indicate two convenient methods which are easy to adopt for temporary work. One I use when mounting in triblet tubing alone; the other when I use additions to the triblet, or make special tubes.

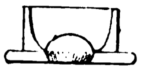
Suppose an eyepiece is to be made of two lenses having foci equal 1½in. and ½in. respectively. They are to be mounted just 1in. apart.

Cut (or make, if necessary) a piece of tubing which will just admit the larger lens, and in this case about ¾in. long. Cut another piece which will snugly slide into it, and let it be of the same length, but cut an eighth of an inch or more off the end. Thrust this narrow ring into one end of the larger tube; run a little solder in to secure it. The lens may now be put in its place, resting on the soldered ring, and when the inner tube is slid in it will be quite secure.

In the upper end of this inner tube a ring of brass may be soldered, carrying a smaller tube of ½in. length, carrying the eyelens at one end and the diaphragm at the other.

I will now suppose that the eyelens is to be mounted by the second method. Take a slip of stout zinc, of the right size to make a tube which will slide snugly into the small brass tube, if possible, but its inside diameter must be about $\frac{1}{20}$in. less than the lens' diameter. Before bending it into a tubular form, cut a channel along it near one edge, so that when it is bent the lens may be slipped into the channel, whilst the tube is sprung open, where it will be held securely when the tube is closed, and slipped into its place in the brass tube. These two methods apply only to lenses with thin edges. A modification of the first plan will do for thick lenses, such as achro-combinations.





In the trade they are usually worked to fit accurately-bored cells and cemented. I work them to fit, &c., but I usually leave a tiny collar at bottom of the cell on which the lens bears, and so it needs no cementing.

The small but thick fronts for an o.g. I mount with cement in a cell turned out of a solid piece, as indicated in the sketch accompanying this.

In the eyepiece sketch the light lines are brass, the dark ones zinc.
**Rob. Orus.**

## DAYLIGHT v. LAMPLIGHT FOR MICROSCOPIC OBSERVATION.

[24672.]—MR. NELSON'S views hereon (letter 24626) are curiously opposed to those of Dr. Carpenter. I quote from "The Microscope," 5th edition, page 169:—"The young microscopist is earnestly recommended to make as much use of daylight as possible, not only because in a large number of cases the view of the object which it affords is more satisfactory than that which can be obtained by any kind of lamplight, but also because it is much less trying to the eyes. So great, indeed, is the difference between the two in this respect, that there are many who find themselves unable to carry on their observations for any length of time by lamplight, although they experience neither fatigue nor strain from many hours' continuous work by daylight." Who is right?
**W. A. Cooper.**

## THE FIFTH VOLUME OF "HOLTZAPFFEL"—A DUBIOUS WORD.

[24673.]—I HAVE just completed the reading of the fifth volume of Holtzapffel's great work, and consider it, in most respects, a *chef d'œuvre*.

I am glad to see that the author has allowed someone familiar with the English language to do his "punctuating" for him.

Nothing could be more absurd than the punctuation of Vol. IV., which, in many instances, obscures the text hopelessly. One paragraph I have read over some dozen times, and I am not yet sure if I know what the author intended to mean.

Vol. V., however, seems quite free from this *bizarre* defect, and no one can fail to admire the beautiful photographic illustrations, although they cause the book to cost us, in the United States, at least 12dols. (50s.), which is a good deal for a book of that size.

I should be glad if Mr. Holtzapffel would give some explanation of a word he uses, page 587, where he speaks of a colouring material, presumably one of the aniline group, as "Orine."

This I hever heard of before. Does he, par hazard, mean "Aurine," or what?
**"Roi ne Puis, Souza je Suis."**
Brooklyn, N.Y., Aug. 10.

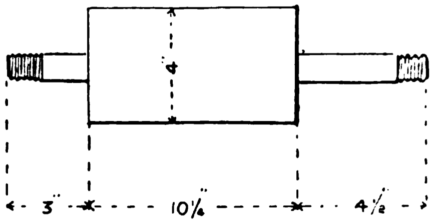
## THIRTY-LIGHT DYNAMO.

[24674.]—IN my last letter I described the construction and winding of the armature. After the armature is wound, and before the wires are soldered to the commutator, it must be thoroughly tested for insulation. The parts to be tested are the wire binding on the outside of armature for insulation from armature wires, the armature wires for insulation from the iron core, and the commutator bars for insulation from each other, and from the shaft and the washer that holds them together. The insulation of these bars being perfect, the armature, after being carefully examined to see that none of the wires bulge out, may be put on one side ready for mounting.

We must now turn to the consideration of the F.M.'s. The F.M.'s are really the most important part of the dynamo. The F.M.'s are to the armature what the boiler is to the engine. No matter what size the engine, if the boiler is not large enough very little power can be got out of it. In the same way, no matter how large the armature, if the field-magnets are not sufficiently powerful very little work can be got out of it; and to complete the analogy, the exciting coils bear to the magnets the same relation that the fire does to the boiler. From the foregoing remarks it will at once be seen, even by the most amateur electrician, that the field-magnets are the very life and soul of the machine.

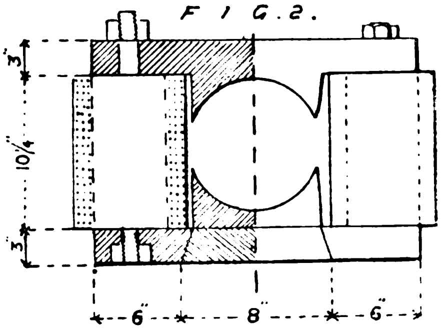
In choosing the type of F.M. to be used, I have had two considerations before me: a low resistance magnetic circuit, and simplicity of construction. During a practical experience of 5 years at dynamo construction, I have had many types of F.M.'s through my hands; but I think, on the whole, that the type adopted by Mather and Platt, Joel, Elwell, Parker, and others is the easiest, and, at the same time, one of the most efficient the amateur can construct.

FIG. 1



As will be seen by reference to sketches, the F.M. consists of two pole-pieces with extensions, and four upright electro-magnets. Fig. 1 represents one of these bars. Fig. 2 is a side elevation and half section. Fig. 3 is a plan of the bottom pole-piece, showing the position of the four magnet-bars. The sizes marked in the sketches are finished sizes, so the builder of machine must have the parts large enough to stand turning and planing. The pole-pieces are made of cast iron and afterwards annealed. I must warn the intending constructor to take his patterns to the foundry when they are casting machine work, as there is cast iron and cast iron, some specimens which I have seen resembling dirty sandstone more than anything else. When the bottom pole-piece is cast the lugs *c* and *c'* are removed, and the same pattern used for the top pole-piece. The electro-magnet (Fig. 1) must be made of the best wrought iron and carefully annealed. If it can be obtained, Swedish charcoal iron is the best brand to use, as it is so beautifully soft.

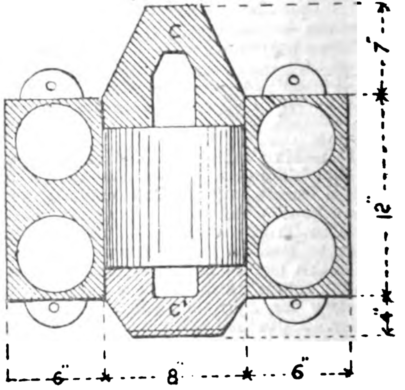
FIG. 2.



Having got our raw material, we may start on the construction of the F.M.'s. The first thing to be done is to have the upper surface of the bottom polar extensions and the lower surface of the top polar extensions carefully planed, care being taken to have a light finishing cut taken so as to bring the surfaces up smooth.

The next to claim our attention are the four electro-magnet bars. It will be at once seen that to insure perfect contact between the four bars and the polar extensions the bars must be of exactly equal length; the magnet-bars must also be of such a length that, when they and the pole-pieces are bolted together, the pole-pieces will be the right distance apart to give the armature its proper clearance. There are several ways of doing this; the one I have always used is to have a cylinder of wood turned right size—that is, the size of the armature and clearance. The bottom pole-piece is placed on the bench; the block of wood is then put in the position which will be occupied by armature, and the upper pole-piece placed on the top of it. The length of the electro-magnet bars can then be easily measured by observing the distance between the surfaces of the polar extensions. In the section half of Fig. 2 I have endeavoured to show the manner in which the cast-iron pole-pieces are bolted to the wrought-iron magnet-bars; the top pole-piece will be seen to be fastened by four ordinary nuts. But a somewhat different plan must be adopted with the bottom pole-piece, as the nuts must not project beyond the iron of pole-piece (the bottom pole-piece being used as a bedplate), and at the same time if recesses were cast in so that the spanner could be got to the nuts, the iron thus taken out of the body of pole-piece would considerably reduce its capacity as a conductor of lines of force, and this of course would lead to a reduction of the E.M.F. of the dynamo. If a hole were drilled and tapped in the polar extension, and the bar then screwed in, the difficulty would be overcome. At the same time, it must be remembered that if the hole is not drilled at a perfect right angle with the plane surface of the polar extension, the shoulder of the magnet-bar will not fit down snugly, and a great loss of magnetism would be the result. To overcome this difficulty, I have four square recesses cast in the under service of pole-piece, and in these square cavities I fit, somewhat loosely, a square nut. This nut is held in place while the bar is screwed down. The nut may then be loosed, and the screwing down of the bar finished by means of a pair of large pipe tongs. As the nut cannot turn round, the shoulder of the bar is drawn to the planed surface, and perfect contact made, even if the holes in the pole-piece are not quite straight. There are several points which I should like to go into, such as construction of brushes, holders, bearings, &c.; but as most of those interested in this letter will be quite capable of dealing with the questions, I think it would be occupying an undue amount of space to describe them in detail. I may say, however, that the bearings need not of necessity be adjustable. They should be made to carry a gunmetal bush, which being made to gauge, could be renewed in a few minutes. On no account use white metal or any other anti-friction metal which has a low melting point. I had a dynamo to repair some months ago which met with an accident from this cause. The machine was used for electroplating. The plater left the machine running while he went to his dinner, when, from the needle of the lubricator sticking, or some other cause, the bearing at the pulley end of the dynamo became so hot that the lining of the bearing melted, with the consequence that the armature wires were torn off. The brush holder should, of course, be made adjustable round the axis of commutation, and should be so arranged that it could be readily clamped in any position. The brushes, which may be either layers of copper strips or hard-drawn wires, should press on the commutator with just sufficient force to take up the current. Any pressure in excess of this only serves to increase the wear and tear of the commutator. In a well-made modern dynamo the spring of the brushes themselves is not relied on, but the pressure is obtained by means of iron or brass spiral springs. The amount of pressure exerted is easily regulated by turning the spindle on which the brushholder is supported. If the commutator does not run perfectly true, the pressure necessary to insure perfect contact will be com-

FIG. 3.



siderably increased. Grooving of the commutator, once the bugbear of dynamo manufacturers, is now almost entirely prevented by allowing the armature from ⅛in. to ¼in. endshake. The armature, moving gently backward and forwards while running, entirely prevents the formation of those rings which used to be so fatal to the life of the commutator and the temper of the electrician in charge.

We now come to the question of winding, and the proposition presents itself, Shall the machine be wound as a compound series or shunt? It is impossible for me to know the requirements of all those who may build this dynamo; so I think it will be best to give the sizes and quantity of wire required for each system, and then leave to the choice of the maker which system he pleases. Before I do this, however, I shall go into the different systems, and try to explain their respective advantages and disadvantages. We will take the series system first.

In a series dynamo the whole of the current generated in the armature passes round the coils of the field-magnets, with the consequence that on open circuit the E.M.F. at the terminals of machine is very small, due, in fact, to the residual magnetism of F.M.'s; thus, when a set of partly-discharged accumulators are introduced into the circuit the machine is instantly reversed. The series machine is at a disadvantage in lighting incandescent lamps, as, although this machine (series wound) would light forty 20's easily enough, yet it would not even redden two. With five lamps in circuit, the current passing round the F.M.'s being only about five ampères, the E.M.F. of machine would not rise to above 28 or 30 volts. The advantages of the series machine lie in arc-lighting, as its current can be kept nearly constant, while the E.M.F. varies within considerable limits.

In the shunt dynamo, only a part of the current passes through the coils of the field-magnets, the remainder going to feed the outside circuit. Unlike the series machine, the E.M.F. of the shunt dynamo is greatest on open circuit, and a single incandescent lamp placed between its terminals would be driven much beyond its proper candle power; as the current in the outside circuit is increased the current in the shunt-coils is diminished, and the E.M.F. of machine gradually falls until, with the full number of lamps in circuit, the E.M.F. of machine will have reached its normal amount, the difference in the amount of the E.M.F. between one lamp in circuit and forty lamps being about 12 volts. The shunt-machine has one advantage—it cannot easily be hurt by an accidental short circuit, and the disadvantage of the E.M.F. falling as the current is increased can be avoided by using a variable resistance. This resistance prevents the E.M.F. from rising too high when there is only one or two lamps in circuit. As more lamps are turned on, the resistance in circuit with the shunt coils may be decreased, and the E.M.F. kept constant; but as this requires someone to switch on more or less resistance as the lamps are turned on or off, it is rather inconvenient.

The compound winding has been introduced to obviate the difficulties experienced when shunt or series-wound machines are used. In the series dynamo the E.M.F. increases with the current; in the shunt dynamo the E.M.F. decreases with the current. It is thus possible to wind a dynamo with a certain proportion of both shunt and series coils, that their opposite effects on the steadiness of the E.M.F. may so neutralise each other that a machine with a constant E.M.F. will be the result. It as well, however, to observe that this perfect condition is seldom, if ever, obtained.

We must now consider the amount of wire required for F.M.'s, and I will take the series first. 100lb. of No. 10, 25lb. on each bar, all four bars connected in parallel arc, resistance of the four coils in parallel arc 0·6 ohm.

For plain shunt-winding, 90lb. of No. 16, 22½lb. on each bar, all four bars connected in series.

For compound winding 60lb. of No. 18, 15lb. on each bar, all four bars connected in series, and connected as a shunt on armature, 36lb. of No. 12, 9lb. on each bar, all four bars coupled in parallel arc, and then connected in series with armature.

It will be found best to wind the wire on a wooden framer of such a size that when the core was knocked out the coil would slip easily over the magnet-bar. This is the method of winding adopted on most modern dynamos, as in case of a breakdown of the insulation the coil can be easily removed for examination. In the compound winding it does not much matter whether the shunt wire is wound on first, and the series wire then wound over it, or whether the series and shunt wires are wound as two separate coils; so the builder of the dynamo may use that method which is most convenient.

The speed of the dynamo will be about 1,500 revolutions per minute, and at that speed the E.M.F. will be 48 volts at its terminals; this amount of E.M.F. is just right for Woodhouse and Rawson's 45 volt lamps, allowing for some loss in the leads. If it is desired to run 50 volt lamps, from 100 to 150 more revolutions per minute will give the extra E.M.F. required.

The amount of current which may be taken from dynamos with only one layer of wire on the armature is very large in proportion to the size of wire used. For continuous work (day and night) the density of current in the armature wires should not exceed 3,000 ampères per square inch, and for runs of from three to five hours' duration the density per square inch should not exceed 5,000 ampères. From these facts we may calculate the current the machine will safely give thus:

$$·109^2 \times ·785 = ·0093.$$

$$\frac{3000}{·0093} \times 2 = 64\ 4 \text{ ampères.}$$

It will thus be seen that when well made the machine will light from 30 to 60 20 c.p. lamps easily, and even if through bad workmanship the E.M.F. should be considerably reduced, the dynamo would still light what I have stated—viz., 30 20 c.p. lamps.

Spon-street, Coventry. **W. H. Eaves.**

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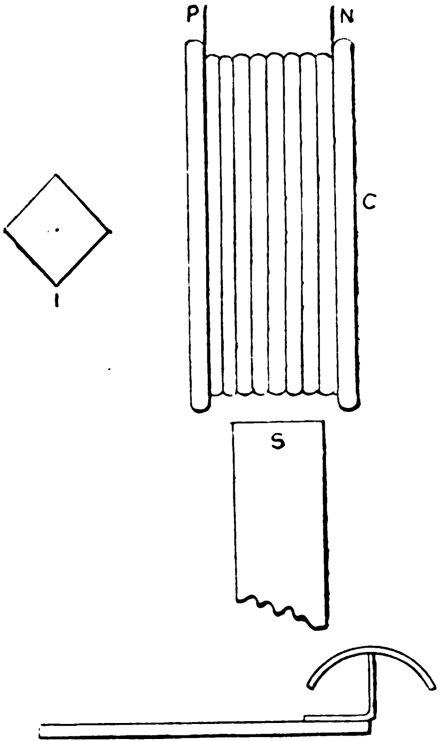
## INDUCTION COIL ROTATIONS.

[24675.]—Inclosed is the illustration of an experiment I have recently made on rotary motion by vibration. The apparatus is a modified form of Lontin and Fonvielle's rotating disc, and can easily be made by any of your readers who are interested in the theory of electricity.

In the illustration C is a coil of silk-covered wire, No. 28, and about 30 yards long, something like a galvanometer coil, and is wound on a square frame made from a match-box; the opening is 1¼in. by ¾in.



A, B is a piece of sheet brass 4in. long by ⅜in. wide, having a common brass pin soldered at the end and fixed at right angles to A B; on this pin is set a piece of square sheet iron or tin ¾in. by ½in., with a centre mark made by a punch, and then bent, as shown, so that it may balance and revolve on the point of the pin, like a compass needle. The brass plate is fixed on a piece of wood (which is not shown), so that the square piece of iron can revolve either inside or just outside the coil C, as in the figure at I.

When the pole of a bar magnet S is placed, as shown, near the coil of wire, and the ends P N are connected to the pillars of the contact breaker of a common induction coil which has an iron core about 8in. by ⅞in., and 16 yards of No. 16 cotton-covered wire (no secondary coil is required), the square of iron I revolves very rapidly, as long as the battery current continues from one-cell Bunsen battery. Any piece of iron, such as a nail or screw, will revolve when suspended by a fine silk line; but if the piece of iron is long, there are four dead points in the rotation which prevent it revolving, unless it is first started by mechanical means."

The effect is owing to the action of the extra current on breaking contact; the rotations can also be produced by a battery of high electro-motive force, and a mechanical contact-breaker.

**J. Sutcliffe.**

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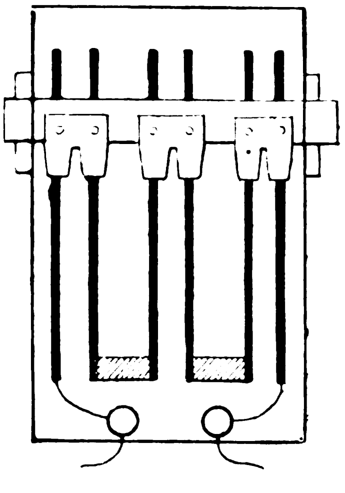
## VARIABLE RESISTANCE FOR USE WITH AMMETER, &c.

[24676.]—I inquired some weeks ago for a rough, quickly variable resistance for letting on a current quickly to an ammeter or galvanometer, so as to avoid the sudden swing of the needle.

I have found that Jablochkoff candles answer very fairly for the purpose used as a Poggendorf's rheostat; the conducting patch at the top being removed, and a slider fitted so as to bring any desired length of the carbon rods into circuit. The resistance of a candle 25cm. long is about 2·5 ohms, and several of these may be fitted into grooves cut in a piece of board and bedded firmly in cement, so that one side of the carbon rods projects slightly above the board. One rod of each candle is connected with the next by a strip of copper, and a slider with brass contact-springs is fitted on the board, so that the current may have to pass up and down along the whole series of rods, or any desired length of them.

An extra copper spring contact-piece (not shown in the drawing) is fitted to the slider, so that when pushed down close to the terminal binding screws contact may be made direct between them, and the resistance reduced to nothing.



If greater resistance is required, the rods, when firmly bedded in cement, may be scraped or filed down to half their thickness or less.

I do not recommend this as an accurate resistance measurer, but only as far preferable to any arrangement of wires for the purposes above indicated, or for rough-and-ready adjustable shunts.

**E. R. P.**

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## WHAT IS "CREATION"?—ANOTHER ASPECT.

[24677.]—As a simple man, it has struck me as something wonderful that natural historians have always attributed Creation to external causes alone, without any reference to an internal power. I suppose that the peculiar education of the time being has prevented the mind from perceiving only half the tale. Evolution, sexual selection, hereditary features, adaptation and survival of the fittest, are only part and parcel of one general and particular law—viz., from a centre. Yes, you say, the universe is derived from the sun as a centre; but this is not so, for there are other suns than ours. Then there must be a universal centre, not only in one particular but in all, even the most minute. Can you find anything that does not proceed from a centre? Take music, a range of sound—say a piano. Now this is derived as to its visible substance from the universe, yet without the centre of sound it has no meaning or being. Strike the soundboard, or make all the strings vibrate at once, and there is only a void; but divide this vibration and find a centre, a middle C or A, tune each part in accordance, and a musical creation ensues. This central power exists in harmonic shape or mode from the bass to the treble, and is independent; but mark how it acts, never equally, but always in opposition to itself. Take a tensioned string. Its sound begins in the centre; if you strike or bow it here discord results, and there will be no creation; but analyse the sound into harmonics and the two halves act in opposition, and the divisions are unequal to the whole string.

Berkeley's philosophy intimates that things only exist because we perceive them; more modern thought insists that things or matter is the cause of perception. Goethe is bolder; he says—"Matter can never exist and be active without mind, nor can mind exist without matter." But there are vibrations both of string and pipe that are so quick that it is impossible to hear them, and also so slow that the sound passes away unperceived by the mind. It always ceases in the centre, whether quick or slow, because the centre of sound is universal.

Please allow another simile. Greenwich is taken or derived from the universe, and by itself has no relation to time, but being made a centre it is a creation, a measurement of distance and time. This creation is quite independent of Greenwich, for New York or Calcutta would do as well, yet it would be the same centre with different and opposing action as it is now. We are too apt to think that the universe is only that part that we see, whereas the greater part is unperceived. How about the impenetrable darkness that still covers the interstellar deep that is greater than our minds can perceive. Byron took one of his characters to the confines of the universe before it became a supposed darkness. But we know that the zenith becomes gloomy on the ascent of high mountains, and higher still would become a chaotic night. Is it true that one can see the stars in daytime by descending a deep coal-mine, or that the stars are reflected on the water down a deep well, and is the darkness always surrounding us? We can only have an idea of the universe from the particular centre that is our individual creation, and that idea only by contrast. There is no contrast without a centre to mark the difference, no balance, no lever, and no motion without this universal independent centre. A wheel can only turn round on an immovable centre, which centre is really the ground it runs on, say the fulcrum. Gravitation, attraction, action, and reaction are all governed by the same internal law, that always acts in opposition to itself, and which can never be understood by only observing one side of the question of creation by collecting external facts without considering the internal cause. This will be found in each individual creation. We only feel the heat of the sun, because we have an internal fixed temperature of our own, without which we should be insensible to heat or cold. Instead of saying that man is descended from apes, &c., it should be that all things are from one universal centre, which always creates with a likeness to itself, yet each individual is different to its own self and all others. I wish I could express my meaning better. **Fiddler.**

## WHAT IS CREATION?

[24678.]—WHILE I consider that this subject has now been pretty well ventilated in your columns, I may, perhaps, be permitted to reply to "F. W. H.," who was one of the original correspondents on the subject. He asserts (in letter 24662, page 546) that "Darwin's theories, showing evolution, adaptation, natural and sexual selection, &c., all working together *to bring about changes* in existing matter, are met by his opponents simply with crude assertions, &c."

Now, although I am not an opponent, even a humble one, I would advise "F. W. H." to read more carefully Darwin's voluminous and most interesting works, and I think he will see that he misunderstands the position taken by that great naturalist. Instead of bringing about new and original changes in organic forms, the phenomena which Darwin has embodied as a theory simply explain intelligently how, when new forms have appeared, they may be propagated—how a variety, appearing at first as a single abnormal specimen, may, in time, become a dominant one. He postulates over and over again in his works that, "*unless new variations do appear, natural selection can do nothing.*"

Now, the question under discussion in your columns has been, How do such new variations at first appear? I have unhesitatingly ascribed the phenomenon to "Creation," and have challenged "F. W. H." and others to suggest any other possible explanation.

"F. W. H." erroneously includes *evolution* with natural and sexual selection, adaptation, &c., as among the methods employed by Darwin in explaining organic nature, for, though I have carefully studied the whole of Darwin's works, I have not met with one instance in which he ascribes any phenomenen to "evolution."

In fact, "evolution," if it be not what I defined it in letter 24256, page 257, or if it be not synonymous with natural selection, must either mean spontaneous generation or an undefinable nothing.

If the term "creation" be obnoxious, I have no objection to substitute for it the term "transformation," suggested by "F. W. H.," subject, however, to my explanation in letter 24329, page 304, since no new transformation can be self-introduced or self-transformed; but as the more direct and lucid of the two I prefer the term "Creation."

**H. B. F.**

## SAFETY BICYCLES.

[24679.]—IF you can grant me the space, I should like to say a few words on the subject of safety bicycles, which I see has been lately ventilated in your columns. I cannot claim a long or varied experience, as, with the exception of the "boneshaker" of my youth, I had not ridden a bicycle until April, 1884, when I bought a Facile. I have since ridden some 5,000 miles, and I have no hesitation in saying that as a roadster the Facile is far superior to the ordinary bicycle: it is safe and comfortable, easy to mount and dismount, and certainly very fast. I am not by any means an athlete, being engaged in a sedentary business, and am 35 years of age. I am very fond of trying conclusions with anything and everything I meet on the roads, and yet I very rarely find a rider of an ordinary bicycle who is my equal in point of speed, be the roads what they may. I know several men who have given up the ordinary for a Facile, and they all say that they feel much less strain and fatigue after riding 50 or 100 miles now than they did formerly. I myself recently rode 155 miles in 20½ hours over some of the worst roads in Lincolnshire, and crossing the London stones from Highgate Archway to Peckham Rye, and suffered much more from want of sleep than from fatigue.

With regard to the geared Safeties, they are very extensively advertised; but I seldom see them about, although I frequent those roads where cyclists most do congregate. I see at least 20 Faciles for one other Safety. I have only been passed once by a geared Safety, and then by a man who is now one of the best Facile riders I know. From what I hear from riding men, I should be very sorry to exchange my Facile for any other Safety machine now on the roads. I will only add in conclusion that the Facile wants learning; no one can bring out its speed until some time has been spent in getting the feet and ankles used to the rapid motion of the pedals; but I am sure that those who give that time will find themselves well repaid.

Cyclists' Touring Club. **W. D.**

## MIDLAND ENGINES.

[24680.]—I REGRET to say that there is an error in my last letter (24639), which I suppose was caused by my general heading, "Midland Engines." I used it in an open sense—not limited, as would appear, to the large cylinder express engines. The two breakdowns mentioned occurred with the smoke consuming four-coupled engines used on the Metropolitan extension of the M.R.

The large cylinder type are, in my opinion, by far the best on the line, but I do not consider that their performances come up to many others. The Midland Railway Company are generally considered to own the best in the world; at least, their partisans say so. However, I am very glad to see by the letters in the "E. M." that there are some champions of the L. and N.W. compounds. I prefer the 8ft. G.N. engines for passenger express traffic to any others which I have tried, the run from King's Cross to Grantham especially, which is undoubtedly the best in England, being invariably taken by these engines. **Shylock.**

## L. & N. W. COMPOUNDS.

[24681.]—IN letter 24580 I stated my belief that, taken as a whole, the compounds consumed as much as the Precedents, if not slightly more. Nevertheless, I am greatly surprised at the figures given by "Kappa" (24641), showing, as they do, an average consumption by the two compounds of some 4½lb. per mile more than the six Precedents. This is indeed startling, especially as economy in fuel is the very *raison d'être* of all compound engines. I think the best compound in point of fuel is "Experiment," which burns about 28lb. per mile. The big compounds burn about 32lb., which certainly seems very poor as compared with the non-compound engines of the G. N. and Midland burning 26lb. In what respect does "Adiabatic" (24642) consider the compounds "wonderful"? In the coal consumption? Will "Adiabatic" tell us in what single detail the compounds are better than the Precedents? I totally fail to see their advantages, though their defects are obvious to all who are not absolutely blind. **G. D. Seaton.**

Aug. 24.

## THE SWADLINCOTE ACCIDENT: THE TWO-MINUTE BRAKE AGAIN.

[24682.]—MAJOR MARINDIN'S report upon an accident which occurred at Swadlincote (near Burton) on the Midland Railway has now been published, and attention is once more directed to the dangerous and inefficient character of the Clayton so-called automatic vacuum, or better known as the "two-minute" brake. On the 13th June a return excursion train, consisting of engine and tender, No. 1,440, and equal to 16 coaches, arrived at Swadlincote. The engine and tender had steam brakes and vacuum apparatus, the vehicles were fitted and worked with the vacuum brake. The engine was detached to run round the train, the vacuum brake was applied but leaked off, and the train commenced to run back. The line being on a heavy falling gradient, a pair of runaway or catch points had fortunately been provided, or doubtless the carriages would have run back two miles to the Swadlincote Junction with the main line, and come into serious collision; as it was the rear part of the train was thrown off the line at the points, and came into collision with three goods waggons; there were about thirty passengers in the runaway train, but they happened not to be in the vehicles which left the line. The facts of the case show at a glance the danger of the leak-off brake, and Major Marindin reports as follows:—

"It must be remarked that when the engine was uncoupled the continuous brakes were fully applied throughout the train, but the whole of them must have leaked off in less than two minutes. I cannot," he continues, "consider a continuous brake which leaks off in two minutes to be at all a satisfactory one, for it must frequently happen, as in this case, that it is desirable to hold a train by means of a continuous brake after the engine has been uncoupled, and in the case of a break away, either on an incline when running, or owing to a collision or other accident to the train, I can easily imagine that serious consequences might follow the release of the brakes so soon after their application. This slight accident should, in my opinion, be a warning against reliance being placed upon this brake under all eventualities."

A reference to back numbers of the ENGLISH MECHANIC will show that the dangerous "two-minute brake" has by its failures and inefficiency given the Midland Company numerous unmistakable warnings; it is to be hoped the leak-off system will be abolished before some really serious disaster occurs, as it certainly will sooner or later, if this unreliable appliance is continued in use. When the brakes return is published it will be interesting to see if this accident at Swadlincote is recorded in the list of failures.

**Clement E. Stretton, C.E.,**
Hon. Mem. A.S.R.S.

40, Saxe Coburg-street, Leicester.

## THE BINEGAR COLLISION.

[24683.]—As an old, practical signalman I should like to say a word. It seems it was a new line, and Colonel Rich had been down and inspected the arrangements. Well, he hadn't found them right and safe for traffic, and would have them altered. Mind, I speak as a practical man feels on the matter. When the Colonel found things weren't right, would it not have been better for him to have said, "This locking is wrong, I can't let you open the line till all is made safe"? Instead of that he seems to have said things are wrong, but you may open the line and put the locking right after. Can you or your readers explain why they didn't carry out the rules, and why was there no man at points as per rule 149*a*? **Signalman.**

## RIFLE SHOOTING.

[24684.]—ALTHOUGH perhaps not quite agreeing with "Invicta's" idea of the advantages to be derived from the use of Morris's or other tubes as a substitute for actual long-range practice, I certainly fail to see that his advice is as bad as "Bacchus," in his letter of last week, would have us believe. The reasons why these tubes are not of much utility as practice for long-range firing were sufficiently set forth in Sergt. Grey's letter of last week. Now as to the advantages of these tubes—and it is evident that they do possess some merit, as they would not have been admitted into the army, and have received such commendation from those who "ought to know." If "Bacchus" is a rifle shot, he cannot deny that plenty of aiming drill is an immense assistance to the eye, especially at a Wimbledon "bull" at 200 yards; and granting that he agrees in this, he cannot but agree that a mark, the size of a shilling, twenty yards distant is equally good practice, educating, as it undoubtedly does, the brain and hand to work in unison. Now it certainly is anything but interesting to stand or kneel for one or two hours before a mark and merely aiming and pressing the trigger, and obviously it is here that these tubes come in, and give pleasure and excitement to what otherwise would be but very monotonous work. We all like to see something for our trouble. Even the pea-shooting boy would be ill-content to blow wind, no matter how much he might be assured that his aim was straight; he delights to see the pea hit something, even though it be the tip of the nose of an unoffending nervous passer-by.

One word more. If recruits were trained more with Morris's tubes we should have fewer bullets whizzing about in all directions than we have now. Besides being less expensive, it would most certainly be more safe.

If "Invicta" would like good practice with the Martini at 100 yards—this should suit "Bacchus," as it is not converting the weapon into a small bore—here it is:—

Get a mechanic to bore a piece of steel to take a ·450 revolver cartridge easily, and let this steel be turned up to nicely fit into the breech as far as the shoulder where the rifling commences, and to have a rim the same size as that in a ball cartridge so as to fit the extractor, and this is all that is required to convert the military weapon into an excellent sporting rifle, and with it one may have good target practice with little noise.

Leicestershire Regiment. **J. S. Rochard.**

### VENTILATION OF COAL-MINES.

[24685.]—In reply to "Lyons," letter 24664, in your paper of 21st inst., "heavy" ventilation, as the present system is called, is stated to be the cause of more frequent and worse explosions than formerly. The reason is obvious.

When gas is about, a mine is really ventilated by a current of fire-damp travelling at a velocity that may fire a safety-lamp in less than a minute; especially may this be so in return airways. Now, the speed is here the greatest offender, since no lamp will fire in a low-speed current; besides, when gas appears, it has become a common practice to increase the velocity of the current, and so increase the danger.

Under such circumstances, what is best to be done? As it is at present, pure air in the down-cast shaft is sucked half-way through the mine, and in its advance so far gets fouled, and on its return gets worse fouled. Hence many a mine has been fired in the return airway by lamps or the furnace.

My argument is that one-half the quantity of foul air now passing the face of the coal would, if delivered there as fresh air, do far superior service.

The colliers would breathe a better atmosphere, while the speed of ventilation would be too slow for danger.

It should never be forgotten that a current moving only 7ft. a second—i.e., about good walking speed—is very risky.

In my opinion, the speed to the up-cast shaft or shafts of air delivered near the face of the coal, as I have suggested, would not exceed 4ft. a second. Thus that fruitful cause of explosions, "speed of a fire-damp current," would not occur.

Now, as to cost of engines, compressors, pipes, &c., no doubt it would not be done for nothing; but 6d. per ton would cover interest on the capital required. As about 500 men lose their lives annually by explosions in collieries, the question arises as to checking that loss at the price of 6d. a ton to the consumer.

I greatly prefer a moderate but sufficient supply of fresh air at a low velocity—which can do no harm, while doing much good—to huge volumes of foul air at a higher velocity, which is often most mischievous, and will continue to be so under the present system of "heavy ventilation."

August 24th. **J. D. Shakespear.**

### COLLIERY EXPLOSIONS.

[24686.]—It affords me much pleasure to discuss a question in the English Mechanic, provided the views I have expressed are correctly given when they are referred to by correspondents.

In your paper of 14th inst. is a letter (24606) signed G. Worlands, saying that "As a mining engineer, it will not be difficult for me to show that Colonel Shakespear's suggestions are practically of little value for the purposes intended."

Now I have not the slightest objection to that opinion so far; but when he makes out that I advocate that gas should be "kept back by a great pressure," he shows clearly that he does not understand me, nor the question of positive *v.* negative ventilation. I have never made, nor am at all likely to make, any recommendation so impossible to carry out as that of ventilating at a greater than atmospheric pressure. But that is very different from the practice of sucking the ventilating current from the down-cast through the mine to the up-cast shafts, for the tendency then is to lessen pressure; besides, the current is fouled both going and returning.

My argument is that air might be delivered under pressure near the face of the coal, which, on expanding as it would when free, resume ordinary atmospheric pressure, and become the ventilating current. Mr. Worlands has perverted that reasoning into an idea for heading back gas at a pressure of 30 atmospheres. The idea is nonsense, and not mine.

Mr. Worlands' remarks as to the value of discipline are right, no doubt; but explosions continue in spite of discipline, and will continue in spite of it, for the mine-storm below ground corresponds to the hurricane above.

Inst. C.E., Aug. 18. **J. D. Shakespear.**

### ALUMINIUM.

[24687.]—Many thanks for Mr. Allen's kind offer (letter 24600, p. 519). I will explain my present position. It is near 60 years since I became an experimentalist. My first patent for aluminium was dated Dec. 16th, 1856, No. 2,980. I commenced with calcining ammonia alum and obtained 2cwt. or 3cwt. of $Al_2O_3$. It was not remunerative. I then substituted cryolite, a double fluoride of aluminium and sodium only to be found, I believe, in Greenland. It was an improvement, but did not pay. The following is an extract from the *Chemical News*, May 26th, 1860, p. 291—the Society of Arts Exhibition of Inventions:—"In conclusion, we may briefly name the specimens of worked aluminium exhibited by Mr. F. W. Gerhard, the metal having been produced by the process of the above gentleman at his works at Battersea. We have never before seen the metal with so fine a tint and of such apparent purity." This was obtained from cryolite. Since that period I have been occasionally experimenting on a small scale in plumbago crucibles 2in. or 3in. in diameter, either in a Fletcher's gas furnace, or more frequently in a common fire-grate. It was in the latter that I made my successful experiment in obtaining Al and calcium without the aid of sodium about four years since. The problem was solved. I then commenced with the salts of Al, Mn, and Ca for electro-plating, and succeeded, the patents for which are now offered for sale (see the Sixpenny Sale Column). Should I dispose of them, I shall be enabled to have an appropriate place, which I have not at present, to make my experiments on a larger scale, and produce ounces and pounds instead of grains; but I find energy diminishes (age 75).

I had almost forgotten to name my last experiment. It was to produce crystals of alumina (corundum), and if I had added a few grains of the oxide of cobalt to the alumina, I should have had two or three crystals of sapphire. My process is superior to Ebelman's boracic acid process, which requires more days' heating than mine hours. Can you inform me of the properties of boron? I see it advertised at 2s. per grain. Suppose it could be obtained in large crystals, what would be their value? **F. W. Gerhard.**

Wednesfield-road, Wolverhampton.

### EXAMINATION OF MINERALS BEFORE THE BLOWPIPE.

[24688.]—No. 16. A double carbonate of barium and calcium, generally called "barytocalcite" (or "alstonite," from Alston Moor, in Cumberland, the only locality, I believe). This mineral is unique in its way. It is only found in one place in the world, and is, I think, the only mineral in the world which assumes a green tint by mere heating *per se*, as baryta and $MnO_2$ fuse together at high temperature, the mass assuming a green colour, Plattner was perhaps right in guessing the presence of a little heterodox manganese oxide in this mineral. On the other hand, neither Johnston, Delesse, Hauer, or Children, who analysed it, could find a trace of Mn; and I observe Col. Ross's system does not detect that oxide either. Professor Brush, in Dana's "System of Mineralogy," says, "with the fluxes, reacts for manganese"; but this is a mistake, as the merest trace of $MnO_2$ fused with soda, alongside the powder of this mineral fused with soda B.B. on Al plate assumes a brilliant greenish-blue like turquoise, whereas barytocalcite affords a dull, slate-blue bead, to my eyes, quite different. I inclose the two soda beads, and shall feel obliged if you will send them to Col. Ross for his inspection.

No. 17. Strontium sulphate, or "celestina." I maintain, with all due deference to Col. Ross's note, my opinion as to the similarity of the blowpipe reactions of this mineral and of "barite."

No. 18. Strontium carbonate, called "strontianite."

No. 19. Fluor spar evidently; but surely it affords more than "a *slight* choking smell" B.B. (due to disengaged hydrofluoric acid), considering it contains 48·7 per cent. of fluorine?

No. 20. Gypsum.

No. 21. Crystallised calcium phosphate, called "apatite" by Werner, from ἀπατέω—I deceive (probably from Spain).

I was not aware phosphoric acid, as well as sulphuric and carbonic acids, afforded effervescence in boron trioxide before the blowpipe. Col. Ross does not mention the reaction in any of his works on the blowpipe. **Mineralogist.**

### PYROLOGY.

[24689.]—As Mr. Allen is apparently tired of this subject, and must, besides, be very busy preparing for his Association visit to Aberdeen, I shall, with his acquiescence, drop it for the present; content with his admission that the ball of calcium pyroborate discovered by me is a new definite chemical compound (as, indeed, none but lunatics could deny), and that "no one doubts the fact that the ball is four times the weight of the lime used to make it, when small quantities are employed."

I have now in twelve years discovered about thirty other similar and equally obvious chemical compounds, which, although the combining proportions have not yet been determined, are entirely new to the science of chemistry. Besides these, there are some admittedly new substances, as, e.g., the black pyroxide of zinc, &c., and many new oxides developed by the use of aluminium plate as a support. Whether these are of sufficient interest to him and other leading English chemists to engage their leisure attention, it is for them to determine. They will not deny that a knowledge of them and their reactions upon each other anhydrously would extend and probably complete their knowledge of chemistry as a whole. Further than that, it seems to me, and even to some very eminent professors with whom I have conversed on the subject, that the English chemist who first could and would "seriously" take up the study of this subject, and patiently strive to assimilate the results he obtains with the known analogous reactions of the same substances in aqueous solution, would probably stand at the head of his profession.

For myself, I am too old to undergo the (to me) necessary course of study in aqueous-solution analysis; and, besides, the Government laboratories (which I consider I have contributed to keep up by my taxation all my life), where I should have to undertake such a course, are exceedingly expensive in the way of fees, &c., instead of being, as they ought to be, free to taxpaying students, who would, of course, pay for use of apparatus and reagents.

Again thanking Mr. Allen for the courtesy and and ability with which he has conducted this discussion, I beg to conclude it by stating in reply to his last query (page 519, "E.M.") that you cannot employ a platinum crucible in anhydrous analysis, (1) because platinum itself at *red* heat communicates opalescence to borontrioxide, just as calcium, hydrate does; (2) because you cannot maintain a sufficiently high temperature in the menstruum and its contents through the "walls" of a crucible; and (3) because the effects of oxidation and reduction cannot be thus properly applied to the assay for the same reason. In short, you must have *direct application* of the different parts of the pyrocone to the assay. **W. A. Ross.**

P.S.—I hope Mr. Allen does not really think I would "attempt to ridicule the wet methods." My object was to show that the blowpipe properly used is as close a detective of traces of oxides, &c., as even the spectroscope, especially when used in conjunction with the microscope.

### A NICOTINE SYNTAGMA.

[24690.]—Those of your readers who have done me the honour of using and approving of my condensing tobacco-pipe are aware that its greatest defect was the horrible smell of the nicotinic essential oils evolved by it when the protruded end of the sponge in the unscrewed mouthpiece of the new pattern was defecated in squeezing out the "juice" during a smoke by the pressure of the breath, blowing the sponge against some opposing surface.

In the open-air this was of no great consequence, as the smoker can generally find a wall, or post, or tree against which to press the sponge while he blew out the collected empyreumæ; but in a room the difficulty of doing this inoffensively constituted a very serious drawback to the enjoyment of my pipe in company.

I think I have now completely overcome this defect by a piece of smoking-room furniture, to which I have given the name of a Nicotine Digester or Syntagma, because it instantly absorbs the offensive products of smoking without communicating any smell to the room. This is effected by pressing the protruded sponge-end of the mouthpiece, strongly blown through, against the side of an ordinary yellow well-burned house-brick cut in half; this pressure leaves a small, dry, brown strain on the surface, but no smell, even on any other side of the brick itself. The half-brick is inclosed in an ornamental bronze filagree stand, having four open sides, and placed on the table on the left hand of the smoker. The stand has a door for admission and extraction of the brick, and a handle for the smoker to hold while he presses his sponge against the brick, the unscrewed bowl of the pipe being placed, *pro tem.*, on the table. After long use the brick is purified simply by being put into the kitchen or other fire for a short time.

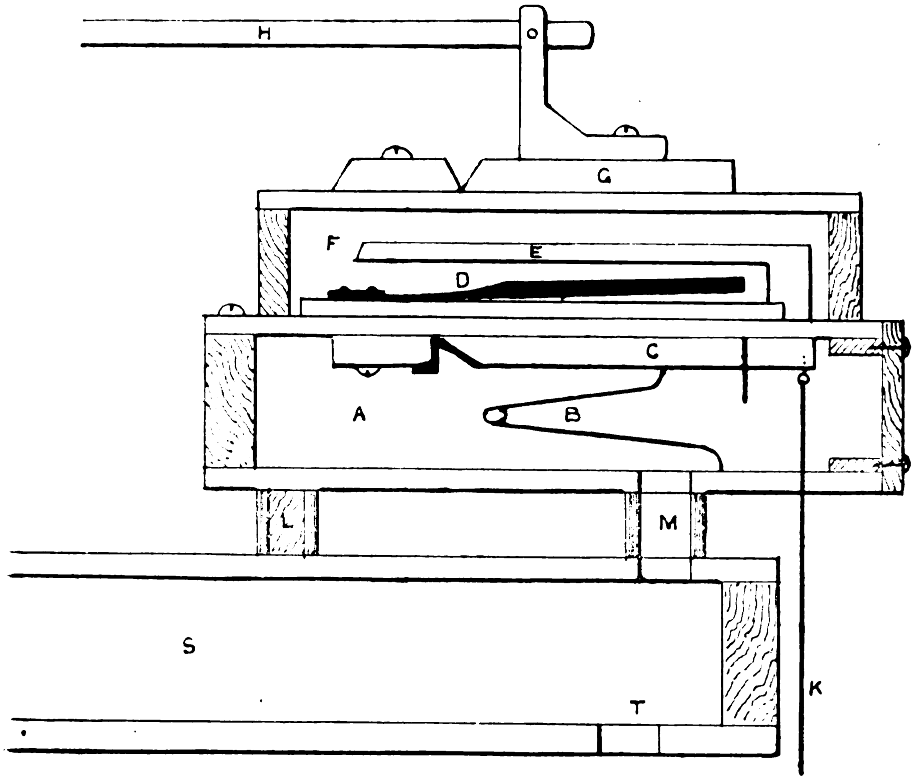
The principle is this. The alumina of the brick becomes semi-caustic by burning, and then possesses intensely absorbent qualities for fluids, evolving with water or saliva a well-known strong, but not unpleasant, odour, which overcomes that of the small portion of the nicotine unabsorbed by the brick.

N.B.—This implement could, of course, be easily fixed on the inner sides of smoking-carriages of railways; when there would be no more pools of the disgusting discoloured saliva usually found on the floor, as no one expectorates in using my pipe. A few drops of scent may now and then be put with the forefinger over the spots.

A friend suggests that slips of firebrick might be slid into the lids of the ordinary metal fusee or "light" boxes. **W. A. Ross.**

### AMERICAN ORGAN PEDAL BASS ATTACHMENT.

[24691.]—As proposed, and promised by me on p. 374, Vol. XL. of the English Mechanic, I send sketch and brief description of a good arrangement for an American organ pedal bass attachment. In sketch, A shows the windchamber, in which are situated the pallets in connection with the pedal bass reeds. The pallet springs are fixed similar to those found in small pipe organs. The pallets are actuated by pull-down wires connected to inner ends of pedals. The reeds and tubes are mounted on a sounding board, distinct from that of the instrument to which the arrangement is applied. In fact, Seen by me for the 1st time 30 Oct /85 [illegible]



the whole arrangement is entirely independent from the American organ action. The attachment should be raised from the soundboard of the instrument by two standards and also two tubes, the latter applied for the purpose of conducting the air to the pedal bass reeds, and also to partly act as a support for the arrangement. If the arrangement, or action, is raised about 1½in. above the soundboard of instrument, that will be sufficient. It is simply intended to be raised from the soundboard, in order to facilitate the operation of access to the back rows of reeds of instrument. If preferred, the pedal bass reeds and tubes may be mounted on the main soundboard of instrument, but in this case the pallet action would require to be arranged somewhat different to the method which I here describe. It may be necessary to remark that this pedal bass attachment is most suitable for those who contemplate building an American organ with a separate pedal bass action. It can also be applied to ready-made American organs, providing there is sufficient room at the back portion of the soundboard. As in pedal practice there are never more than two reeds sounding at the same time, the amount of air required is not very considerable; but the pressure of air certainly demands some consideration, as the pedal bass reeds will not speak well under a light pressure. In reference to sketch, B shows pallet spring, C the pallet, D the reed, E the tube, F the soundbox over tubes and reeds, similar to that usually placed over the horizontal sub-bass arrangement. G is the mute controlled by the stoprod H. K shows the pull-down wire connected at the upper end to pallet, and at the lower end to inward end of pedal. S is the windchamber of American organ to which the arrangement is applied, and T shows the windway to bellows. L shows one of the standards, and M one of the conducting tubes. On four of these (two at each end)—viz., two tubes and two standards, the whole of the pedal bass action rests. I think this may be considered one of the most simple, and, at the same time, one of the most effectual arrangements for a pedal bass action. If this method is employed, it will be difficult and inconvenient to adopt a compass over two octaves of pedals. The tubes and reeds of the pedal bass should be so arranged on the soundboard as to allow a space of 2½in., or a very trifle less, between each natural note, from centre to centre. There is another arrangement which I shall shortly describe, in which the reeds are placed in vertical tubes, like small organ pipes. The latter suggested plan is somewhat superior to that which I have described, but it requires a certain amount of room for the tubes, which is not to be found in American organs generally. The greatest desirability in arranging a pedal bass is to procure a good sonorous tone, full and round, a tone that can be felt as well as heard, and differing from the weak and dingy rattle so prominent in many of the sub-bass arrangements.

**G. Fryer.**

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## WATCHMAKERS' QUERIES.

[24692.]—Referring to letter 24655, I think the reply by "Peganredstuff" is quite clear. The vibrations of the balance may easily be found by multiplying the numbers of the wheel-teeth from, and including, the centre-wheel by twice the number of the escape-wheel, and dividing by the product of the pinion leaves. Having found the required number of vibrations, say 18,000 per hour, which is equal to five per second, fix on the balance spring by pressing the collet down over it; take hold of it at a radius equal to the distance of the stud from the centre of the balance; now set vibrating, and count. Two or three springs may have to be tried before one is got to suit. With a little practice it is easy to count every second or double vibration so near that when pinned in the watch, in many cases, it is only a few minutes wrong in 24 hours.

"Escapement's" method may do when there is an old spring as guide, but is quite inapplicable when the spring is wanting altogether. If two balances of the same weight, but one much larger in diameter, be tried with the same spring, the large one will vibrate much slower owing to its radius of gyration being greater, although when weighted the spring will be deflected the same with both balances.

This method of fitting springs is only suitable for common watches, as when isochronism has to be taken into account the operation is rendered much more difficult.

22nd August. **G. W.**

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## LATHE WORK AND OPTICAL INSTRUMENTS.

[24693.]—I was glad to see the letter of "An Amateur" (24650) in your last issue, and hope someone, able and willing to do so, will give your amateur readers, especially those living in the country who have no opportunity of seeing certain kinds of work done, some practical help on lens-grinding, and making the necessary tools for such work. The papers should be illustrated by good working diagrams.

**H. A.**

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## THE SOARING BIRD—A MECHANICAL PROBLEM.

[24694.]—Having read with much interest the leading article in "Ours," of Aug. 14, upon this subject, I must say that I thoroughly object to Mr. Lancaster's theory; for the sufficient reason, in my opinion, that he assumes that the action of the air upon an inclined plane which is free to move would produce an upward current, but ignores the fact that an inclined plane to move in any direction would certainly travel backwards and downwards with a speed proportionate to that of the air which sustained it, and unless sustained by a power unknown to us, would not wait one instant for the commencement of said upward current. Now, I have also witnessed this soaring of sea birds in warm latitudes, and venture to submit two theories to the crucial criticism of the critics of "Ours." I start with the proposition, which I am prepared to prove if anyone disputes it, that everything upon this earth is unceasingly in motion, although it may be invisible to the unaided eyes of mankind. 2. There cannot be any kind of motion whatever without friction; and, 3. There cannot be any friction, of which I am aware, which does not develop electricity; but because almost, if not all, the bodies conceivable by us are conductors, more or less. This universal and ceaseless production of electricity has been heretofore suffered to go on without any apparently, to me, of our savants endeavouring to turn this feature of the electric problem to the advantage of mankind. Now, all electricians are aware that when two neighbouring bodies are charged with electricity of the same name —viz., + or −, positive or negative, that they will repel one another with a force proportionate to their mutual areas. Thus, this soaring taking place in warm air, I am, I think, in a position to prove that said birds can be and really are highly charged with electricity, and that also in a state of high tension. I consider this theory to be consistent with fact when we bear in mind that suitable apparatus will show that even the working of the brain acts as does our ordinary pumps in this respect, and collects this all-pervading electricity; but, apparently, according to my present light, only to be spilled, as it were, upon the ground again. How these facts have hitherto escaped the notice of electricians making this branch of science their assiduous study, I am at a loss to understand, but trust that I will be in a position shortly, when I have secured my rights by patents, to publish a new treatise upon this most interesting topic, accompanied with descriptions of entirely novel experiments and results, as will render a new text-book upon this subject far more important than the newly-revised Bible appears to be. This electrical theory as to bird soaring is the one that I prefer myself; but a prudent general always provides for a means of retreat, and I propose theory No. 2 as a base in case of a possible defeat upon No. 1. Most of "Ours," I conclude, then, have, at some time in their career, worked up a piece of fresh bread into a ball about the size of an ordinary pea, stick a pin through the same, and placing the pin in a suitable piece of pipe stopping; then throwing back the head (not of the pipe, but that of the operator), holding it vertically (the pipe stem). Upon blowing, the pin and pea dance about upon the ascending column of air for a considerable time before some inadvertent change in the conditions causes them to fall. Some also, as well as myself, have doubtless taken a piece of pipestem, made a hole in a piece of board, inserted said stem therein level with the board's upper surface, holding board horizontal, and placing over the orifice of said small tube, say, a watch-glass with the concave side downwards. No amount or pressure of blowing underneath can blow off the said watch-glass. A bird's wing is not, in my experience, a flat plane. It is decidedly curved on both sides—upper side convex, and the under one concave—which formation I have carefully studied, and offer the following explanation: In the case of the bread pea, I submit that when we blow, the pressure of the issuing column of air raises pea and pin, which would instantly fall off were it not that any column of water or air issuing from any given orifice draws a certain amount of the body surrounding it, if said body be capable of motion, along with it. Take the ordinary injector as a case in point, and in this case the air rushing in from all sides, save that where column of air occupies, keeps said pea in position. In the case of the watch-glass, we have a column of air of relatively small diameter impinging upon the centre of the curved surface, and turned off on every side at an angle. It rushes freely down the curve and produces a partial vacuum under the whole area of said glass, so that it is pressed down with considerable force instead of being blown away, as one might naturally expect to see; and lastly, in the case of the bird's wings, if there be any wind stirring it strikes the curved surface, and its horizontal motion is gently converted into a curved downward motion, which causes a rush of air off the upward surface of said wings, in obedience to the laws I have enunciated. Consequently, the bird's body endeavours, as it were, to occupy the partial vacuity, or rather, is pushed up by the underlying air. If the bird allows itself to fall when it is calm, precisely the same result will follow, only that the air will rush past the wings and take the air on top of same along with it, thus producing the same upward tendency of its body. In conclusion, permit me to submit these two theories to the readers of "Ours," as being more practical than the American one upon page 509. I submit that he is entirely in error as to the conduct of a flat surface or body set free in air.

**A., Liverpool.**

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## AUTOMATIC MUSICAL INSTRUMENTS.

[24695.]—A correspondent having given the number, I have obtained Mr. Wenham's specification, which has cleared up certain points which I had not quite comprehended from his letters in the "E. M."

The arrangement is certainly a very clever one, and as simple as it is clever; but I would ask Mr. Wenham to kindly reply to a couple of questions relating to its actual working. Since the plungers are all in the same line, they must necessarily be placed about the centre of the white keys in order to (at the same time) act on the black keys; but in order to depress the black keys fully, it is necessary for the plungers to have a stroke of ¾in., while the extreme depression of the white keys at this point of their length is only ⅜in. Since the vibrating bar depresses all the plungers equally, it must happen that while the white keys are struck down to their full extent, the black keys are only struck down half-way, from which peculiarity one would expect considerable differences in the loudness of the notes and consequent irregularities in the music. The other question is this: When a note has to be rapidly repeated, is the plunger pushed under the vibrating bar *for each repetition*, or is it left under the bar till the number of repetitions is complete? In the former case it would apparently be necessary to insure very exact time between the passage of the paper strip, and the movement of the bar; while in the latter case the repetitions might be more rapid than the music required.

I am rather surprised that cartridge paper is found rigid enough to work the levers and bell cranks, and overcome the inertia of the long connecting wires, not to mention the resistance of the springs, that throw up the lever points into the perforations. Since I last wrote I have seen several more varieties of these instruments, but the only one that struck me as of special interest was an arrangement by which the "pneumatic action" long since used for large pipe organs was adapted to these little automatic concerns. By this method the perforations were able to be made much smaller, and more reeds acted on for a given width of paper band. I think about 9in. width of band controlled 30 or more reeds. If any correspondent can give me the particulars of the specification, I should like to get a copy, as though the principle is old the arrangement of the parts (so far as I could see them) was new, and was also particularly neat and compact.

I am glad Mr. G. Fryer is about to fulfil his promise to send a drawing of a complete instrument. If the reeds in his two-row arrangement are so placed that those opposite each other in the same channel are a note and its "twelfth," a certain amount of variety is obtainable by allowing one or the other or both simultaneously to sound by suitably-placed valves commanding the air passages. I use the expression "twelfth" as if it was an organ, as Mr. Fryer will readily understand.

A. S. L.

### AN EASILY MADE RAIN-GAUGE.

[24696.]—Yes, the gauge described in letter 24646 is very easily made, but very bad when it is done, for the rod rising above the funnel will collect rain which ought to pass over it, and will make the gauge show several inches per annum too much. Moreover, if frost catches any rain in the gauge a leak will soon follow. G.

## REPLIES TO QUERIES.

*** *In their answers, Correspondents are respectfully requested to mention, in each instance, the title and number of the query asked.*

[56031.]—**Reservoirs (U.Q.)**—Thickness of a tube 12ft. long by 72in. diam., to collapse with a pressure of (14 × 3) = 42lb. will be ¼in. Ends dished inwards to a radius of 6ft. The above gives minimum thickness. I should make plates ⅜in., and put a few angle bar rings, say 3in. deep, round outside to preserve the circular form.—Glatton.

[56440.]—**Warnerising (U.Q.)**—The waterproofing liquid is prepared by dissolving 1oz. caoutchouc, or other elastic gum, and 1oz. paraffin or other wax in 1 gallon of any hydrocarbon solvent, such as benzoline. Hydrochloric acid gas or chlorine gas is passed through this solution for some time; it is then filtered or decanted, the clear liquid placed in a retort, and distilled at a temperature of 145-165° Fahr. When the vapour distilling over is no longer acid to litmus paper, the distillation is stopped, and nine-tenths of the liquid in the retort is drawn off. This portion is claimed to be perfectly free from acids or alkalies. Full particulars will be found in the patent No. 5,486, 1882, Nov. 18, price 2d.—Alto Petit.

[56961.]—**Boating.**—Many thanks to "Invicta" and others for their replies on this subject. I think it cannot fail to be of general interest to many of our readers. I earnestly join with T. Handel in hoping "Invicta" will favour us with particulars and sketch of the method he considers best; and that J. Adams will give us full details of the one he speaks of going eight miles an hour with half the labour of rowing. I think T. Handel's arrangement might be considerably improved upon. In giving details of propelling arrangement, kindly give dimensions of boat, and particulars and dimensions of paddles or screw. Is the paddle or screw the most economical, both as regards power or speed? Would the outside of the boat not be best covered with canvas? Could the most power be got from the hands or the feet? I hope this subject will not be allowed to drop until something definite and useful is brought out.—Aqua.

[56985.]—**Planing Machine.**—Press of business must be my excuse for not thanking "J. H." for his kind reply to my query before, and for sketch. Many years ago it came to my lot to fit up a machine from similar castings. In them the weakness feared of the V's breaking off was avoided by making the thickened portion containing the hollow V a little deeper, thus affording more support, the rack frame being made so as to match, and though only about 9in. longer, I never remember its lifting under cut. I advocate this form of V because, in the case I mention, it being well planed, the surfaces had only to be smoothed, and required no further fitting. Perhaps one reason of its steadiness was owing to the V's being barely half as wide as yours, and much more acute. I regret much forgetting the dimensions of this table, as I am anxious to know what should be the depth and weight of a carriage of the same area as yours to be exempt from lifting under cut with V's as I propose. From some crude experiments I am led to believe that it is quite possible to modify this tendency of rack and pinion to separate or the reverse, by timing them to each other so that the ascending teeth only shall engage with the rack in the first case and the descending in the other.—J. C. G.

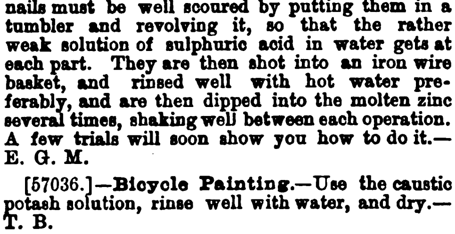
[57028.]—**Stamping in Relief.**—There are any quantity of receipts for lacquer in back numbers of the "E. M.," but the base of nearly all is shellac dissolved in methylated spirit. Writing from memory, I should say that about an ounce of shellac to one pint of the spirit would be amply sufficient, and if you would like a coloured lacquer a little of any aniline dye can be added. The lac will require a day or two to dissolve (giving it an occasional shake), and the insoluble portion will settle to the bottom of the bottle. The clear solution must now be poured into another bottle for use. Bottles should be clean and dry before use. The articles to be lacquered can be placed on an iron stove or on a sheet of iron over an ordinary fire till they are about as hot as can be held, and a thin coating of lacquer brushed on with a camel hair or other soft brush. If they are too hot the lacquer will blister and spoil the appearance at the right heat; the lacquer will dry smoothly the moment it is put on. The same part should not be brushed twice over. I have been told that the lacquer can be applied to the brass when cold, and then afterwards heated till the lacquer gets transparent; but I have not tried this method. A smaller and lighter press will do for stationery, and can be bought second-hand also for a very few shillings. It is far better and cheaper in the end to put every tool to its proper use; anything in the shape of a makeshift always causes a loss of time. Your own judgment will require to be used in these matters, and it will not take you long to experiment on a piece of paper with the dyes and press you use for the brass, and if they will not do you can then get something else that will.—Os.

[57030.] — **Galvanising Clout Nails.** — The nails must be well scoured by putting them in a tumbler and revolving it, so that the rather weak solution of sulphuric acid in water gets at each part. They are then shot into an iron wire basket, and rinsed well with hot water preferably, and are then dipped into the molten zinc several times, shaking well between each operation. A few trials will soon show you how to do it.—E. G. M.

[57036.]—**Bicycle Painting.**—Use the caustic potash solution, rinse well with water, and dry.—T. B.

[57065.]—**Cork-cutting Machine.**—Will not the illustrated description on p. 181, No. 970, do for this querist?—Nun. Dor.

[57116.]—**Bell Telephone Circuit.**—To Mr. Bottone.—Perhaps the following arrangement is the best under the conditions. T and T′ are the telephones (shown detached from the microphones for clearness' sake), M and M′ the microphones, S S′ are switches, on turning which the microphones can be thrown in or out of circuit, as also can the telephones. B is the battery, L the go, and R the return wire. T′ is shown as sending, T as receiving. The circuit is complete through R, M′, D′, L, T, S back to B. If the switch S be placed so as to make contact with M, while S′ is placed against X′, then T can transmit, whilst T′ can receive, since the circuit is now complete from B to S; from thence throw M to D, L, T′, S′, R, back to B. No coils could be used on this single battery and single line circuit.—S. Bottone.



[57122.] — **Problem.** — In the solution by "W. A. S." ought not the – 4, six lines up from the bottom to have been divided by 20 like all the rest of the equation? I admit my inability to work it out, or even to understand how "W. A. S." obtains his results, as I never learned the modern system of putting all the terms on the left hand side, and making them = 0, which, I suppose, simplifies matters to those who are used to it.—J. K. P.

[57166.]—**Model Well.**—Thanks to Mr. Scudamore; but he has, I think, failed to understand my query. Out from the side, and close to the bottom of a leaden cistern on end, a siphon is soldered; the cistern is supplied by a tap from another reservoir. My query was: "The bore of supply-pipe to the leaden cistern being smaller than pipe forming siphon, how is it able to fill the latter at the bend, drive out all air, and cause siphon's action to commence?"—H. A.

[57182.]—**Great Northern Locomotives.**—Errata.—A fortnight since I wrote that the trailing wheels were 3ft. 6in. It should have been 4ft. I mentioned also that I thought a new broad gauge was being built with 9ft. wheels; but I find on further inquiry it has only 8ft. drivers.—Angus MacMuir.

[57183.]—**Planing Machine.**—To F. Shakespear, Dresden.—The answer given to this query by "J. H.," on p. 527, is correct according to the way in which he understands the query itself. I interpret it differently, and should say that the way to make your "clamps" and angle-plates hold their work is to "cramp," not "clamp," them together by means of horizontal bolts. In this way a couple of angle-plates make a very excellent parallel, or even angular vice. A "clamp" is a structure of unburnt bricks arranged for burning, and a very unsavoury structure too. A "cramp" is a mechanical arrangement for bringing things into close contact, either by screws as usually done in mechanical arrangements, or as in masonry, by bending down the ends of a small bar of iron to form what are called by some "corkings," or, in my opinion, more correctly, "calkings"—i.e., *little heels*; and these cramps are fixed by pouring melted lead into the groove in which they lie. They first expand with the heat, and then contract and "cramp" the work forcibly together. A *clam* is another thing altogether, being merely a plain piece of wood, metal, cork, or any other substance introduced for preventing the work under treatment being injured by teeth or jaws of vice, chuck, or other "cramping" arrangement. Thus far I wrote for insertion in last week's issue, but forgot to forward it. Curiously enough, the job I now have in hand required holding in the manner above described, as it was too high to plane safely in the ordinary vice. I happened to have by me, ready planed up, two castings of angle-plates, 6in. long, the branches of the ∟ being 2⅜ and 1⅜ respectively, and ⅜ thick. One bolt to each held them down perfectly, and a pair of iron rods screwed on both ends for the nuts held them together effectually. This was without the use of any set screws. Of course, in this case, the work being only about 4in. wide, there was room to put the tie bolts *outside* the work, and as it was of the form of a capital ∩ (upside down), it would have allowed of one through the middle, and that would have sufficed, and in many cases the work may be raised and have the ties under it; but often it is necessary to select your angle-plates of some greater length than the work itself, and put the ties outside.—J. K. P.

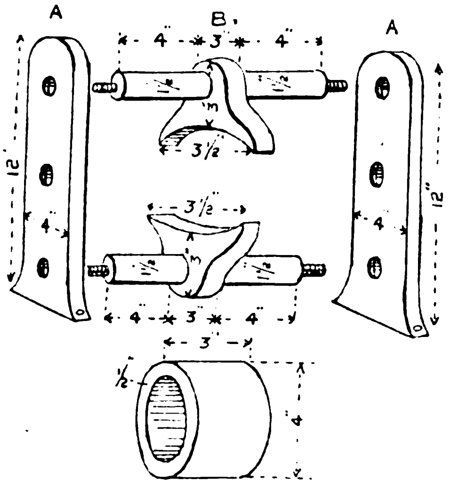
[57185.] — **Dynamo.** — To W. H. Eaves, Coventry.—When I read your query I expected you had made a mistake, and allowed for it; but as you have now given me the exact size I can advise you more correctly. Wind the armature with a single layer of No. 18 double s.c. wire, and for the field-magnets use about 30lb. of No. 18 d.c.c. wire. At a speed of 2,000 per minute, you will get from 50 to 55 volts, with a current of 12 ampères, including that required to excite the F.M.'s; so you may reckon on getting 10—20 c.p. lamps from your machine. Be sure you have a very powerful field, and use the best iron you can get in the armature rings and F.M.'s—W. H. Eaves, Coventry.

[57189.]—**Income-Tax.**—I have evidently made a mistake here; but although my general conclusions were not correct, the advice I gave was so.—Os.

[57201.]—**Violin Strings.**—It is difficult to give accurate dimensions for double bass strings, as they seldom run even all through their length, and also lose in diameter as they stretch and dry with use. I have just measured one of mine and find them $\frac{11}{100}$, $\frac{15}{100}$, $\frac{20}{100}$ of an inch, but believe that on another bass of mine, which I cannot refer to, as it is at the Loan Exhibition, the diameters would be found rather smaller. The third string appears rather thick in proportion; but this allows of your tuning down to G, which is now very usual. Of course Bottesini, for solo work, uses much thinner strings; but he usually tunes to a much higher pitch. A set of the best Italian strings should cost about 15s., but you may buy others much cheaper, although I think the economy doubtful.—J. W. M.

[57201.]—**Violin Strings.**—Take your instrument with you to any respectable music shop. You can there ascertain the "probable cost" and "relative thickness" of the double-bass strings. I quote prices of good strings, in case the querist should not be able to take the advice offered above. Firsts, superior, 3s. each, Roman, 5s.; seconds, 5s. and 7s.; thirds, 7s. and 11s. All double-basses are not made strictly to one measurement or form, and the quality of tone produced depends chiefly on the care bestowed in its manufacture, and also on the quality of the material used. The quality of the strings used is also of some importance with regard to the quality of tone. You will find a string gauge very useful when you want to purchase a set of strings. Always keep to one particular gauge for each string. This advice holds good both for violoncello and ordinary violins, as well as for double-basses. The distance from foot of bridge to soundpeg can be ascertained by measuring.—G. FRYER.

[57221.]—**Gramme Dynamo.**—To MR. BOTTONE.—The inclosed sketch shows the dimensions and form of the parts required. One pattern will serve for both the standards, A and A′; also the field-magnets, with their horns, B and B′, can be cast from the same mould. The armature can be cast; but would be better, if made from sheet iron, by rolling up. You will require about 6lb. of No. 16 on the fields, and 2lb. of No. 18 on the armature. The more sections you have in the armature, the steadier the machine will work.—S. BOTTONE.



[57223.]—**Chemical Action in Leclanche.**—I think it would have been better had Mr. Kean (p. 549) corrected the equation given. The reduction of alumina by sugar itself would be a mere detail compared to the spontaneous generation of manganese and oxygen in a Leclanché cell.—WM. JOHN GREY, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[57224.] — **Prevention of Noise.**— "Spes" will find a cue to the solution of his difficulty about the transmission of sound by taking a wooden rod, say, 20ft. long, putting a watch at one end, and his ear at the other, when he will hear distinctly the ticking of the former. Let him then saw the rod across the centre, and the sound is no longer transmitted. Hence, he will simply have to place his lathe on a platform which has no contact with the boarded floor, and the noise of his lathe would, I think, be so far diminished as to leave little ground of complaint from his next-door neighbour. Inasmuch, however, as brickwork is also, to some extent, a transmitter of sound, I should recommend that the timbers supporting the platform should have some elastic or soft material placed between them and the wall, on which they would rest. The transmission of sound from floor to floor and house to house is a very important question, and I am surprised that it has not received more attention in the columns of the "E.M." than it has done. I find by experience that a party wall of 14in. in thickness does not prevent the sound of a piano being heard from an adjoining house, and, with an attempt to obviate this, I am about to try the experiment of building the party wall of a pair of semi-detached houses in two thicknesses, leaving a clear space of 9in. between the two houses, covered only by the continuous roof at the top, and iron gratings in the front and back walls. I am of opinion that the outer walls of the kitchen, and other heated flues, being only 4½in. thick, will cause such a rush of wind through this 9in. space as will carry with it any amount of sound which might otherwise be heard from one house to the other.—Z. A.

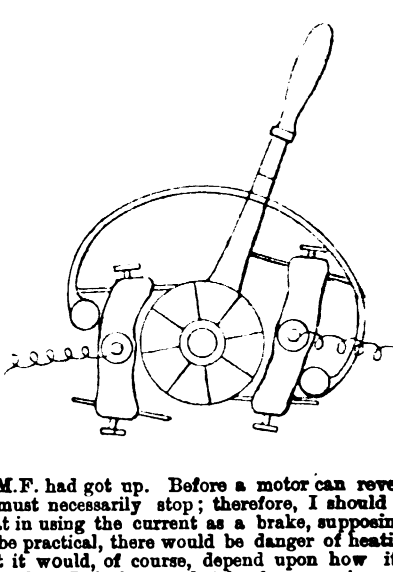
[57233.]—**Fret Saw.**—If possible, get an old sewing machine and table, as some parts of the machine will come useful. If you are unable, you would require to make a table and a corresponding arrangement to what I am about to describe. I bought an old style Wheeler and Wilson machine and table for a few shillings, and decided to make the fret machine of mahogany. The dimensions given are those of my own when finished; but, of course, you can alter them if you wish. Get two pieces of 1in. mahogany, 4ft. by 3in., and two 2ft. by 3in. Bolt one long piece flat on the table so that the centre will be about 2 or 3in. on one side of the hole through which the belt comes. (You will see reason and distance presently.) Dovetail the two short pieces into the ends of this piece, making them fixtures; or, if you wish it portable, a screw through the dovetails would answer. The two short pieces are now upright. Into the tops of these dovetail the second long piece, making it a tight fit, but movable. You have now the stand in which the saw frame will work. Next take two pieces of mahogany 3ft. 9in. by 2in., and two 12in. by 1¼in. The two long pieces must be planed so that they may taper from the middle to each end, keeping one side of each straight, and making the ends 1in. and the middle 1¾in. deep. These four pieces are for the saw frame. Dovetail them or fasten them at the corners with squares on the face. I have both, finding the dovetails hardly kept it stiff enough. All the straight edges of these pieces must be inward. Next come the guides for this frame. Get two round ½in. iron bars about 21in. long. Make them as smooth as you can. Then in the bottom corners of the stand fix two blocks, and 1¼in. from the uprights drill a hole in each exactly to fit the ends of the rods and about 1¾in. from the front of the stand. Repeat the process on the movable top-piece, but be careful to get the two pairs of holes parallel and perpendicular, or the frame will stick. Now procure four screw eyes, and file them out to slide easily on the rods. Screw these into the back of the short pieces forming the sides of saw-frame, with same care to have them parallel and perpendicular, and seeing that the top and bottom pairs are the same distance apart as rods. Take off the top of stand, slip the eyes on the rods, and replace the top. The frame now ought to slide easily. Now for the movement. Do away with the whole of the old sewing machine except the bed-plate and the pulley on which the belt runs. The axle of this pulley projects from one side of the bed-plate. Fix the bed-plate so that the pulley will be just under the saw-frame (taking care, of course, that the pulley and driving-wheel are in a straight line, though they need not be perpendicular to each other). Now, on the end of the axle fix an eccentric, which should come nearly, but not quite, in the middle of saw-frame. Now connect your saw-frame and eccentric by a rod working on pivots in each. When you work the treadle the frame should slide bodily on the guide rods. It may work a little hard at first, but after a short time will run smoother. Mine has about 1½in. or 2in. stroke. Next, exactly in the middle of top and bottom of saw frame drill holes to take the saw clamps. These should be small rods with the clamp at one end and a screw cut for about 2in. at the other, on which is a wing nut to tighten the saw. You must be careful to get the holes exactly perpendicular, and it is well to have the rod of the clamps square, and working through a square hole in a piece of iron screwed inside of frame to prevent the wood wearing. Now the table for the fret wood. At any height that suits you to the back and front (from end to end) of the stand screw two pieces of mahogany, 2in. deep and exactly level. Get a piece of pitch pine, 3ft. 6in. by 2ft. by ⅜in., and screw it on these supports, so that the frame works outside the ends. I have two crosspieces screwed under mine, and let into the two supports, so making the table stronger. Cut a hole for the saw to pass through. To check the recoil at bottom, I took two cotton reels and sawed them across, to make the four halves. Then two halves were screwed to the front of uprights of stand, and the others to the uprights of frame, so that stout elastic bands passed round them would be stretched before the frame reached bottom of stroke. You would require to suit position of reels to your own machine. I am a young draper, and although very fond of machinery, am unfortunately out of the way of seeing any, so that my description may be prolix enough to try even Job's patience, and you, or some other writer, may be able to suggest improvements. However, I made the machine about two years ago, and have done a good deal of work, sometimes cutting two pieces of ⅜in. walnut at once. The advantages, to my mind, over the two-arm bought machines are larger bearing-surface in table, and the saw working perpendicular with no tendency to swing when turning corners. I cannot recommend any book, having picked up all I know from experience. Two things I can advise—namely, keep your saws tight; and do not crowd the wood on them quicker than they can cut. Faults in these two things are the principal reasons for saws breaking. I enlarge my own patterns, as then I can make any alterations. If you are unable to understand anything, and will advertise your address, I will do anything I can.—E. J. A. B.

[57237.]—**Grooves of Pulleys.**—This was the subject of the second communication that I ever made to the ENGLISH MECHANIC, and involved a sketch. It is to be found in Vol. VIII., Feb. 2nd, 1869, No. 203, p. 460. If the Editor likes to insert it over again, it may go in just as it there stands—at least, as far as the sketch is concerned. I have no objection to writing the directions afresh, if Mr. Editor consents to a reproduction.—J. K. P.

[57244.]—**Dentistry.**—Referring to the remarks of "Dens" and "Vincent," on p. 550, I should like to say that there is no trade—I beg pardon, profession—in which there is more quackery than in that of dentistry. A diligent study of the *Transactions* of the Odontological Society would enable anyone who is already a decent mechanic to become a superior sort of dentist.—A. MALLARD.

[57244.]—**Dentistry.**—I really cannot say that I would advise this querist to make a vulcaniser. I have known these to explode; two instances are within my recollection. The usual pressure when they are in operation is 80lb. or 90lb. to the inch, and they should be tested to 600lb. The fees at the various dental schools are about £50, more or less, and it takes four years to get through, including twelve months at mechanical work under a recognised dentist. Diploma at College of Surgeons (after examination) is £10.—Os.

[57249.]—**Electro-Motor.**—The direction of rotation of a motor depends on the relative positions of the poles of the armature and field-magnets. Merely reversing the current would not reverse the direction, unless the fields were connected up different to the usual way. There is danger of heating by sending the full working current through a motor before its speed, and, consequently, its counter E.M.F. had got up. Before a motor can reverse, it must necessarily stop; therefore, I should say that in using the current as a brake, supposing it to be practical, there would be danger of heating; but it would, of course, depend upon how it is wound. I inclose a sketch of a reversing gear invented by Dr. Hopkinson.—EUGENE BROWN.



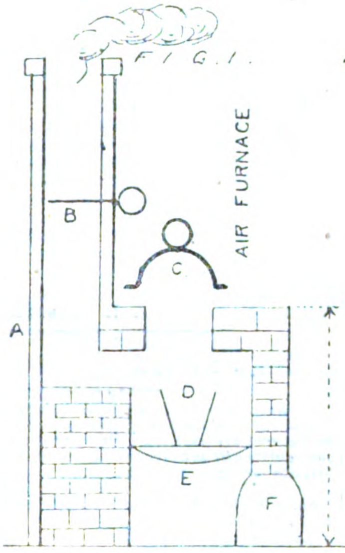
[57251.]—**Agglomerate Blocks.**—"C. D. R." says: "There are quantities of so-called agglomerates that have not a particle of manganese in them." I suppose it would be too much to ask your correspondent to name the dealers in these spurious agglomerates, appending, of course, his own name and address; but he can scarcely have any objection to telling your readers how they may recognise the agglomerates without a particle of manganese, or the means adopted by "C. D. R." to ascertain the truth of his statement.—SILVERTOWN.

[57252.] — **Free Reeds.** — Many thanks to "A. B. C." for his kind attention to this query; but if that gentleman had put the speed of wave of each interval only (4ths and 5ths) a little more simply, I should have understood him better, as I am not an adept at figures. I wish to inform Mr. F. that I am the author of query No. 56676, but not of query 56400, and I know nothing whatever about it. Mr. F. says that a reed may be made to sound a trifle flat under various circumstances. That is just what I have experienced in tuning reeds for various small instruments (steel reeds, of which I have made hundreds) in a temporary tuner which I have made. I have tuned two reeds, unison or octave, without the slightest wave in tuner, and when I put them in the instrument perfectly tight as in tuner, and same size of hole, they don't always sound in tune under any pressure of wind. Has the thickness of reed anything to do with it ?—Amateur Tuner.

[57255.]—**Storage Battery.**—(1) If flat plates are used the best way to keep them in position is to place slips of wood, or vulcanite, or hard substance between each two consecutive plates at the top and bottom, and bind together with two or three elastic bands. Contact is formed by flaps of lead projecting, so that plate and flap is all in one piece. (2) when they are fully charged gas is given off. (3) This depends on which form is used, Faure or Planté. (4) Two cells would only give four volts, and this is not enough to light a 10 candle-power lamp; if 12 cells were used, 10 or more lamps could, I think, be lit.—Bunsen.

[57257.]—**Equatorial Mounting.**—In reply to "Landbird," I would point out that whatever plan of equatorial he may adopt, it is essential that the tangents for slow motions should never be out of gear. The object is, of course, found with the fast motion, which must be obtained by unclamping some kind of screw, which releases the axis at once, and when found can be again clamped instantly, and the object followed by the slow motions of the tangents. If the tangents are taken out of gear to give the fast motion to find the object, which is a frequent method, he will find that while they are being put in again the object will be gone. In a word, the fast motion must be got by a clamping screw, and not by taking out the tangents.—T. Westlake, Fordingbridge.

[57261.]—**Cupola.**—"J. K." had better build a small air-furnace, and use a plumbago pot. If he has the use of a tall chimney, as he speaks of, 30ft. or 40ft. would do first-rate. You can flux with either limestone or broken bottles. With regard to the iron, I would advise him to get new pig-iron, Scotch, Glen Garnock, Welsh pig, Blainhaven, or any other soft pig, and a little machine scrap; old burnt fire bars and the like are only fit for fire bars again. I should recommend you to make a small fan, if you have not got a chimney large enough. You can erect a small chimney, or use the house chimney, and assist with the fan. You can then either make a small blast furnace and do without the pot, or make a square furnace about 3ft. square, with a hole about 15in. square. Connect with chimney, and cover with an iron plate, with fire bars half-way up; use coke. I will give more information if required. I will give you two small sketches of air and blast furnaces :—



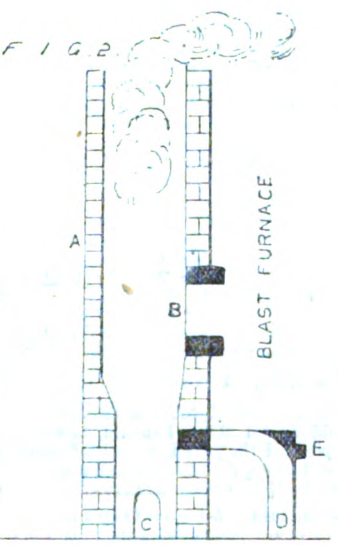


Fig. 1.—A, furnace stack; B, damper; C, cover for furnace; D, plumbago pot; E, fire bars; F, draft-hole; common house chimney will do.

Fig. 2.—A, furnace stack; B, charging hole; C, tapping hole; D, blast pipe; E, peep hole. If it is only for a very small amount of iron, turn the blaze into house chimney, and only make furnace about 24in. deep; cover top over, and turn the draught.

—Sand Rat.

[57265.]—**Bees.**—I should not advise R. Parkes to keep bees in a room, for unless specially built for the purpose there is no end of trouble, and even if built for the purpose it requires more skill and attention than out of doors. All the best beemasters advise the stocks to stand out of doors, and each stock on a separate and independent stand. You can then operate on any one hive without jarring or annoying any of the others. I shall be glad to give you or any other inquirer information, and, by the bye, if you are now beginning, get an old stock which has swarmed once this year, or an early second swarm, for in either case you will get a young queen. Of course you should see that either of the above have, say, 20lb. or 25lb. honey, and a good population, so as to stand through the winter.—J. I. S.

[57269.]—**Surveying Chain.**—"Surveyor" will, I believe, find all the information he wants in Heather's "Mathematical Instruments" (Weale's series). I knew an old surveyor who used to check his chain on a standard line, marked on a garden wall, made of heavy slabs of slate, and always kept by him a lot of ½in. round links to put on or take off from chain as required.—H. A.

[57270.]—**30-Light Dynamo.**—To "W. H. E."—As you will observe by the perusal of my second letter on this subject (which is now in the Editor's hands), the machine is designed to light 45 volt lamps at a speed of 1,500 per minute. To get 50 volts the machine would have to be run at 1,600 per minute. If you object to the speed being so high, you must wind the armature with No. 14 instead of No. 12, when 50 volts would be easily obtainable at a low speed. Any further particulars you may desire I will give with pleasure.—W. H Eaves, Coventry.

[57272.]—**Dynamos for Practical Purposes.**—Although it is not a very practical idea to have an engine to drive a dynamo, which in turn has to drive a Griscom with a loss of about 50 per cent., still, as perhaps this is required more for show than for actual work, I subjoin the following dimensions:—Height of fields, 12in.; dia., 2in. Armature (Pacinotti form), 4in. in dia., 3in. long. Armature wound with No. 16 wire; fields with No. 14. Power required to drive about ¼-horse power. No secondary battery required.—S. Bottone.

[57273.]—**Radius of Curve.**—In the latter part of this question the span is given. Suppose this to be S, then the formula for finding the length of the radius will be—

$$R = \frac{S^2}{8V} + \frac{V}{2}$$

When S = 70ft. and V = 7·5in., R = 11763·75in. If many ordinates are to be calculated with such a large radius, and so small a versed sine, it will be found much less laborious to use the formula—

$$EF = \sqrt{R^2 - ED^2} - (R - V),$$

which differs only in form from that which is given in the question. Putting in this R = 11763·75, and V = 7·5, it reduces to—

$$EF = \sqrt{(11763{\cdot}75)^2 - ED^2} - 11756{\cdot}25.$$

For finding the ordinates for every 2ft., it is now only necessary to make E D successively equal to 24, 48, 72, &c.

Thus for E D = 24 E F = 7·475in.
,, E D = 48 E F = 7·402in.

—Milverton.

[57276.]—**Experiments in Light.**—A Sciopticon or similar lantern. Before you do anything read the admirable articles on the subject, published about three years ago, by Mr. Lewis Wright, in our paper.—S. Bottone.

[57277.]—**Science and Art Department.**—I am too busy at present to take up this subject, but will write next month.—Wm. John Grey, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[57278.]—**Recovering Silver.**—It is quite worth while to recover silver from nitrate bath. Add solution of common salt till no fresh precipitate is observed. The precipitated chloride should be washed, dried, mixed with two parts of carbonate of soda, and a little borax, and well heated in a crucible; when the silver is reduced, the heat should be raised to fuse it. Silver print clippings, if there is a large quantity, should be burnt in a closed stove, the ashes collected and treated with nitric acid; this may be added to the nitrate bath before its treatment. Platinotype clippings should be burnt and boiled with a mixture of nitric and hydrochloric acid; the result is a solution of bichloride of platinum.—C. E. T.

[57278.]—**Recovering Silver and Platinum.**—Silver from old bath. Place clean strips of zinc in the bath as long as liquid blackens clean zinc. Remove what is left of the zinc, throw the whole black-looking mud on a filter, wash with several waters. What remains on the filter is pure silver in a state of fine division. *Platinum.*—Burn the clippings. Treat the ashes first with strong nitric acid, to dissolve any lime, &c. What remains may then be treated with nitro-hydrochloric acid, which will dissolve the platinum. The solution, after filtration through glass-wool or asbestos, may be evaporated until it crystallises as platinum chloride.—S. Bottone.

[57278.]—**Recovering Silver.**—It is most certainly worth while recovering the silver from your bath. You have first to filter the bath solution and add a strong solution of sodium chloride (common salt) until it ceases to precipitate; filter, wash the precipitate, and mix with twice its weight of sodium carbonate. Heat a common fireclay crucible to redness in your furnace, and throw little at a time into some of the above mixture, occasionally stirring until all effervescing ceases; then finally fuse, and on cooling, you will find, by breaking the crucible, a metallic button of silver. Your paper clippings may be treated by reducing to ashes, boiling in nitric acid, filtering, and precipitating with a solution of sodium chloride, and finally treating as above. To extract the platinum from your platinotype paper cuttings, reduce to ashes by heating in an iron pot over a fire; after which, put the residue in a long-necked flask with enough aqua-regia to cover it; boil about thirty minutes, pour off the acids, and replace by fresh. Continue boiling about fifteen minutes longer, then pour off the acids into the first lot, and evaporate down to drive off excess of acids; afterwards precipitate with a solution of ammonium chloride, filter, and wash precipitate with 50 per cent. solution of methylated spirit (the ammonium chloroplatinate here formed being partly soluble in water). The precipitate is then put in a porcelain crucible, and strongly heated until it is reduced to a spongy mass, which is pure platinum. This is afterwards dissolved by heat in aqua-regia, and crystallised; these crystals, being very deliquescent, must be kept in a closely-stoppered bottle, or in a hermetically-sealed tube. If Mr. G. Park should require any further information I will be glad to give him it.—A. Treyer Evans, Monmouthshire.

[57279.]—**Planing.**—Is not F. Shakespear aware that with any job requiring accuracy of workmanship, such as planing a lathe bed, boring a cylinder, surfacing a shaft, &c., once the tools are set in motion for the finishing cut they must not upon any account be stopped until the end is reached, or a ridge would be the certain result, as the tool would cool, and so become a shade shorter? The error is doubled by the work also cooling.—A., Liverpool.

[57279.]—**Planing.**—I never yet paid for any planing done by steam power that I did not go over again for my own satisfaction in my hand planer, or that I had not to true up by filing. Perhaps others are not so particular, and I know that many think because a thing has been planed it must needs be true. It all, or nearly all, depends on how the work is chucked, and whether it is sprung out of truth by being forcibly bolted down. With end-stops and side-stops to prevent the work slipping about, its own weight will often render bolting down quite superfluous.—J. K. P.

[57282.]—**Watch-Work.**—To begin with, "B. L." must get some steel Swiss turns, with a good assortment of runners. This will cost about 10s., and will do almost any job of turning. The tools for cutting are gravers. About half a dozen will be enough. Have one large square, two lozenge, and three small square. Also an assortment of screw-ferrules, five or six assorted sizes. Be very particular as to what edge you get on your gravers, or you will never do a job properly. Go to Grimshaw and Baxter's for them. The whole need not cost more than 14s.—Escapement.

[57284].—**Copper Coating Boiler.**—Iron cannot be electro-coppered with an acid solution by

reason of the very fact mentioned in the query. When iron is placed in a solution of cupric sulphate the iron is dissolved in the acid, and the copper deposited in its place; this mechanically prevents the adhesion of the two metals. The cost of the solutions and batteries required to copper the boiler you have would probably be more than the price of a galvanised iron boiler, which I would advise you to get (that is, if you value a quiet life). —Os.

[57286.]—**Bed Sores.** — Querist does not state where the bed sores are situated; but I presume they are at the lower part of the back. If so, let him place the patient on a semicircular air cushion, concavity downwards, to relieve pressure; keep the sores well dusted with iodoform, and apply salicylic absorbent wool in thick pads, which will avoid the necessity for frequent dressing. This, however, is only treating symptoms. Is there no surgeon within reach who could remove the diseased bone before it kills the patient?—Doctor Medicinæ.

[57286.]—**Bed Sores.**—Some time since I was laid up with rheumatic fever for more than six months, and could not move without assistance. The pain I suffered in my hip and knee-joint from pressure was excruciating. I obtained two springs, such as are used for chairs, sofas, beds, &c. (to be had at the ironmonger's), and had a pad fitted to each end. One I placed between my knees, and the other under my hip-joint, and found considerable relief. "W. S. L." might, try a ligature of indiarubber (to be obtained at most haberdashers'), and fastened with a buckle similar to those used for ladies' belts; this will do away with the inconvenience of knots.—Q. K.

[57290.]—**Woolwich Exam. Question.**—We have here two equations—viz., log. 3 = ·4771213, log. 7 = ·845098; to find two unknown quantities—viz., "M" (the modulus) and log. 11. Apply formula—

$$\log. x = 2\text{M}\left\{\frac{x-1}{x+1} + \frac{1}{3}\left(\frac{x-1}{x+1}\right)^3\text{\&c.}\right\}$$

First—

$$\log. 9 - \log. 7 = \log. \frac{9}{7}$$

$$= 2\text{M}\left(\frac{1}{8} + \frac{1}{3}\cdot\frac{1}{8^3} + \frac{1}{5}\cdot\frac{1}{8^5}\ \text{\&c.}\right)$$

$$= 2\text{M} \times {\cdot}1256571.$$

$$\therefore 2\text{M} = \frac{\log. 9 - \log. 7}{{\cdot}1256571} = \frac{{\cdot}1091446}{{\cdot}1256571} = {\cdot}868591.$$

Again—

$$\log. 11 - \log. 9 = \log. \frac{11}{9}$$

$$= 2\text{M}\left(\frac{1}{10} + \frac{1}{3}\cdot\frac{1}{10^3}\ \text{\&c.}\right)$$

$$= {\cdot}0868591 + {\cdot}0002895 + {\cdot}0000017$$

$$= {\cdot}0871503$$

∴ log. 11 = ·0871503 + ·9542426 = 1·0413929; or 1·041393 to six places. I can't imagine of what use the third logarithm given can be. The whole question seems rather too hard on the examinees.—X. Y. Z.

[57291.]—**Weights of Copper Wire.**—Most electrical works contain tables of weights, &c., of copper wire. Among the best of these are Sprague, Kempe, and "The Electrician's Pocket-Book" (Cassell). Write to King Mendham's for their catalogue, in which much useful information is given.—S. Bottone.

[57291.]—**Weights of Copper Wire.**—Tables of the weights, &c., of electrical wires can be had from most manufacturers and dealers (see advertisements in current number); it is, therefore, perhaps hardly fair to ask space for such a long list as that applied for. A. P. Trotter's patent wire gauge—which was described and figured a few months ago in this paper—will give at one operation the standard wire gauge, and the diameter in decimals of an inch and of a millimètre, of any thickness from No. 6 to No. 40. Also the sectional area in thousandths of a square inch, and formulæ by which weights and resistances can be computed therefrom. The description did not, however, convey a correct idea of the actual size of the gauge, which measures only 2½in. by ½in., and weighs ½oz. —R. T. Lewis.

[57295.]—**Bookbinding.**—"Surveyor" seems to have confused "blocking" with "rounding," making it difficult to understand his meaning. If a book is properly rounded and pressed, it is not likely to become flat again. The reason why the backs are not firm is probably because the books are badly sewn. "Surveyor" would do well to obtain a copy of "Bookbinding for Amateurs," by W. J. E. Crane, 2s. 6d.; publisher, L. U. Gill, 170, Strand, London.—Thos. F. Cass.

[57296.]—**Surveying Chain.**—A chain should most certainly be exactly 66ft. long, and nothing allowed for it not being quite tight or straight, as it should always be so, of course, not pulling it too tight so as to stretch it. The best way for "Surveyor" to test his chain (that is, if he lives in or near London) is to take it to Guildhall, where there is a standard chain gauge laid in the floor of the hall. (I believe gauges are also to be found in several provincial towns.) It is not much good testing (?) it with a tape, even if the tape is new. I suppose "Surveyor" knows that the 66ft. include the handles, as he talks about there being only nine links at either end. Of course, the other two are made up with the handles.—Ikey Mo.

[57298.]—**Faulty Dynamo.**—I cannot, unless you give all details as to the quantity of wire on fields, armature, size of wire, mode of coupling, what experiments have been tried with it, tell what is wrong. Either write to this paper, giving full details, or send it to me, when I will repair it. —S. Bottone, Stanley-road, Carshalton.

[57301.]—**Shaft.**—The diameter of the shaft for the 26in. pinion will be 6·784in. I recommend Anderson's "Strength of Materials and Structures," published by Longmans and Co., London.—A. Gray.

[57303.]—**Electric Motor.**—A small Siemens armature about 6in. long by 2in. in diameter would do the work you require. The fields should be 6in. by 6in. by 1in., with massive pole-pieces and a good heavy iron plate for base. Wind the armature with No. 18. and balance the resistance with No. 16 on the fields.—S. Bottone.

[57306.]—**Dynamo.**—Why not rewind the armature again as a Brush? Or if you find that too difficult, wind as a Pacinotti, which gives excellent results.—S. Bottone.

[57309.]—**Algebraical.**—Consider the pint of water as divided into $n$ equal parts—$n$ being a very large number—and consider these parts, added one at a time to the pint of wine. The first addition may (if $n$ be a large enough number) be considered as expelling $\frac{1}{n}$ of a pint of unmixed wine, leaving $1 - \frac{1}{n}$ of a pint of wine and $\frac{1}{n}$ pint of water. The next addition will expel $\frac{1}{n}$ of $\left(1 - \frac{1}{n}\right)$ wine, leaving $\left(1 - \frac{1}{n}\right)\left(1 - \frac{1}{n}\right)$ wine—*i.e.* $\left(1 - \frac{1}{n}\right)^2$ wine. So after the third addition $\left(1 - \frac{1}{n}\right)^3$ wine will remain. Therefore, after $n$ additions—i.e., the whole pint of water, there will remain of wine

$$\left(1 - \frac{1}{n}\right)^n = 1 - 1 + n.\frac{n-1}{2n^2} - n.\frac{n-1}{2}\cdot\frac{n-2}{3n^3} + = 1 - 1 + \frac{1}{\lfloor 2} - \frac{1}{\lfloor 3} + \text{\&c., if } n \text{ be taken}$$

indefinitely great.

$$= e^{-1}$$

$$= \frac{1}{2{\cdot}71828}$$

This fraction of a pint will therefore be the quantity of wine remaining in the mixture.—F. B. A.

[57312.]—**Trueing Lathe.**—Had I such a job to do I would make a temporary wooden square as long as the shears, then put on the largest face-plate upon mandrel, see that it revolved perfectly true first, and then applying a carefully planed up straight-edge of wood, also in conjunction with aforesaid square, the "biz" would be done.—A., Liverpool.

[57313.]—**Steam Launch.**—Size of boat for engine 3in. by 3in., say 16ft. by 4ft. by 2ft. 1in.; size of vertical boiler for ditto, 1ft. 9in. by 2ft.; propeller—diameter 17in., pitch 16in. This boat would seat three persons; speed, about four and a half to five miles per hour.—O.E., M.E.

[57314.]—**Strength of Gear Wheels (U.Q.)**—You have not given sufficient particulars yet. Assuming that the weight of 5cwt. is hung by a chain from one side of a 10in. drum on the same shaft as the 15in. wheel, the pressure on teeth will be $\frac{5 \times 112 \times 10}{15} = 373\text{lb.}$ If two teeth are always in gear the pressure on each tooth = 186·5lb., and ½in. pitch would do for this. I should, however, make it ¾in. pitch if the gear is to be used much. No shrouding will be required for so small a weight. The wheels may be 1½in. wide.—Glatton.

[57315].—**Botanical.**—All sorts of paper is used; it depends greatly on length of purse. A thick printing paper will do very well, demy size. For book, get Bentham's "Flora"; this, with Balfour's or Henfrey's "Botany," will greatly assist you.—Os.

[57316.]—**Turbine.**—The best turbine is considered to be that invented by Professor Thomson. There are a great many others made, especially in America, but none give so great a percentage of efficiency as this one. If "Jakes" advertises his address I shall be pleased to give him further particulars. I may add I am not interested in the manufacture of the turbine.—Engineer, London.

[57317.]—**Scarlet Fever.**—From personal experience, an efficacious and indestructive method of disinfecting rooms, bedding, &c., is a small fire—composed of paper, cinders, lumps of common brimstone, and lucifer matches—placed in a fire basket or any utensil that will resist heat, and stood on any old tray or zinc in centre of room; bedding, &c., to be about, that the fumes can penetrate, but away from danger of ignition; windows and register closed. After setting light to fire, shut door and lay wet cloth at the bottom to prevent the sulphurous smoke escaping. It does not discolour, but gilt frames should be removed. It is a searching remedy, destroying the infection in the flakes of skin from the peeling. It was recommended by the physician who attended a child of mine in scarlet fever away from home, and we returned to a family of five children who happily did not catch the illness.—Jane Wrenn.

[57317.] — **Scarlet Fever.** — It is difficult to understand exactly what the querist means by the infection of scarlet fever being conveyed in milk. Under certain conditions, it decidedly can be conveyed in milk. If milk has been kept in a room in which scarlet fever is present, such milk is certainly not to be regarded as safe if introduced into the human stomach. All liquids have a tendency to attract impure matter from the air, which is proved by water becoming stagnant if allowed to remain unused. The infection from scarlet fever, like that from other infectious diseases, can be transferred from one person, or place, to another, in various ways, and under various circumstances. Condy's fluid is one of the best-known disinfectants, and full directions for its different uses in disinfecting is to be found on the outside of the bottle.—G. Fryer.

[57317.]—**Scarlet Fever.**—Contagium can be, and has been in several cases, conveyed in milk. The clothes used by the patient, and bedding, when it can be done, should be steeped in chloralum or carbolic acid solution for an hour, then boiled, and hung on lines in the open air. Chloralum is best, as it is non-poisonous and cheap. The bed and other articles which cannot be washed, should be fumigated with sulphurous anhydride, or, better still, when it can be done, exposed in a disinfecting chamber to a temperature of 240° F. for one hour. The doors, windows, &c., of the room should be closed, and ½lb. of sulphur burned in it over a pail of water; the room should then have free ventilation, the ceiling be whitewashed, the paper stripped from the walls and burned. The furniture and paint should be washed with soap and weak solution of chloride of lime.—Temeraire.

[57317.]—**Scarlet Fever.**—There are several methods of disinfecting rooms by gases, &c.; the best seems to be by sulphurous acid. Shut the windows, doors, and chimney, and stop up all the chinks, &c., with paper. Get two tubs of water, put two sticks across them, and saucer on the top; into each saucer put 1½lb. of sulphur, put red-hot coals into them, and get out of the room as fast as you can. When outside, stop up cracks of the door you came out at by putting rugs and mats against it. Leave the room alone for 24 hours, then open the door, rush in, and open the windows. Leave the windows open for 24 hours more, keep letting in plenty of fresh air, wash ceiling and walls with solution of chloride of lime, 2oz. to 2 gallons of water. Sulphuring a room disinfects bedding, furniture, and everything in the room; but it is well to have everything baked if possible, and in severe cases it is better to burn as much as possible. The clothes may be washed in Condy's fluid till the fluid ceases to change colour; when the fluid is clear it is disinfected (even drinking glasses ought to be disinfected). The clothes may be baked (not on metal plates) at a temperature of 220° C. Everything ought to be freely exposed to the air, which is a good disinfectant. There is no doubt whatever the infection of scarlet fever can be conveyed in milk. Many cases have been known in which it was so.—R. A. R. Bennett.

## UNANSWERED QUERIES.

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*The numbers and titles of queries which remain unanswered for five weeks are inserted in this list, and if still unanswered are repeated four weeks afterwards. We trust our readers will look over the list, and send what information they can for the benefit of their fellow contributors.*

Since our last, "Glatton" has replied to 56031 "Alto Petit," 56440.

56837. Drill Chuck, p. 354.
56842. Lathe Query, 354.
56843. To Mr. Wetherfield, 451.
56845. Coil Springs, 354.
56861. Eccentric on Crank Shaft, 355
56863. Flexible Material for Winding Round Piston, 355.
56864. Safe Making, 356.
56865. Bolts and Nuts, 355.
56866. Hand Drilling, 355.
56873. Terrestrial Eyepiece, 355

57023. Second and Fourth West India Regiments, Colonial Police Forces, &c., p. 441.
57032. Clock Making, 441.
57034. Painting Iron Bath, 441.
57037. Sewing Machine Work, 442.
57047. G.W.R. Goods Engines, 442.
57053. Coil Connections, 442.
57062. Automatic Musical Instruments, 442.
57067. Mineralogy, 442.
57071. Beat Valves in Hydraulic Rams, 442.

# QUERIES.

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[57320.]—**Model Dynamo.**—I wish to make a model dynamo after the Edison style, big enough to light a three c.p. lamp. Will anyone kindly give me size of F.M.'s and armature, and quantities of wire, &c.?—Silly Billy.

[57321.]—**Webster Condenser.**—I wish to make a Webster condenser. Will someone kindly give radii of curves, and arrangement of lenses?—Draco.

[57322.]—**Violoncello.**—Would any readers give the dimensions for a full-size cello, give length of neck, and say best kind of wood to use?—C. Leech.

[57323.]—**Restoring Clock Case.**—Will any of our kind readers tell me how I can restore an old dead gilt clock case? The case is of a French make, and made of brass.—Horological Tommy.

[57324.]—**To Mr. Bottone.**—I have wound the cog armature of my Gramme with No. 18 wire; it is covered first with silk and then with cotton; a telegraph engineer has tested its resistance, which he finds to be 1·1603 B.A. units; the resistance was taken at temp. 75°. What quantity of wire, and size, shall I require for the four field-magnet bars of the original Gramme form, to be wound in series arrangement?—Tyro.

[57325.]—**Atoms**—I would feel very grateful to any reader who would suggest some graphic method for illustrating atomic vibrations, or give details of the experiment with floating magnets described by Capt. Abney, in No. 1063, "Photography and the Spectroscope," page 494, so as to enable me to construct the arrangement?—P. B. F.

[57326.]—**Pattern Making.**—Would "Invicta" oblige me, or any other gentleman, by saying how to make a lathe gap bed so that the moulder will have no difficulty in moulding the pattern; also, the best way so that he can release it from the sand? Length of bed, 3in. by 6in, 4½in. across face, 5in. deep, of the screw-cutting type.—Iron.

[57327.]—**Fire-proof Composition.**—Would any reader please give component parts of a good fire-clay—metallic fire-clay or asbestos composition—which can be plastered on each side of an iron plate, studded with projections to help hold the composition on—a composition which would stand a fairish blow with the poker without cracking or breaking off? The plate will be placed in a furnace and required to keep a blood-red heat. How long might such plate last?—Fire-clay.

[57328.]—**Tinman's Tools.**—I should feel extremely obliged if any reader of the "E. M." would name the tools required in a tinman's shop, and expound their use. This would be very interesting to some of our readers. Please say the best method for tempering mason's tools?—M. H.

[57329.]—**Engine Stop-valve.**—In an ordinary steam stop-valve, should the steam be admitted to the upper or under side of the valve? I have heard it argued both ways. Which is correct, and why?—Junior D.

[57330.]—**Legal.**—A minor contracts a debt—not for a necessity—and the bill being sent to him pays part, holding the receipts for the same. After a time the creditor declares that the debt was contracted by the minor's parent, through the son, and threatens proceedings. Until this time no claim has been made on the parent, but repeated applications have been sent to the son for his account. Can proceedings be taken against creditor for attempting to extort money on false pretences?—Up a Tree.

[57331.]—**Crystals of Gold.**—Will any friend let me know the various crystals of gold (other than perchloride), and how I may prepare them?—F. L.

[57332.]—**Manufacture of Aluminium.**—Will some of our chemical friends (Messrs. Grey, Allen, &c.) kindly say why is it necessary to use the double chloride of aluminium and sodium in the preparation of aluminium? Why would not the chloride of aluminium do by itself? The metal can be prepared from the chloride alone. What part does the chloride of sodium play in the process?—Ex-Garrison Gunner.

[57333.]—**Solder.**—What is the difference between "hard" and "soft," solder, and how are they made? The solder one buys in the shops is, as a rule, unsatisfactory, and I find that tinsmiths in general prefer to make their own themselves. I saw one at work some time ago, and he kept casting and recasting it, pouring it out on a flag and watching it till he thought it satisfactory. They also keep the secret of making it to themselves.—Ex-Garrison Gunner.

[57334.]—**Heinrich Dynamo Machine.**—Will someone kindly say if these dynamos are used anywhere, as I have not seen or heard of any? From a description on page 28, Vol. XXXIII, the principle is spoken of as being very efficient, and in the following number an article appeared giving the theoretical reasons why this form of armature is superior to the solid Gramme or Pacinotti. Have they proved satisfactory?—A. W. Lambert.

[57335.]—**Battery.**—I have two trough batteries (only one of which I propose to use at once) of 7 cells, about 30in. by 15in. by 14in., and purpose lighting my study with one of the above, using four 10-c.p. lamps of 10 volts each, coupling the 7 cells in series, but am at a loss as to best way of charging. I propose to use nitrate of soda (as the zincs will not need removing when battery is not in use) in porous cell, with carbons and sulphuric acid in outer cell. On page 210, Vol. XXXIX. there is a battery described much the same as mine, having two zincs and two carbons. Would "Electrical Engineer," or some other kind person, tell me the quantity of nitrate of soda per gallon of water for carbon cells and the same for sulphuric in outer cell with the zincs? Any other way of charging battery without polarisation whilst disconnected, as also duration of working of charge, will be gratefully received by—A Sceptic.

[57336.]—**Eccentric for Loco. Engine.**—Will one of your readers kindly inform me, as I am only a novice, the proper way to set out an eccentric for a locomotive engine, showing how he gets his sizes and the rule? In a book I have (by Michael Reynolds) he gives a size, for instance, of the valve gear as follows: Travel of valve 4in., throw of eccentric 5½in. by 2⅞in., breadth of eccentric 2¼in., lead ⅛in., lap outside ⅞in.; also in another place he mentions the radius as being 2¼in., and the total throw as 5in. Will you kindly explain the meaning of the terms the "throw" and the "radius" as given?—Milo.

[57337.]—**Carbolineum.**—An oil which forms an excellent preservative for fishing nets, or wooden piles driven in water, which it materially hardens, but does not close up the pores. In use in Germany, especially for nets. Can any of "Ours" speak of it?—P. P.

[57338.]—**Canadian Mounted Police.**—Will some reader kindly give information about the above force? What are the necessary qualifications, mode of entry, pay, &c., &c.? Any information will greatly oblige.—North-West.

[57339.]—**Diffraction Gratings.**—I should be much obliged if any correspondent would inform me of the advantages and disadvantages of diffraction gratings, as compared with prisms for viewing the solar spectrum, &c.?—Rosicrucian.

[57340.]—**Organ Tuning.**—Will one of the organ correspondents of the English Mechanic kindly inform me what the usual rate of charge for organ tuning and regulating is, in England (when taken by the year), and the number of visits required to be paid annually—say organ to consist of two manuals and reeds, and about 15 to 20 stops? Much doubt on the subject exists here, and any information from one acquainted with the practice in England would be gladly received by others as well as myself in this colony, directly or indirectly concerned in the question.—R. Cecil Clifton, Perth, W. A.

[57341.]—**Polariscope—Soleil—Laurent.**—I have a polariscope by Soleil (Duboscq), which is constructed on the principle of the transition tint, teint de passage, produced by means of a bi-quartz, with the usual arrangements of Nicol prisms, quartz compensators, &c. Now that the half-shade polariscope of Laurent is coming so much into use, I would like to contrive some arrangement by which I could permanently alter the Soleil to a Laurent, or even preferably use it as either. I think the removal of the bi-quartz, and substitution of a cell containing the half-quartz plate of the Laurent might do it. Will some of our scientific correspondents help me? I have Landholt's book, and have carefully read Glazebrook and Shaw's "Practical Physics," and Glazebrook's "Physical Optics," from which I think such a substitution as I suggest is possible. I shall be very greatly obliged for any kind assistance.—Chemicus.

[57342.]—**Carbon Moulds.**—Can any readers of the "E. M." give me any instructions how those moulds of charcoal or coke dust are made, the same that were on sale at the Paris Exhibition, 1878, and are used for making glass bottles, globes, &c., as they are so much cheaper than brass or iron?—E. F. H., Goos, Russia.

[57343.]—**Cupric Oxide.**—Would some of our kind readers please say which is the cheapest way of obtaining this oxide on a large scale?—E. F. H., Goos, Russia.

[57344.]—**Punching Round Washers.**—Can any of your readers describe a punching machine made to punch round washers, at one stroke of the machine?—Scotch Mechanic.

[57345.]—**Electrical Weather Vane.**—Will F. M. Rogers please describe the mechanism of the above? See sketch on p. 411.—Glatton.

[57346.]—**Jewellery.**—Can any reader tell me how to make (1) the mounting for a cat's-eye breast pin? (2) Silver head for walking cane?—Demetrius.

[57347.]—**Heating Surface—Condensed Steam, &c.**—Will some correspondent kindly help me with the following information, viz.:—What is meant by the expression "train mile"? When the quantity of heating surface of locomotive tubes and the diameter and length of tubes has been decided upon, how can the number of tubes be found? Give a worked example, and say if all or only a portion of the tube heating surface of locomotives is taken as effective? What rule can I use to obtain the length of pipe, or the surface of a series of pipes to conduct the exhaust steam from a 12in. diameter cylinder non-condensing steam engine, with 18in. length of stroke, steam on pressure-gauge of boiler, 65lb. per square inch? And how can I find the diameter and number of length of tubes required? The length of each tube to be about 4ft., and the diameter from ⅞in. to 1in., would be the most convenient sizes to use. Kindly give examples.—Thanet.

[57348.]—**Back-ache.**—This appears to be no uncommon form of complaint with mechanics of middle age. I am troubled with it, and if any subscriber could give reliable counsel for its relief, I think he would receive the thanks of many. I am a machinist, 35 years old, very thin, and otherwise fairly healthy. The shop I work in is no better or worse than most, and I live as well as I can, and drink very little and smoke less. The pain is seldom acute, but generally a dull, aching, stiff, unpliant sort of feeling, which the moving and lifting castings, or whatever the job in hand is, aggravates, and the system feels rather depressed and quickly tired. I have had it more or less for the last two years. I have been advised to try this, and to try that, and have also been told it is not curable, and is a symptom of the decline of the bodily powers, commonly called the approach of old age. What says the English Mechanic? I may add that it is rather worse on first rising in the morning, and generally worse on Mondays after the Sunday's rest, and doctors don't seem to understand.—Hammer and Tongs.

[57349.]—**Gramme Dynamo.**—Will any person give me directions and measurements for making the above to light six 10-c.p. Swan incandescent lamps? Also the size of a small steam-engine to drive the same?—W. Laurie.

[57350.]—**Butter Fat in Cream.**—Can any correspondent inform me if there is any ready method known for estimating roughly, the quantity of butter fat in cream, or give me suggestions in what direction experiments should be made to discover such a method? I am working with the hydrometer at present, but can get no definite results.—Fresh Butter.

[57351.]—**Ascent of Bullet.**—The initial velocity of a Martini-Henry bullet is 1,320ft. per second; if fired vertically in vacuo, it would ascend 27,225ft. or rather over five miles. Can any reader give the answer, taking into account the resistance of the air?—W. John Grey, F.C.S., Analytical Chemist, Newcastle-on-Tyne.

[57352.]—**Dynamo.**—To Mr. Bottone.—I have a dynamo that gives 40 volts. Could you be so kind as to inform me what resistance to place in circuit, so as to bring the E.M.F., down to 30, 20, 10, and 5 volts between the poles.—F. G.

[57353.]—**Skewer-Making Machine.**—Would some kind correspondent favour me with instructions how to construct a machine for making wood skewers?—Amateur.

[57354.]—**Surveying.**—Will some reader kindly recommend a good textbook on surveying?—J.

[57355.]—**Small Dynamo Worked by Town's Water.**—In the Inventions Exhibition, I am told there is a small dynamo or magneto machine, attached to a kind of turbine, worked by town's water supply, so that one can have electricity by turning on the water tap. Can any brother reader give particulars of this machine and how to construct a small turbine for town's pressure?—A Gormless Lad.

[57356.]—**Storage Battery.**—To "C. D. R."—I propose to charge my battery with a small Gramme dynamo. Will you kindly tell me how I can make a storage battery that will light a 10 c.p. Swan lamp? I bought No. 1016 of the "E.M." but it only gives directions for lighting small microscopic lamps, so that as plain an explanation as possible will be esteemed a favour?—W. Laurie.

[57357.]—**Tinfoil.**—To "Invicta" or Others.—I will be much obliged if any one can tell me the reason of tinfoil geting white after it is rubbed with mercury, and put on the glass? It seems all right for a while, but after they are put up on their edge, the silvering comes all off; but if I put more mercury on, and draw the glass off, and put it on again, it will do; but I want it right at once. The foil is 2, B, and thicker sometimes. How long should the mercury be on before I put the glass on it? Also it gets blistered, and air goes underneath? Is it the mercury or tinfoil that is bad?—Foil.

[57358.]—**Putting Bars in Lancashire Boiler**—Will any kind reader please inform me the best way of putting new fire bars in Lancashire boiler? What I want to know is, how much play there should be endways, and should they fit tight across furnace? The flues are 2ft. wide, and furnace about 5½ft. long; the bars are at present in two lengths, with cross-bar in centre; they rest on dead plate at each end, and hook in centre bar, but they buckle in one length, and drop off dead plate the other. The bars don't half wear out before we are obliged to have new ones. I trust some of our readers will give me a few hints, and oblige.—One Anxious to Learn.

[57359.]—**Putting New Cotton in Lubricators.**—Will any of "ours" please inform me of the best way of putting fresh cotton in lubricators, and do you put more or less cotton for using the oil faster?—and oblige One Anxious to Learn.

[57360.]—**Chronometer Balance.**—Will Sir E. E. Beckett, or some reader, kindly answer the following, it being asked in the honours grade in watch and clock making examination of the City and Guilds Institute? In what way would a chronometer balance be affected on being transferred from the poles ($g = 32·25$) to the equator ($g = 32·09$), the temperature being assumed to remain the same.—G. W.

[57361.]—**Laying out Sheet Iron and Boiler Work.**—I am pleased to see the abridged article on the above subject in this week's "E.M.," particularly as I am just in need of assistance in boiler work, having to order plates for a new boiler of the old cylindrical type, with round ends to be formed in the usual way of seven plates, six tapering from the circumference towards the apex, and one circular to form the extreme end. Will any of "ours" kindly give an example in projection, that will enable me to find the proper curves or lines to cut the flat plates to, so as to form the hemispherical ends of a boiler, 6ft. diameter? Such an example, I have no doubt, will be of great service to many.—Enquirer.

[57362.]—**Engine.**—I have a pair of condensing engines, 40in. cylinder, 6ft. stroke, cutting off steam at 3-10ths of stroke. If I increase my boiler pressure, and cut off steam at 1-10th of stroke, how much more strain will put on my wheel? It is 20ft. diameter, and pitch of tooth 3 15-16th.—Young Engineer.

[57363.]—**Lamp for Soldering.**—To Mr. Bottone, or Others.—Can you please tell me of any kind of lamp suitable for soldering under following circumstances? I have a small carpenter's workshop (amateur), but cannot have a fire, nor can I have the gas without more expense than I can go to. It must be something safe and easily managed, as my friends are afraid of fire in the workshop? I am thinking of following some of your electrical articles.—E. J. A. B.

[57364.]—**Electrical Veterinary Oil.**—Can any reader inform me of the composition of this oil, and the method of preparation?—Alto Petit.

[57365.]—**Phosphor Tin.**—Which is the best method for estimating phosphorus in this alloy?—Alto Petit.

[57366.]—**Chewalla.**—What is this prepared from?—Alto Petit.

[57367.]—**Deflector.**—Could any of our railway experts state why an iron deflector (allowing the water in the boiler to circulate through it) is not used in place of the ordinary brick arch in loco. fireboxes, as it would appear to me to add considerably to the heating surface of the boiler?—W. S., and Mac.

[57368.]—**Organic Chemistry.**—Can anyone inform me what is the acid produced by the action of the fungus called the ginger-beer plant, upon the sugar in which its growth takes place? Evidently carbonic-acid gas is produced, and another acid resembling citric or tartaric in flavour, apparently no alcohol; but I have no means at home of analysing the resulting mixture?—F. B. A.

[57369.] — **Locksprings.** — What is the simplest method of improving the temper of common locksprings? Marchen.

[57370.]—**To "Sigma."**—I have your book "Electricity"; but I cannot make out from it what I want particularly to know—how many square inches of zinc are required to give one ampère of current through one or more ohms' resistance in each kind of battery? Will you kindly put me in the way of getting this?—Finem Respice.

[57371.]—**Extra Currents.**—In "Experimenter's," reply to No. 56649, regarding extra currents, he shows that the "break secondary" (direct) splits in the multiple arc arrangement of the coils, the parts meeting at a point, and because they are equal and opposite destroy each other. How the destruction of the two parts is thus effected I fail to see? Is it not the case that in the series arrangement the "break secondary" traverses each coil separately, whereas in the multiple arc arrangement, half of this current traverses each coil at the same time; and thus the demagnetisation of the cores is quickened in the latter arrangement to a much greater extent than in the former?—Telegraphist.

[57372.]—**Organ Pipes.**—I have four octaves open diapason wood pipes C to C, which I want to continue down to CC. Would any of the musical gentlemen to "Ours," inform me whether, by continuing the scale down to CC, but reducing the length by half, and using stoppers, obtain the correct note, as I have not height enough for the full length of the CC pipes?—Pipes.

[57373.] — **"Genuine Humber" Tricycle.** — I shall feel greatly obliged if any of my brother-readers can give me some information as to the possibility of fitting Bown's ball bearings to the above. My bearings (both main shaft and pedal shafts) have gone entirely wrong: the cheeks between which the balls run are soft in places and consequently have worn oval, and the soft parts have burred up to such an extent that it is no longer possible to tighten them up. As I have only had the machine since February last, it is rather annoying, to say the least of it. I may say that I am a practical man, and that I shall have no difficulty in carrying out any instructions which may be given on the subject?—Cyclist.

[57374.]—**Portland Cement.**—Will any of your chemical correspondents oblige me with the most approved method of analysis of Portland cement; and also of the slurry during the process of manufacture? I have looked through all the back numbers, but cannot find it given anywhere.—Zax.

[57375.]—**Heating Greenhouse.**—I have a small greenhouse which I endeavoured to heat during the winter with a small round upright, slow-combustion stove (Portaway's No. 2), which I fed with small, crushed coke. As far as heat was concerned all was well, but the dust which it created when cleared out was more than I could tolerate; so I took out the stove and placed it in an archway which passes under one end of the greenhouse, and then brought the flue (3½in. cast-iron rainwater pipe) through the floor and along its entire length and then out through the roof, thinking, as the greenhouse is very small, this would afford sufficient heat. But I found that unless the stove was full of fire, I could not get any heat in the greenhouse, although it warmed the archway beautifully. There was also a very close smell from the pipes. Would it be possible to put a coil of small-bore pipe inside the stove taking out the fireclay, and carrying the pipe through the floor of the greenhouse to a tank at the end with a return pipe. The coil could not go to the bottom of the stove by 4in., on account of the draught door? There would be room for a coil 12in. deep, and 9¾in. external diameter. What I want to know is would there be room for sufficient fuel to keep it going without attention at night? What is the minimum bore which would work freely? (the smallest possible would, with the hot water in tank, be sufficient to heat the house). Should the coils be close together or a space between them? Would ordinary wrought-iron steam-pipe do? The distance from the stove to the tank is about 12ft. Or can any of our practical men suggest any other plan of using the stove? I would rather not use the coil if I can achieve the result in a simpler manner.—A, H. H.

[57376.]—**Electricity in the Microscope.**—At some of the scientific gatherings of the year there has been on exhibition a slide in which, with the microscope, has been shown the zig-zag sparks of the electric current. Will some of my friends tell me how to make such a slide, and say if I am to use with it a spark coil?—E. B. Fennessy.

A new appliance for drying and superheating steam has been devised for multitubular boilers by Max Gehre, of Hanover. As superheaters in the firebox act unequally, and are liable to great strain, the Gehre apparatus is placed in the smoke-box, being composed of a chest traversed by tubes forming a continuation of those in the boiler, but of rather larger diameter. The steam is thus superheated by contact with the outsides of the tubes and the inside of the chest, both heated by the products of combustion.

Dr. C. Lang, in *Biedermann's Central Blatt für Agrikultur-Chemie*, lays down the law that night frosts are only to be feared when the dew point lies below the freezing point of water.

A temperature of 570 deg. will produce a dark blue colour on polished steel, and 590 deg. a pale blue. Oil or grease of any kind will answer for drawing the temper of cutlery. The temper for lancets is obtained at 430 deg. Fahr., axes at 500 deg., swords and watch-springs at 530 deg., small saws at 570 deg., and large saws at 590 deg. Copper-coloured spots are not produced by tempering, but they may be obtained on the polished surface of steel by immersing the article in a solution of sulphate of copper.

# ANSWERS TO CORRESPONDENTS.

⁂ *All communications should be addressed to the* Editor *of the* English Mechanic, 332, *Strand, W.C.*

## HINTS TO CORRESPONDENTS.

1. Write on one side of the paper only, and put drawings for illustrations on separate pieces of paper. 2. Put titles to queries, and when answering queries put the numbers as well as the titles of the queries to which the replies refer. 3. No charge is made for inserting letters, queries, or replies. 4. Letters or queries asking for addresses of manufacturers or correspondents, or where tools or other articles can be purchased, or replies giving such information, cannot be inserted except as advertisements. 5. No question asking for educational or scientific information is answered through the post. 6. Letters sent to correspondents, under cover to the Editor, are not forwarded, and the names of correspondents are not given to inquirers.

⁂ Attention is especially drawn to hint No. 4. The space devoted to letters, queries, and replies is meant for the general good, and it is not fair to occupy it with questions such as are indicated above, which are only of individual interest, and which, if not advertisements in themselves, lead to replies which are. The "Sixpenny Sale Column" offers a cheap means of obtaining such information, and we trust our readers will avail themselves of it.

The following are the initials, &c., of letters to hand up to Wednesday evening, Aug. 26th, and unacknowledged elsewhere:—

K. B. Williams.—W. F. Stanley.—W. G. Stewart.—W. Hayward.—Foster and Williams.—J. Zaehnsdorf.—J. L. —J. I. S.—A Subscriber.—O. J. L.—Mechanicus.—W. Bundy.—H. Dowsett.—R. Jackson.—Co-Operative. —Young Beginner.—G. A. Bolton.—Chesterfield.—H. —Annie.—J. Martin.—An Ink-wirer.—J. Vinicombe.—P. W. Stanley.—Lancashire.—A. J. D., Cambridge.—Tyrol.—P. W. R.—A Marine Engineer.—John Grant. —M. H.—A Friend of the Bone Shaker.—J. Joslin.

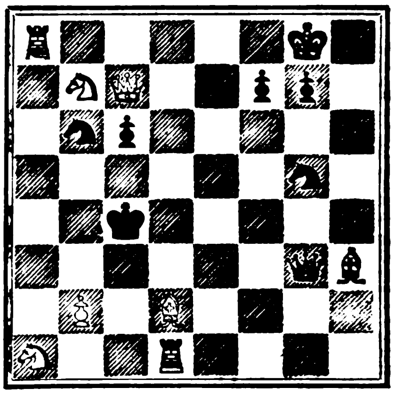
W. (We think you will find a work of the kind published at *The Field* office, Strand, W.C.)—G. Fryer. (The query is unsuitable. No one knows how the people Columbus found in America got there. Probably from China or the North by way of Alaska.)—Jno. J. Latham. (If your signature was "One in Despair," you were answered in the number for Aug. 14, and referred to p. 456. At any rate, as you have taken "the 'E. M.' so long a time," it is strange that you do not seem to be aware that a great deal about loss of hair has been inserted.)—S. B. R. M. (See p. 520, No. 749, for the boot polish or harness blacking.)—S. Thomson. (Scarcely of sufficient interest, and not likely to be answered.)—Walter. (The gas will not get in if the pressure is always 30lb.; but the water is sometimes turned off and then gas enters by the leaks. 2. What a water company is "obliged" to do depends entirely on the special Act under which it works. It is strange that there is no proviso compelling the company to supply water for fire-extinguishing purposes. 3. We believe they are issued by the Queen's printers, East Harding-street, E.C.; but those of the more important are published in the newspapers.)—A Hopeful Student, G. A., H. W. (We have frequently stated that the guide to the Whitworth Scholarships can be obtained from the secretary of the Science and Art Department, South Kensington, price 6d. See answer to "A. M." last week.)—R. B. S. (We believe it is out of print; but ask the booksellers. As a rule they know.)—T. E. W. (Query against the rules; but the agents mentioned are no doubt Wallis, Euston-road, N.W., and Dawkins, Charterhouse-street, E.C.)—Seeker. (Query not suitable, and it is doubtful whethey anyone has taken the trouble to count them.) —J. Slack. (The process you describe is lithography; but copies can be taken in aniline ink from a surface made up of glue 1 part, glycerine 4 parts, and sufficient whiting to colour. See indices for several other copying processes.)—W. M. B. (The numbers are out of print. 2. Vellum is usually understood to be picked skins of parchment, those made from the skins of young animals. The process is described in any cyclopædia.) —An Interested Reader. (It would do for bell-ringing; but the same arrangement is better with caustic potash. See "Tinpot Battery" in indices, and p. 5, No. 885.) — Ignorance. (Query too vague. What is it you wish to know? Electric bells have been described over and over again.) — Hydrogen. (Look in any textbook.)—G. H. (Better purchase a piece; but direction for silvering glass will be found in many back numbers.)—Esse. (Not necessarily, but it seems to be in your case. Why not keep oils of the kind in a well-ventilated place.)—Student. (Cement it on with marine glue or shellac, or rivet it.)—Muneor. (For welding cast steel see p. 338, Vol. XXXV.; pp. 337, 465, Vol. XXXII., and so on. Borax or plaster of Paris is generally used.) —Polisher. (Hydrofluoric. See p. 156, No. 891, and p. 376, No. 927.)—F. E. Baxter. (So far as we know nothing more than a simple writing-pad or book with firm sides, or a portable desk resting on a tripod. Sporting reporters are those who have most occasion to use such appliances, and an application to one of the papers which report racing will probably bring forth the desired information.)—Roots. (Any bookseller can help you to the work you require, for any good arithmetic contains the rules.)—W. J. H. (See a textbook of chemistry. It is a powerful narcotic.)—Allan Kaye. (We do not know of any "work" on the subject; but you can find designs for such machines in our columns.)—Enquirer. (Try "Electric Illumination," by J. Dredge, published at 35, Bedford-street, Covent-garden.)—V. (No book on such a subject, but the processes are described in the cyclopædias.)—A. Madocks. (Ivory black, otherwise "drop black," used with gold size and varnish. Any of the large colourmen will supply you with the article ready prepared.)—Economy. (Of course it would be cheaper, because you would save the manufacturer's profit. Get a catalogue from Barnet and Foster as advertised on front page.)—Escapement. (Price varies according to quality. Inquire of Messrs. Hughes, Drury-lane, W.C.) —M.M.I.Sc.S. (We should think it just the reverse, and that some mistake has been made; but why not write to the paper in which it appeared?)—A Reader. (For a metronome, see p. 216, No. 841.)—Sufferer. (For treatment for jaundice, see pp. 242, 264, 284, 310, 357, 381, Vol. XXXI.)—P. F. (Scrape the horns well, then use powdered charcoal and oil on a bit of rag or leather until the marks of the scraper are removed. Put the final polish on with rouge and water and the hand. Of course, you can use a buff in the lathe, if you have one.)—H. R. H. (It is a swindle, and we have stopped all the advertisements. A warrant is out for the apprehension of the advertiser.)—Ichi Ban. (The name of the firm still appears in the London Directory, but we know nothing of them; and we do not think the correspondent you mention is likely to know much about missing Japanese registered letters.)

# CHESS.

All Communications for this department must be addressed to J. Pierce, Langley House, Dorking.

## PROBLEM DCCCCLIV—Check.

*Black.*



*White.* [9+7

White to play and mate in three moves.

Solution to 952.

| *White.* | *Black.* |
|---|---|
| 1. R-Q 5 | 1. P. takes R (*a*) |
| 2. Kt-Q 4 | 2. Anything |
| 3. Q or P mates | |
| | (*a*) 1. K takes R (*b*) |
| 2. Q takes K P (ch) &c. | |
| | (*b*) 1. Q takes R (*c*) |
| 2. Q-K 3 (ch) &c. | |
| | (*c*) 1. Q-Q 3 (*d*) |
| 2. Q-R 4 (ch) &c. | |
| | (*d*) 1. Q-Q 5 |
| 2. Kt takes Q, &c. | |

## NOTICES TO CORRESPONDENTS.

Correct solutions to 951 by T. L. Robins, F. A. Vincent, and T. Colson (good).

To 952 by H. Culmer, R. A. Bennett, A. A. E. Lecluse, J. A. Miles (very good and difficult), V. S. Pochin, and A. S. Olver (difficult).

To 953 by A. S. Olver (charming), H. Culmer, E. S., J. A. Miles (accurate but easy), Streetgate, and R. A. Bennett.

T. Colson.—In 952, if 1. $\frac{\text{Q takes P}}{\text{Q-Q 5}}$.

A. A. E. Lecluse.—In answer to your second query—on the whole, yes; yes also to third.

The following modification of the rules of proposed New Game Correspondence Tourney, as given in preceding number, may perhaps be more acceptable:

1. That the number of entries should be limited to twelve.
2. Each player to play simultaneously two games with each opponent.
3. The six who have the highest scores to divide the subscription money between them in proportion to the number of games they have won.
4. If a player retire from Tourney before it is concluded, he shall forfeit his entrance fee.
5. If he retire before half the number of his games are played all would be cancelled; if after, those not played would be scored against him.
6. Time limit for each move, two days.
7. Entrance fee, £1.
8. Each player to play two opponents simultaneously.
9. If a game is drawn it counts half to each player.

**Every Workman** connected with the Building Trades requiring a Situation should advertise in "THE BUILDING NEWS," published every FRIDAY, price Fourpence, at 332, Strand, London, W.C.

"THE BUILDING NEWS" is the Principal Journal representing Architects and Builders, and has the largest circulation of any Professional Journal in the kingdom.

Every Workman should insist on seeing "THE BUILDING NEWS" every week at his Club or Coffee House. He will find more "Lists of Tenders" for new work in it every week than in any similar paper, and can thus judge where work is likely to be had. He is also specially invited to make use of "Intercommunication" if he wants to know anything about his trade; to write to the Editor if he has any suggestions to make, and to advertise in the paper when he wants work.

The charge for Advertisements for Situations is One Shilling for Twenty-four Words, and Sixpence for every Eight Words after.

## CHARGES FOR ADVERTISING.

| | s. | d. |
|---|---|---|
| Thirty Words .. .. .. .. .. .. .. | 2 | 6 |
| Every additional eight words .. .. .. .. | 0 | 6 |

Front Page Advertisements Five Shillings for the first 40 words, afterwards 9d. per line. Paragraph advertisements One Shilling per line. No front page or paragraph advertisement inserted for less than Five Shillings. Reduced terms for series of more than 6 insertions may be ascertained on application to the Publisher.

ADVERTISEMENTS in EXCHANGE COLUMN—for

| | s. | d. |
|---|---|---|
| Twenty-four words .. .. .. .. .. .. | 0 | 3 |
| For every succeeding Eight Words .. .. .. | 0 | 3 |

ADVERTISEMENTS in the SIXPENNY SALE COLUMN.

| | s. | d. |
|---|---|---|
| Sixteen words .. .. .. .. .. .. .. | 0 | 6 |
| For every succeeding Eight words .. .. .. | 0 | 6 |

*** It must be borne in mind that no Displayed advertisements can appear in the "Sixpenny Sale Column." All advertisements must be prepaid; no reduction is made on repeated insertions; and in cases where the amount sent exceeds One Shilling, the publisher would be grateful if a P.O.O. could be sent, and not stamps. Stamps, however (preferably halfpenny stamps), may be sent where it is inconvenient to obtain P.O.O.'s

The address is included as part of the advertisement, and charged for.

Advertisements *must* reach the office by 1 p.m. on Wednesday, to insure insertion in the following Friday's number.

## NOTICE TO SUBSCRIBERS.

Subscribers receiving their copies direct from the office are requested to observe that the last number of the term for which their subscription is paid will be forwarded to them in a PINK Wrapper, as an intimation that a fresh remittance is necessary, if it is desired to continue the Subscription.

## TERMS OF SUBSCRIPTION.

### PAYABLE IN ADVANCE.

5s. 6d. for Six Months and 11s. for Twelve months, Post Free to any part of the United Kingdom. For the United States, 13s., or 3 dols. 25c. gold; to France or Belgium, 13s., or 16f. 50c.; to India (via Brindisi), 15s. 2d.; to New Zealand, the Cape, the West Indies, Canada, Nova Scotia, Natal, or any of the Australian Colonies, 13s.

The remittance should be made by Post-office order. Back numbers cannot be sent out of the United Kingdom by the ordinary newspaper post, but must be remitted for at the rate of 4d. each to cover extra postage.

Messrs. JAMES W. QUEEN and Co., of 924, Chestnut-street, Philadelphia, are authorised to receive subscriptions for the United States for the ENGLISH MECHANIC, at the rate of 3 dols. 25c. gold, or Thirteen Shillings per annum, post free. The copies will be forwarded direct by mail from the publishing office in London. All subscriptions will commence with the number first issued after the receipt of the subscription. If back numbers are required to complete volumes, they must be paid for at the rate of 4d. each copy, to cover extra postage.

Vols. IV., VII., XXVI., XXVIII., XXX., XXXII., XXXIII., XXXIV., XXXV., XXXVI., XXXVII., XXXVIII., XXXIX., and XL., bound in cloth, 7s. each. Post free, 7s. 9d.

All the other bound volumes are out of print. Subscribers would do well to order volumes as soon as possible after the conclusion of each half-yearly volume in February and August, as only a limited number are bound up, and these soon run out of print. Most of our back numbers can be had singly, price 2d. each, through any bookseller or newsagent, or 2½d. each, post free from the office (except index numbers, which are 3d. each, or post free, 3½d.)

Indexes for Vols. I., VI., VII., VIII., and IX., 2d. each. Post free 2½d. each. Indexes to Vol. XI. and to subsequent vols., 3d. each, or post free, 3½d. Cases for binding, 1s. 6d. each.

**Holloway's Pills.**—Typhoid and other Fevers may be arrested in their early stages by a course of these purifying Pills. This medicine controls the circulation, lessens the shivering, and modifies the hot periods. Holloway's Pills relax the parched skin, diminish the excessive thirst, clear the furred tongue, and restore to health.

## OUR EXCHANGE COLUMN.

*The charge for Exchange Notices is 3d. for the first 24 words, and 3d. for every succeeding 8 words.*

**Good Value Offered** (cash or instruments) for all kinds of sound or repairable Scientific Appliances.—CAPLATZI, Science Depot, Chenies-street, near British Museum. Established 1862.

Good Treadle **Lathe**, 5in. centre, iron bed, 3ft. 6in., compound slide-rest, 2 division plates, face-plate, drill chuck, boring stay, hand T-rest, tray, and few tools; to make room for larger.

For small **Engine and Boiler** combined, not less than 1½ horse-power, or good drilling machine for power; or small circular saw bench (iron), with saws, to value of £10.—CHAS. ALLEN, 46, High-street, Woolton, near Liverpool.

**Shafting**, 7½ft. 1¼, 4 pulleys, turned, speeded; Polishing Machine, foot power, heavy wheel, cost £4 10s.; Youth's Tricycle, 26in. wheels; exchange; inspection appointment.—SMITH.

**Lathe**, 6ft. oak bed, iron-faced, double crank, 4-speed wheel, turned gut, iron standards; inspection appointment; exchange.—W. SMITH, Bilston-road, Wolverhampton.

Wanted, **Lists**, Engineering, Architectural, and Scientific Books; Civil Engineer's "Proceedings," early vols., "Engineering," any vols. Exchange Instruments or cash.—Z. C., 62, Loddiges-road, Hackney.

Wanted, 1½ Horse-Power **Launch Engine and Boiler**, horizontal. Exchange 54in. "Premier" Bicycle, balls, worth £10, and uniform.—BRYAN, 37, North-street, New Charlton.

What offers for 28 Coloured **Slides**, Zulu War, 3¼ square mahogany frames.—THROP, Bill Poster, Lowmoor, Yorkshire.

Mahogany **Camera**, ½-plate, by Cox, Ludgate Hill, dark slide and portrait lens. Exchange. Great bargain.—OPTIC, 12, Shawbury-road, Dulwich.

Good **Oil Paintings** in exchange for good ½-plate folding Camera, or will copy or paint photographs to full value.—G. KEITCH, Fishponds, Bristol.

Two Old **Water Colour Paintings**, oval shape, signed A. Kauffman, 1790, discoloured but not broken. Want offers in exchange.—G. KEITCH, Fishponds, Bristol.

Wood Turner's **Lathe**, 6in. centres, 2ft. flywheel, 4ft. bed, with few chucks, for Boiler, 1 or 1½ horse-power.—Particulars of BISHOP, Kidderminster-road, Croydon.

**Victoria Camera**, 2 lens, 750 Victoria and Gem mounts, 150 Sheets Albumenised Paper; studio Camera Stand, Ash Tripod do. Offers.—W. SHARPE, Madeley, Salop.

**Nickel Plating Vat**, 12 gallons, quantity of Anodes, Nickel Salts, Batteries, &c., cost over £[illegible]. Offers. J. GRIME, Prospect-street, Hull.

**Omnicycle**, nearly new, cost £26 10s., Butler's latest patent, three different powers. Offers.—J. GRIME, Prospect-street, Hull.

**Hot-Air Engine**, ½ H.P., Buckett's Caloric, new, in perfect working order, cost £[illegible] 10s. Offers wanted.—JOHN GRIME, Prospect-street, Hull.

A **Case of Apparatus and Chemicals** for Blowpipe Analysis, new, cost 21s.; Electric Pin and Battery, cost 25s.; A Ship's Quadrant, in oak case; Light mahogany Tripod Stand. Wanted, Change Wheels or Chucks for 3in. Lathe, or offers.—WALKER, 37, Garnethill-street, Glasgow.

**Pipe Organ**, in polished hardwood case. Exchange for a good Piano or offers.—10, Park Parade, Ashton-under-Lyne.

Wanted, exchange offers for 2 pairs of **Black Fan-tail Pigeons**; also for 10,000 Silkworm's Eggs.—C. BROWN, 16, Marlborough-road, Chiswick.

I will exchange a **Musical Box**, in perfect order, playing 8 tunes, for one broken or out of order.—HAWKINS, 122, Corporation-street, Manchester.

Will exchange some **Long-Flying Tumblers** for Castings of Model Horizontal Engine, 1in. bore, or small bench vice.—L. MORGAN, Swan Inn, Llanelly, Carmarthenshire.

**Camera and Lens**, by Lerebours and Secretan, Paris, tripod stand, bath, dipper, &c. What offers?—GEO. SMITH, 8, Hawthorn-street South, Sunderland.

**Shadbolt's Turn-Table**. "Carpenter's Revelations of the Microscope." The "Northern Microscopic News," four volumes, complete; Doubled Barrelled Gun in case; Cornet a Piston, in case, by Besson, Paris; Shower Bath, with force pump, complete. Wanted, First-class Monocular Microscope and High-power Objectives.—C. PECK, Heaton Moor, Stockport.

Half-horse **Horizontal Engine**, extra strong, with governors, in perfect working order, been working electric light; and cash, for 18 carat curb pattern gold albert. Offers.—T. A. C., Fairfield House, Warrington.

For exchange, one of Ramsbottom's **Double-action Steam Pumps**, 4½ cylinder, 10in. stroke, 2½ ram, in good working order, value £10, for double breechloading gun, in case, with all appliances, or offers.—Apply to F., Victoria-terrace, Bramley, Leeds.

Vols. I. to XIV. "**Mechanic's Magazine**," well bound in leather, 10 vols. "Family Friend," Sir E. Beckett's "Clocks, Watches, and Bells," "Electric Telegraph," in exchange, with cash, for small lathe and tools; lowest price to W., 78, Viaduct-street, London, E.

Also Six-chambered **Revolver**, pin fire, and cartridges; anything useful.—As above.

Wanted, 2 H.-P. **Otto Gas Engine** in good condition; exchange 100 light "Oppermann" Dynamo, cost £90, and cash.—WARNE.

Five-light Oppermann **Dynamo**, with lamps, cost £8 10s. Exchange single stone diamond ring to £6 10s.—WARNE, 39, St. John's-street-road, E.C.

Tough, mild, **Weldable Steel**, ½ to 1in., round or square. Offers requested for large or small quantity.—GILBERT, Orford-road, Sheffield.

New Waltham **Lever Silver Watch**, guaranteed perfect. What offers in exchange, machinery or otherwise?—HARDWICK, Siddals-road, Derby.

Wanted, a good 6-keyed **F Piccolo**, in exchange for a good 6-keyed, ebony D Piccolo.—W. HARTNUP, Junior, Hurst-green, Sussex.

"**English Mechanic**," from Oct. 5, 1883, to present date. Exchange Telescope, Tools, or anything useful.—Offers to J. J. O., Chirton, near Devizes, Wilts.

**50in. Bicycle**, value £5; will take good Timepiece, "Cassell's English History," complete, or what offers?—S. SENIOR, Digley, Holmforth, near Huddersfield.

52in. **Coventry Bicycle**. Exchange; approval on deposit and paying carriage. Worth £5.—C. H. RICHARDS, 3, Portland-road, Colchester.

15in. **Mirror**, about 12ft. focal, capital figure, requires re-silvering. What offers.—5, Stanley-road, Ball's Pond, N.

**Steam Tricycle**, to carry one or two persons, fitted with every requisite, to make room for larger; exchange two-horse Locomotive Boiler, Screw-cutting Lathe, or offers.—WHITEHEAD, 103, Todmorden-road, Burnley.

**Photographic Enlarging Apparatus**, good make, fitted with Ross lens, Solomon's magnesium lamp, &c. Wanted, 1-1 Plate Camera, bellows body, in exchange, or cash.—G. FOXLEY, 3, Percy Villas, Holloway-road, Leytonstone.

Superior **Violin**, labelled "Antonius Stradiurins, Faciebat, 1650," Carved Head, excellent condition, complete, with bow; good reasons for selling, or exchange for poultry.—JAMES ALDERTON, 27, Union-road, Cambridge.

**Microscope**, equal new, by Nachet; six-guinea musical cabinetto; small self-inking printing press, for photographic magic lantern, or useful offers.—BEDE, Belbroughton, Stourbridge.

**Chemical Cabinet**, cost £6, quart copper still, other chemical apparatus, total cost £10; useful offers to £5 accepted.—BEDE, Belbroughton, Stourbridge.

**Books.**—"**The Circle of Science**," 10 volumes, first-class books, £1 10s. For lathe about 4in. centres, 3ft. bed, or cash offers.—B. MARTIN, New Humberstone, Leicester.

**Photo. Apparatus**, Lancaster's ¼ Merveilleux complete, with lamp, dishes, measure, chemicals, frame, &c., nearly new, 20s. What offers?—To G., 204, Devonshire-street, London, E.

## THE SIXPENNY SALE COLUMN.

*Advertisements are inserted in this column at the rate of 6d. for the first 16 words, and 6d. for every succeeding 8 words.*

**Motor Castings**, materials for Electric Bells, Batteries, Galvanometers, Intensity Coils, Microphones.—KING, MENDHAM, and Co., Bristol.

**Insulated Wire Table**, showing size, weight, resistance per foot, feet per ohm, &c., price 3d.—KING, MENDHAM, and Co., Bristol.

**Standard Ohm**, in box, copper poles, guaranteed correct to ten thousandth of ohm, 21s.—KING, MENDHAM, and Co., Bristol.

Wimshurst **Influence Machine**.—Sole Manufacturers of Improved Pattern. Numerous testimonials as to thorough efficiency.—KING, MENDHAM, and Co., Bristol.

**Galvanometer Cards**, improved for tangent and ordinary combined, 2½in., 8d.; 4in., 1s.; 6in., 1s.; post free.—As above.

Write for **King, Mendham, and Co.'s** large new and reduced Price List, post free 4 stamps.

**Trouser Lengths**, 5s. each. Cheap Cloth for Ladies' Dresses, Mantles, Boys' Suits.—HEWITT, 27, Windfield Mount, Leeds. Patterns free.

**Electric Depot**, 10, Deansgate, Manchester.—Electric Breast Pins, 2s. Electric Bells, 4s. Induction Coils, 5s.—MILLAR, Proprietor.

New Illustrated Price List of **Screws, Bolts, and Nuts** for Model Work, drawn to actual size, sent on receipt of stamp.—MORRIS COHEN, 132, Kirkgate, Leeds.

**Do we get Heat from the Sun?** No! How the Body is Warmed. Spontaneous Combustion accounted for. Eight reasons showing the fallacy of this popular delusion. By R. HUMPHREYS. Stamps 1½d.—11, Cambria-street, King's-road, Fulham, S.W.

**Lathes. Lathes.** Cheap and good. Satisfaction guaranteed. List two stamps. Best make.—ROBINSON, Catherine-street, Sheffield.

**Fretwork.**—Catalogue of every requisite, with 600 illustrations, free for 6 stamps.—HARGER BROS., Settle, Yorks.

**Planing**, not exceeding 10in. by 10in. by 8in.—B. W. CLEGG, 18, Belinda-street, Hunslet, Leeds.

For **Model Work** (wheel-cutting in brass only); also Boring, Turning, and Screwcutting.—CLEGG, as above.

**Mesmerism.**—Complete written instructions. Success guaranteed. Fee, 2s. 6d.—PROFESSOR, 22, Clarendon-road, Anfield, Liverpool.

**Forges**, portable, quite new, circular and square, from 50s. each; bargains.—LOWE, Wallis-road, Hackney Wick.

**Hammond's Patent Mitre Frame Cramp** is the best, cheapest, and quickest Cramp for all mitre frame makers; it cramps the four mitres in one action, and so arranged that they can be nailed at the same time; price 22s.; sent on receipt of money orders payable to G. R. HAMMOND, Snodland, Kent. Diagram sent on application.

**Optical Glass** of finest quality, crown and flint; all sizes in stock to 14 inches diameter, discs and sheet.—BUCKINGHAM, Blenheim-grove, Peckham.

**Lathe Castings, &c.**—See T. Taylor's advertisement in ENGLISH MECHANIC every other week. Established 1847.

**Magic Cube.**—"A marvel of ingenuity."—*Science Monthly.* Post free, 1½d.—JAMES CRAM, Euclid-crescent, Dundee.

**Type**, Leads, Brass-Rule, Wood Letter, Chases, &c., cheap.—J. BROWNING, Stationer, 55, Rhodeswell-road, Limehouse, E.

Pin-hole **Photographs**, new subjects. Lists free. The trade supplied.—DANCER, 53, Hamstead-road, Handsworth, Birmingham.

**Opera and Field-Glasses** wonderfully cheap, and good. List free.—DANCER, 53, Hamstead-road, Handsworth, Birmingham.

**Incandescent Lamps** (carbon), 2 to 8 candle-power, 2s. 6d. Trade supplied. Swan's 20 c.p., 4s. 6d.—PATRICK.

**Arc Lamps**, several second-hand, £2 each. Powerful Motor or Dynamo, £3; ditto, superior, £4 10s. Clearing out.

**Illustrated List** of Electrical Apparatus, 2 stamps.—PATRICK and SONS, 539, King's-road, Chelsea, S.W.

Genuine **Waltham Lever Watches**, in English Hall-marked Silver Cases, with crystal glass, perfect timekeepers, 40s. each; free on receipt of P.O. One week's free trial; money returned in full if not satisfactory.—JOHN J. DENT, Wrawby-street, Brigg.

Humber **Tricycle**, nearly new, perfect condition, adjustable saddle and handles, cash £13 10s.—150, London-road, Sheffield.

**Gold and Silver Fish**, 12 for 5s. Fish Carrier, Plants, Snails, Shingle included. Stamped addressed envelope for inquiries, or illustrated price list of Fish, Reptiles, Amphibia, &c., from every part of the globe.—Zoological Exhibition, 177, Euston-road, N.W.

**Ivory Carvings**, a fine Collection on sale. Can be seen on presenting card.—Mr. LEE, 95, King's-road, Camden-road, N.W.

**Carbon Plates**, best quality, cut and moulded, plain and capped; quality cannot be surpassed.—GEO. G. BLACKWELL.

**Pebble Carbon.**—Graphite for Leclanché cells, splendid conductor; price very low.—GEO. G. BLACKWELL.

**Manganese Oxide**, specially prepared for Leclanché batteries; high strength and purity, greater E.M.F., constant action; been in use 15 years with immense satisfaction; 7, 14, 28lb. packets. Prices on application.—GEO. G. BLACKWELL, 26, Chapel-street, Liverpool.

**Microscopic Cabinets**, mahogany, hold two gross, flat, 25s.; Folding Glass Doors, 30s.—158, Newtown-row, Birmingham.

Crouch's **Binocular Microscopes**. A few exchanges for sale, perfect condition.—66, Barbican, E.C.

**Model Steam Engines** of all kinds made or repaired; separate parts fitted up; boilers made to order; sets of castings of every description. Price list post free, 2d.—LUCAS AND DAVIES, 21, Charles-street, Hatton-garden, London, E.C.

Steel **Name Stamps**, 3d. per letter. Figures (set), 2s. 4d. Letters, 6s. 4d., per post.—E. F. BALDWIN, Robinswood-hill, Gloucester.

**Sixpenny Telegrams.**—Before entering the Telegraph Service have home practice with your own instruments. 30s. set.

**Sixpenny Telegrams.**—Sounder and Key, on mahogany board, full size, 30s. set.—SLEDGE, WYATT, and Co., Clapham.

**Sixpenny Telegrams.**—These instruments can be seen and tried at our office.—SLEDGE, WYATT, and Co., Clapham.

**Sixpenny Telegrams.**—Every set warranted complete, and sent free on receipt of P.O. 30s.—S., W., and Co., Clapham.

**Sixpenny Telegrams.**—Sounder is Post Office Pattern and highly finished, with silk-covered coils, 20s. set.

**Sixpenny Telegrams.**—Every telegraphic clerk should possess a set for home practice.—SLEDGE, WYATT, and Co., Clapham.

**Sixpenny Telegrams.**—We are making these sets expressly for Students of Telegraphy.—SLEDGE, WYATT, and Co.

**Sixpenny Telegrams.**—SLEDGE, WYATT, and Co., Electrical Engineers, 95, Wirtemburg-street, Clapham, S.W.

**Sixpenny Telegrams.**—Number of vacancies will occur for Telegraphic Clerks. Practise at home. Ensure success.

**Sixpenny Telegrams.**—Sounder Set, 30s.—SLEDGE, WYATT, and Co., 95, Wirtemburg-street, Clapham, S.W.

**Water Waste Preventers**, all brass fittings, especially made for strength, 24s.—KNIGHT, Reading-road, Basingstoke.

Valuable **Invention** for Making Waggon Wheels. Large profits guaranteed, by cast iron.—W. LEITH, Glengarnock, Ayrshire.

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